U.S. Fish & Wildlife Service

Recovery Plan for the Sonoran Pronghorn

(*Antilocapra americana sonoriensis*)

Second Revision

Sonoran pronghorn. Photograph by Jim Atkinson, U.S. Fish and Wildlife Service.

November 2016

RECOVERY PLAN FOR THE
SONORAN PRONGHORN
(*Antilocapra americana sonoriensis*)
SECOND REVISION

Original Version: 1982
First Revision: 1998, Amended 2002

Prepared for:
Region 2, Southwest Region
U.S. Fish and Wildlife Service
Albuquerque, New Mexico

Approved: Joy E Nicholopoulos

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A draft of this recovery plan was made available through a Federal Register notice published on July 2, 2015. Comments received from the public and peer-reviewers were considered in finalizing this revised recovery plan. FWS responses to comments can be found at https://www.fws.gov/southwest/es/arizona/Sonoran_Pronghorn.htm.

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Primary authors of this plan are Terry Frederick of Harris Environmental Group; and Jim Atkinson and Erin Fernandez of the FWS. We appreciate the assistance of Phil Miller in developing the population viability analysis. We thank Paul Krausman of the University of Montana; and Wendy Brown (retired 2014), Julie McIntyre, Brenda Smith, and Sarah Rinkevich of U.S. Fish and Wildlife Service for their valuable insights and edits to the plan. Francisco "Paco" Abarca, International and Borderlands Program Manager of Arizona Game and Fish Department, provided essential background information on Mexican agencies, laws, and policies. We thank Phil Miller and Luis Carrillo of the Conservation Breeding Specialist Group for facilitating meetings; Kevin Clark of the San Diego Natural History Museum for providing information and maps for the California reintroduction areas; Ami Pate of Organ Pipe Cactus National Monument for developing figures of the mines in Mexico; Lirain Urreiztieta of Harris Environmental Group for developing the range maps and management unit maps; and Jorge de Jesús Cancino Hernández of Centro de Investigaciones Biológicas del Noroeste for providing information on pronghorn management in Baja California. Thank you to Pete Sorensen of the Palm Springs Fish and Wildlife Service Office, Region 8, for coordinating with us on and reviewing the draft recovery plan and providing edits on portions of the plan relating to the potential California Reintroduction Unit. Thank you to the peer reviewers for your valuable comments on the Draft Recovery Plan: Josef Warman, Espacios Naturales y Desarrollo Sustentable A.C.; Alberto Lafon, Protection de la Fauna Mexicana; Dave Christianson, University of Arizona; John Winnie Jr., Montana State University; and Tim Tibbitts.

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EXECUTIVE SUMMARY

CURRENT SPECIES STATUS

The Sonoran pronghorn (*Antilocapra americana sonoriensis*) was included on the first list of endangered species in 1967 under the Endangered Species Preservation Act, and is currently listed as endangered throughout its range, without critical habitat, under the Endangered Species Act. It is also listed as an endangered species in Mexico by the Mexican Government. The Sonoran pronghorn is one of four extant subspecies of pronghorn, which are endemic to western North America. The first Sonoran Pronghorn Recovery Plan was completed in 1982; this is the second revision. The species' current recovery priority number is 3, indicating the subspecies has a high degree of threat and a high potential for recovery.

HABITAT REQUIREMENTS AND THREATS

Sonoran pronghorn are found exclusively in the Lower Colorado River Valley and the Arizona Upland subdivisions of the Sonoran Desertscrub Biome and currently occur in southwestern Arizona and northwestern Sonora, Mexico. In winter, Sonoran pronghorn prefer sparsely-vegetated, flat, open spaces that are ideal for swift running and visual detection of predators. However, in summer they require denser vegetation that offers thermal cover and moister forage. A mix of these vegetation types is essential to enable Sonoran pronghorn to use the most suitable vegetation type for the season. Sonoran pronghorn move nomadically in response to changing forage conditions and water availability as a result of sporadic rainfall. They require large expanses of contiguous habitat to make these movements and to persist in the harsh desert environment. They also require quality forage, access to water, a mosaic of suitable vegetation structure, and minimal human disturbance.

Threats to Sonoran pronghorn include habitat loss and fragmentation, reduced forage quality, altered habitat structure, extended drought and climate change, reduced access to and availability of water, predation, disease, loss of genetic diversity, human disturbance, and high mortality rates due to accidental death or poaching. Although all threats exist across the range of Sonoran pronghorn, the threats of habitat loss and habitat fragmentation are greatest in Sonora, Mexico, where much of the habitat is privately or communally-owned. The impetus for this revision of the recovery plan is new information obtained on Sonoran pronghorn, new identified threats to the species, and new management efforts. The recommendations in this second revised recovery plan focus on management to reduce and remove threats across the range of Sonoran pronghorn and supersede those presented in the 1998 recovery plan.

RECOVERY STRATEGY

The recovery strategy is to secure a sufficient number of Sonoran pronghorn populations that are viable under appropriate management scenarios within select areas throughout their historical range. In recognition of the binational distribution of the species, and the unique challenges and opportunities this presents, two conservation units for the species have been designated, one in the United States and one in Mexico. The U.S. Conservation Unit is located in Arizona and California and includes the historical range of Sonoran pronghorn in the United States. The Mexico Conservation Unit includes the historical range of Sonoran pronghorn primarily in the Mexican state of Sonora. Within these conservation units there are management units, including the Cabeza, Arizona Reintroduction, and California Reintroduction Management Units in Arizona and California; and the Pinacate, Quitovac, and Sonora Reintroduction Management Units in Sonora.

RECOVERY GOAL, OBJECTIVES, AND CRITERIA

The recovery goal is to conserve and protect the Sonoran pronghorn and its habitat so that its long-term survival is secured, populations within the conservation units are capable of enduring threats, and it can be removed from the list of threatened and endangered species (delisted). To achieve this goal, this draft recovery plan identifies the following objectives:

1. Ensure multiple viable populations of Sonoran pronghorn rangewide.
2. Ensure that there is adequate quantity, quality, and connectivity of Sonoran pronghorn habitat to support populations.
3. Minimize and mitigate the effects of human disturbance on Sonoran pronghorn.
4. Identify and address priority monitoring needs.
5. Identify and conduct priority research.
6. Maintain existing partnerships and develop new partnerships to support Sonoran pronghorn recovery.
7. Secure adequate funding to implement recovery actions for Sonoran pronghorn.
8. Practice adaptive management, in which recovery is monitored and recovery tasks are revised by the Service in coordination with the Sonoran Pronghorn Recovery Team as new information becomes available.

Downlisting Criteria: Six criteria must be met to downlist Sonoran pronghorn from endangered to threatened:

1. At least three free-ranging populations are viable. Two of these must be the Cabeza Prieta population and either the Quitovac or Pinacate population. The Recovery Team defines a viable population as one that has less than a 10% probability of extinction over 50 years and a growth rate that is stable or increasing. Furthermore, at least one new population must have been released, in addition to the Kofa subunit (e.g., Sauceda subunit).

   A population viability analysis (PVA) estimated abundance targets to meet the Recovery Team definition of viability, which is different for each management unit due to different environmental conditions. To be considered viable, a population estimate must meet or exceed the abundance targets and demonstrate a population growth rate that is stable or increasing (r $\geq$0) for at least five of seven years[1]. Abundance targets for each management unit are estimated from the PVA to be: a) 225 in the Cabeza Prieta Management Unit; b) 150 in the Kofa subunit or a new subunit (Sauceda or other future established subunit); c) 150 in the Pinacate Management Unit; and d) 450 in the Quitovac Management Unit. These population sizes must be estimated by monitoring (i.e., aerial surveys).

2. Within the Cabeza Prieta Management Unit, Pinacate Management Unit, Quitovac Management Unit and the Kofa and Sauceda subunits of the Arizona Reintroduction Management Unit, a minimum of 90% of current Sonoran pronghorn habitat within each unit is retained and contiguous. This Sonoran pronghorn habitat is protected through agency policies, land use regulations and plans, landowner agreements, incentives, and/or other programs and agreements. The 90% of retained and contiguous Sonoran pronghorn habitat includes key habitat features such as water sources.
3. Threats to Sonoran pronghorn habitat quality in three units are stabilized or decreasing as measured by indicators described in Appendix E. Threats must be stabilized or decreased in the three management units that correspond to the three populations that meet the population viability criteria in Recovery Criteria number 1. In particular, the threats of overgrazing; unauthorized routes, roads and trails; invasive plant and animal species threatening Sonoran pronghorn habitat; and spread of shrubby vegetation are minimized through agency policies, land use regulations and plans, landowner agreements, incentives, and/or other programs and agreements.
4. Within the Cabeza Prieta Management Unit, Pinacate Management Unit, Quitovac Management Unit, and the Kofa and Sauceda subunits of the Arizona Reintroduction Management Unit, human disturbance is alleviated such that a minimum of 90% of Sonoran pronghorn habitat can be occupied by Sonoran pronghorn.
5. Genetic diversity for three populations, as measured by heterozygosity and allelic richness for nuclear DNA markers, has been retained from levels indicated in Culver and Vaughn (2015). These three populations must meet the threshold of viability as described in Downlisting Criterion 1. The minimum level of heterozygosity of any of the three populations must be 49% (i.e., within 20% of the average heterozygosity of population segments (10) estimated by Culver and Vaughn (2015)). The minimum level of allelic richness of any of the three populations must be 1.96 (i.e., within 20% of the average allelic richness of population segments (10) estimated by Culver and Vaughn (2015)).

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[1] As of 2016, aerial surveys to estimate Sonoran pronghorn population size alternate between the Cabeza Prieta population and the Mexico populations (Pinacate and Quitovac), so that each of these populations is surveyed every other year. Therefore, population estimates will be determined from surveys (in survey years) or the average between the previous and following year's survey estimate (in non-survey years). For information on how population estimates and confidence intervals are calculated, please see the *Recent Population Trends – Arizona* section of this plan.

6. Effective federal, state, tribal, and/or local laws are in place in the recovery conservation units that ensure that killing of Sonoran pronghorn is prohibited or regulated such that viable populations of Sonoran pronghorn can be maintained and are highly unlikely to need the protection of the ESA again.

Delisting Criteria: Once the Sonoran pronghorn is downlisted to threatened, the following criteria must be met before the species can be delisted:

1. At least three free-ranging populations are viable. Two of these must be the Cabeza Prieta population and either the Quitovac or Pinacate population. The Recovery Team defines a viable population as one that has less than a 10% probability of extinction over 50 years and a growth rate that is stable or increasing. Furthermore, at least one new population must have been established, in addition to the Kofa subunit (e.g., Sauceda subunit). Established means that the population is stable and is no longer in need of augmentation from a captive breeding program.

   A PVA estimated abundance targets to meet the Recovery Team's definition of viability, which is different for each management unit due to different environmental conditions. To be considered viable, a population estimate must meet or exceed the abundance targets and demonstrate a population growth rate that is stable or increasing ($r \geq 0$) for at least 10 of 14 years[1]. Abundance targets for each management unit are estimated from the PVA to be: a) 225 in the Cabeza Prieta Management Unit; b) 150 in the Kofa subunit or a new subunit (Sauceda or other future established subunit); c) 150 in the Pinacate Management Unit; and d) 450 in the Quitovac Management Unit. These population sizes must be estimated by monitoring (i.e., aerial surveys).

2. Delisting criteria 2-6 are the same as downlisting criteria 2-6.

ACTIONS NEEDED

Actions were developed for each objective. Primary actions include using captive breeding to increase and stabilize existing populations, as well as to establish new populations; protecting habitat; assuring forage and water availability; reducing human disturbance; conducting research and monitoring; and working with partners to implement recovery projects in the U.S. and Mexico.

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[1] As of 2016, aerial surveys to estimate Sonoran pronghorn population size alternate between the Cabeza Prieta population and the Mexico populations (Pinacate and Quitovac), so that each of these populations is surveyed every other year. Therefore, population estimates will be determined from surveys (in survey years) or the average between the previous and following year's survey estimate (in non-survey years). For information on how population estimates and confidence intervals are calculated, please see the *Recent Population Trends – Arizona* section of this plan.

TOTAL ESTIMATED COST OF RECOVERY

The Implementation Schedule provides the estimated costs of implementing recovery actions for the first five years after the release of the recovery plan, as well as the total cost of recovery. Annual cost estimates are as follows:

Year 1 = $3,880,880
Year 2 = $1,788,570
Year 3 = $2,573,990
Year 4 = $2,576,760
Year 5 = $3,147,450

The estimated cost to implement this plan for the first 5 years is $ 13,967,645.

Continual and ongoing costs, as well as the estimated total cost, are based on the projected timeframe of 20 years to recovery and delisting of the species. The total cost to implement this plan through the year 2036, the estimated recovery date of Sonoran pronghorn, is $27,340,950.

DATE OF RECOVERY

The estimated date of recovery is 2036.

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ACRONYMS AND ABBREVIATIONS

ac	Acres
AGFD	Arizona Game and Fish Department
ANP	Areas Naturales Protegidas (Natural Protected Areas)
ARNG	Army National Guard
BLM	Bureau of Land Management
BMGR	Barry M. Goldwater Range
CBP	Customs and Border Protection
CEDES	Comisión de Ecologia y Desarrollo Sustentable del Estado de Sonora (Commission of Ecology and Development of the State of Sonora)
CFR	Code of Federal Regulations
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CONABIO	Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (The National Commission for Knowledge and Use of Biodiversity of Mexico**)**
CONAFOR	Comisión Nacional Forestal (National Forestry Commission of Mexico)
CONANP	Comisión Nacional de Areas Naturales Protegidas (National Commission of Protected Areas of Mexico)
Cabeza Prieta NWR	Cabeza Prieta National Wildlife Refuge
dBA	A-weighted decibels. The relative loudness of sounds in air as perceived by the human ear.
DGVS	Dirección General de Vida Silvestre (Mexican Federal Office of Wildlife)
Ejido	Communally-owned land in Mexico
ESA	Endangered Species Act
ft	feet
FR	Federal Register
FWS	United States Fish and Wildlife Service
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
ha	hectares
IPCC	Intergovernmental Panel on Climate Change
km	kilometers
Kofa NWR	Kofa National Wildlife Refuge
m	meters
mi	miles
MCAS Yuma	Marine Corps Air Station Yuma
NEPA	National Environmental Policy Act

NOM	Norma Oficial Mexicana (Mexican federal law)
NWR	National Wildlife Refuge
OHV	Off-highway Vehicle
Organ Pipe Cactus NM	Organ Pipe Cactus National Monument
PACE	Programa de Acción Para la Conservación de la Especie (Species Conservation Action Plan – Mexico's equivalent of a recovery plan)
PROCER	Programa de Conservación de Especies en Riesgo (At-risk Species Conservation Program of Mexico)
PROCODES	Programa de Conservación para el Desarrollo Sostenible (Sustainable Development Conservation Program of Mexico)
PROFEPA	Procuraduría Federal de Proteccion del Ambiente (Mexican Federal agency of environmental protection)
PVA	Population Viability Analysis
RMP	Resource Management Plan
SAGARHPA	Secretaría de Agricultura, Ganadería, Recursos Hidráulicos, Pesca y Acuacultura (State of Sonora Ministry of Agriculture, Water Resources, Fisheries and Aquaculture)
SAGARPA	Secretaría de Agricultura, Ganaderia, Desarrollo Rural, Pesca, y Alimentación (Federal Ministry of Livestock, Agriculture, Rural Development, Fisheries, and Foods of Mexico)
SEMARNAT	Secretaría de Medio Ambiente y Recursos Naturales (Federal Ministry of the Environment and Natural Resource of Mexico)
UMA	Unidades para la Conservación, Manejo y Aprovechamiento Sustentable de la Vida Silvestre (Wildlife Conservation, Management, and Sustainable Utilization Units in Mexico)
USBP	United States Border Patrol
YPG	Yuma Proving Ground

PART I. BACKGROUND

The Endangered Species Act of 1973 (ESA), as amended, requires preparation of recovery plans for listed species. A recovery plan presents a set of recommendations for the listed species endorsed by the U.S. Fish and Wildlife Service (FWS). This recovery plan was prepared for the FWS with direction and assistance from the Sonoran Pronghorn Recovery Team (Recovery Team). It establishes recovery goals and objectives for the listed species, describes site-specific recovery actions recommended to achieve those goals and objectives, estimates the time required for recovery, estimates the cost of recovery, and identifies partners and parties responsible for implementation of recovery actions.

Recovery plans are neither self-implementing nor legally binding. Recovery plans constitute a FWS guidance document on the listed species or group of species. They outline a logical path from what is known about the species' biology, life history, and threats to a recovery strategy and program. In some cases, recovery plans are followed by other federal agencies to meet the provisions of sections 2(c)(1) and 7(a)(1) of the ESA, which require federal agencies to use their authorities in carrying out programs for the conservation of endangered and threatened species. Recovery recommendations are based on resolving the threats to the species and ensuring self-sustaining populations in the wild.

A recovery plan was first prepared for the Sonoran pronghorn (*Antilocapra americana sonoriensis*) in 1982, and was revised in 1998. In the case *Defenders of Wildlife, et al., v. Bruce Babbitt, et al.* (Civil Action No. 99-927 [ESH]) the United States District Court for the District of Columbia ruled that the FWS was acting arbitrarily and capriciously and contrary to law by failing to establish: 1) objective, measureable criteria or an explanation why such criteria are not practicable; and 2) estimates of the time required to carry out those measures needed to achieve the plan's goal or, if such estimates are not practicable, an explanation of that conclusion. The court remanded the recovery plan back to FWS to correct. In 2002, a supplement and amendment to the 1998 Recovery Plan was published that used the downlisting criteria from the 1998 plan and provided an explanation for why delisting criteria were not practicable at that time. The supplement and amendment also discussed new information on Sonoran pronghorn biology and discussed the reasons for listing using the five factors required under Section 4(a)(1) of the ESA; these had not previously been applied to the Sonoran pronghorn because it was originally listed before the ESA was in effect.

In summer 2002, the U.S. population of Sonoran pronghorn was almost extirpated (there were only 21 individuals in the population; see Population Trends and Distribution section) due to the most severe drought on record in southern Arizona, the effects of which were exacerbated by other threats, including restriction of available habitat, rapid increase in border-related human disturbance, and others. Sonoran pronghorn in Mexico did not decline as severely in the same year (285 individuals in the population; see Population Trends and Distribution section). In response to the near extirpation of the U.S. population, the FWS, Arizona Game and Fish Department (AGFD) and other cooperating agency partners began intensive conservation actions, including construction of water developments and forage enhancement plots, supplemental feeding, and a captive breeding program in the U.S. Active management efforts were not implemented in Mexico at that time. The captive breeding program on Cabeza Prieta National Wildlife Refuge (Cabeza Prieta NWR) has been successful in producing animals for release, and the Recovery Team subsequently initiated the establishment of two nonessential experimental populations under section 10(j) of the ESA on Kofa NWR and BMGR East (east of Highway 85) using pronghorn from the Cabeza Prieta NWR captive breeding pen. The nonessential experimental (10(j)) population area also includes other unoccupied areas within Sonoran pronghorn historical range. The impetus for this revision of the recovery plan is new information obtained on Sonoran pronghorn, new identified threats to the species, and new management efforts.

This revised plan addresses Sonoran pronghorn throughout its range in Mexico and the U.S., including suitable areas of its historical range within the U.S. where additional population establishment is ongoing or proposed. The revised plan establishes recovery goals and objectives; and provides objective, measurable criteria for downlisting and delisting the species. It also incorporates expanded threats and viability analyses; and includes existing, expanded, and new site-specific management and recovery actions that emphasize habitat management. It estimates time and cost required for recovery, identifies partners and parties responsible for implementation of recovery actions, and identifies gaps in the information needed for management and recovery.

Brief Overview/Status of the Species

Current Status of the Species

The Sonoran pronghorn subspecies is recognized by a number of federal, state, and international listings. The subspecies is currently listed as an endangered species throughout its range under the ESA. The subspecies was included on the first list of endangered species on 11 March 1967 (Office of the Secretary 1967), under the Endangered Species Preservation Act of 15 October 1966, a predecessor of the ESA. When the ESA was signed into law in 1973, the Sonoran pronghorn was placed on the list under section 4(c)(3) of the ESA as an endangered species through the “grandfather clause”, which provides that: “(A)ny list in effect on the day before the date of the enactment of this Act of species of fish or wildlife determined by the Secretary of the Interior, pursuant to the Endangered Species Conservation Act of 1969, to be threatened with extinction shall be republished to conform to the classification for endangered species or threatened species, as the case may be, provided for in this Act, but until such republication, any such species so listed shall be deemed an endangered species within the meaning of this Act.” As a consequence of the “grandfather” clause [Section 4(c)(3)] in the ESA, formal listing factors were never established or required for Sonoran pronghorn to be listed under the ESA. These factors were later described in the 2002 supplement to the 1998 recovery plan (U.S. Fish and Wildlife Service 2002).

The species’ current recovery priority number is 3 (U.S. Fish and Wildlife Service 2010a), indicating the subspecies has a high degree of threat and a high potential for recovery (U.S. Fish and Wildlife Service 1983). A 5-year review that would result in recommendations concerning whether the species should remain listed as endangered, down-listed to threatened, or delisted has not yet been completed.

In addition to the U.S. ESA listing, the Secretaría de Medio Ambiente y Recursos Naturales (Federal Ministry of the Environment and Natural Resource; SEMARNAT) lists the pronghorn as endangered in Mexico (Secretaría de Medio Ambiente y Recursos Naturales 2010). This listing is for the entire species and includes all subspecies within Mexico, including the Sonoran pronghorn, peninsular pronghorn (*A. a. peninsularis*), and Mexican pronghorn (*A. a. mexicana*; SEMARNAT 2010). All subspecies of *Antilocapra americana* are listed on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix 1, but only populations in Mexico are included (Convention on International Trade in Endangered Species of Wild Flora and Fauna 2014).

Sonoran pronghorn in Arizona are also on AGFD’s list of “Species of Greatest Conservation Need” (Arizona Game and Fish Department 2012). The species is protected by Arizona state law (A.R.S. 17-314), and anyone convicted of unlawfully wounding or killing, or unlawfully possessing an endangered species of wildlife may be subject to civil action by the Arizona Game and Fish Commission in the form of license revocation and a minimum fine.

Factors believed to have caused the decline of Sonoran pronghorn in the U.S. and Mexico include: unrestricted hunting; livestock grazing; prolonged drought; and habitat fragmentation by fences, railroads, highways, and canals (U.S. Fish and Wildlife Service 2010b), and possibly disease transmitted by livestock. The Arizona population of Sonoran pronghorn was nearly extirpated by a severe drought of 2002 when 80% of the collared pronghorn died (Bright and Hervert 2005). The Recovery Team and partners enacted emergency conservation measures for the Sonoran pronghorn in Arizona as a result of this drought. The measures included supplemental feeding, supplemental watering, and establishment of a captive breeding pen at Cabeza Prieta NWR. By 2011 FWS published a final rule to establish a second population in historical habitat on the Kofa National Wildlife Refuge (Kofa NWR) and the Barry M. Goldwater Range East (BMGR East) as a nonessential experimental population (U.S. Fish and Wildlife Service 2011a). Sonoran pronghorn were released into this nonessential experimental population on Kofa NWR in 2013, 2014, and 2015. Sonoran pronghorn were released into BMGR East (east of Highway 85) in 2015. Additional releases may occur in the future as needed. Declines in the two Sonoran pronghorn populations in Mexico have also occurred, but have not been as severe and have not resulted in major management changes.

Species' Description and Taxonomy

Description

Pronghorn are endemic to western North America (O'Gara 1978) and are placed within the Family Antilocapridae in Order Artiodactyla, the even-toed ungulates. The Family Antilocapridae, found only in North America, contains only one genus, *Antilocapra,* which in turn contains only one species, the pronghorn. The O'odham name for pronghorn is Ku:vid (or Kukuvid plural). Throughout this document we use the common name "pronghorn" for the species as a whole, including all subspecies, and "Sonoran pronghorn" for the subspecies *Antilocapra americana sonoriensis*.

Pronghorn have slightly curved horns; the males usually have a single prong projecting forward. The horns have a straight bony core and sheaths of fused hairs, which are shed and replaced annually (Hoffmeister 1986). Coat color varies from yellowish to tan, with some white markings, except for black on the top of the nose (Hoffmeister 1986). Pronghorn are the only artiodactyls with pronged horns and horn sheaths that are shed annually (Hoffmeister 1986). The dental formula of pronghorn is I 0/3, c 0/1, p 3/3, m 3/3 (O'Gara 1978).In the field, pronghorn exhibit unique burnt apricot and white coloration, a spindle-legged silhouette, and long, pronged black horns in males (Brown and Ockenfels 2007). They are white on the underparts, and in patches on the lower face, throat, below the ears, rump, and in two triangular neck bands (Brown and Ockenfels 2007). Pronghorn are easily distinguished from other ungulates within their range. Bighorn sheep (*Ovis canadensis*) have massive coiled horns and do not have white bands across the throat; mule deer (*Odocoileus hemionus)* have black on the tail, and no white along sides; white-tailed deer (*Odocoileus virginianus)* do not have a white rump patch, and do not have white along the sides (Arizona Game and Fish Department 2002). Pronghorn are the swiftest terrestrial mammals in the New World. Kitchen (1974) recorded herds moving at 64 to 72 kilometers (km) per hour (40 to 45 miles per hour [mph]) with maximum speeds of 86.5 km per hour (54 mph).

Morphology

The Sonoran pronghorn is one of four extant subspecies of pronghorn (Stephen et al. 2005). Other pronghorn subspecies are the American pronghorn (*A. a. americana*), Mexican pronghorn (*A. a. mexicana*), and the peninsular pronghorn (*A. a. peninsularis*). The Sonoran pronghorn was described in 1945 from morphological traits of primarily one specimen, the type specimen was an adult female skin and skull collected 40 miles north of Costa Rica, Sonora, Mexico. Goldman considered a second specimen, the skull of a female collected at Crittenden, near Sonoita, Arizona, which shared some characters with the type specimen, to be of the same form

(Goldman 1945). However, he stated on geographic grounds individuals in southeastern Arizona would be expected to exhibit gradation towards *A. a. mexicana*. Original morphological analysis conferred subspecific status to the Sonoran Desert race of pronghorn based on smaller size and paler color of the type specimen compared to other subspecies (Goldman 1945). The Sonoran pronghorn skull is narrower than that of other subspecies in mastoidal, orbital, and zygomatic width; the rostrum is narrow; the frontal depression is not pronounced; and auditory bullae are small, but variable (Hoffmeister 1986). Paradiso and Nowak (1971) examined four males from near Carborca, Sonora, a female from Crittenden, Arizona, and the type specimen and concluded that the six individuals are more distinct from other subspecies of pronghorn than from each other. However, the morphological differences observed by Goldman may have been due primarily to the smaller-than-average size of the type specimen (Hoffmeister 1986).

Genetics and Taxonomy

In recent genetic work, Stephen et al. (2005) did not find support for subspecies status for the Sonoran pronghorn in mitochondrial DNA sequence and microsatellite data, yet they found that all populations, including the Sonoran pronghorn, possessed unique haplotypes and microsatellite alleles not found in other populations. In addition, the combined (concatenated) dataset of mitochondrial DNA and microsatellite alleles showed differentiation of the two Sonoran populations and the remainder of the populations sampled for both F_{ST} and G_{ST}. F_{ST} is a test for subdivision between two subpopulations; G_{ST} is a similar measure but corrected for small and inbred populations. This difference between the two populations could be due to a series of bottlenecks rather than prolonged separation (Stephen et al. 2005). However, the study by Stephen et al. (2005) was limited due to a lack of species-wide sampling (they did not sample peninsular pronghorn), and they did not suggest alternative classifications for pronghorn. A sampling of all pronghorn populations from Canada to Mexico would be required to make subspecies-level taxonomic conclusions for this species. Further study of the taxonomy of this species is required, including more intensive sampling efforts and potentially the inclusion of genome-wide nuclear DNA markers, to resolve accurate taxonomic units below the species-level for pronghorn.

A recent publication of microsatellite markers isolated from Sonoran pronghorn (Munguia-Vega et al. 2013) included a comparison of Sonoran pronghorn to peninsular pronghorn, using a subset of 14 of these newly developed microsatellite markers. The data indicated a lower mean observed heterozygosity for peninsular pronghorn than for Sonoran pronghorn (0.31 and 0.48, respectively), and lower mean number of alleles per locus for peninsular pronghorn versus Sonoran pronghorn (2.050 and 4.86, respectively). These results suggest that of the two endangered pronghorn subspecies, the Sonoran pronghorn has retained a greater amount of genetic diversity. Further, analysis of these data indicates that the two subspecies have significant genetic divergence, based on microsatellite data sets (Klimova et al. 2014).

Populations Distribution and Trends

Distribution

Sonoran pronghorn historically occurred throughout most of southwestern Arizona, northwestern Sonora, and portions of southeastern California and northeastern Baja California (Figure 1). Because Sonoran pronghorn were not identified as a subspecies until 1945, historical records do not indicate if pronghorn observed were Sonoran pronghorn, American pronghorn, Mexican pronghorn, or peninsular pronghorn. Genetic analysis of museum specimens may clarify the historical distribution of each subspecies. Pronghorn were observed in every open valley from Nogales, Mexico, to Yuma, Arizona, during the course of an international boundary survey from 1892 to 1894 (Carr 1971). Many of those observed were likely Sonoran pronghorn. Early explorers and travelers also reported seeing pronghorn in almost every valley of Arizona and on all of the open foothills (Brown and Ockenfels 2007).

By 1907 pronghorn were described by E.A. Mearns as rare in the region (U.S. Fish and Wildlife Service 1998). Nelson (1925) stated that in 1923, "Papago Indians [O'odham] reported that a few pronghorn were still ranging in the Santa Rosa Valley in Pima County, Arizona." From 1972 until 2002, no Sonoran pronghorn were confirmed east of Highway 85 on Organ Pipe Cactus National Monument (Organ Pipe Cactus NM) (U.S. Fish and Wildlife Service 2006); however, in 2002, two collared Sonoran pronghorn independently crossed this highway, apparently in response to extreme drought conditions (U.S. Fish and Wildlife Service 2006). One of the animals returned west after the onset of rain in September 2002. The second apparently died from the drought (U.S. Fish and Wildlife Service 2006). Unconfirmed sightings were reported in 1987 by a Border Patrol agent on the Tohono O'odham Nation (U.S. Fish and Wildlife Service 1998). More recently, some pen-released pronghorn have crossed Highway 85. With the exception of the recently established nonessential experimental population, Sonoran pronghorn have not been reported north of U.S. Interstate 8 since 1990 (U.S. Fish and Wildlife Service 1998).

The FWS reconstructed the limits of the historical distribution (Figure 1) of Sonoran pronghorn from historical accounts and summarized it as follows: 1) the eastern distributional limit of Sonoran pronghorn likely extended to the area between the Baboquivari Mountains and the Santa Cruz River; 2) the subspecies ranged northward into west-central Arizona, likely to the vicinity of present-day Interstate 10 and certainly no farther north than the Bill Williams River; 3) the southern limit of the historical range of Sonoran pronghorn followed the mainland coastline of the Gulf of California south to near Kino Bay and east to near Hermosillo, Sonora, Mexico; 4) westward, the range extended into the Imperial Valley of California and the northern Gulf of California coast of Baja California, Mexico (U.S. Fish and Wildlife Service 2010b). This reconstructed historical distribution encompasses an area of about 142,450 km^2 (55,000 mi^2) (U.S. Fish and Wildlife Service 2010b). However, Brown et al. (2006) reviewed the historical distribution of pronghorn in California and Baja California and reported records indicating the species' range extended west to the Pacific coast from Monterey southward to Magdalena Bay, Baja California Sur, and on the Gulf of California side of the Baja peninsula to south of San Felipe, Baja California Sur. The authors did not specifically indicate the historical distributional limits of the Sonoran pronghorn subspecies as compared to the peninsular pronghorn subspecies. A genetic analysis of museum specimens representing animals collected from as far north as Fresno, California, and south to include the Baja Peninsula is currently being conducted, which may clarify which subspecies occurred in the areas of question in Southeastern California and Northeastern Baja California (M. Culver, University of Arizona, personal communication, 2014).

Presently, Sonoran pronghorn only occupy approximately 12 % of their historical range. Their current range (Figure 1) is limited to approximately 17,224 km^2 (6,660mi^2), of which 4,057 km^2 (1,566 mi^2) are in Mexico and 13,167 km^2 (5,094 mi^2) are within the U.S. Five wild populations of the Sonoran pronghorn are now extant (Figure 1). Two of these populations, Pinacate and Quitovac, occur in northwestern Sonora, Mexico. The Cabeza Prieta, Kofa, and Sauceda populations occur in southwestern Arizona, U.S. Detailed descriptions follow:

Population Name	**Description and Location**
Cabeza Prieta	An endangered population in southwestern Arizona, U.S. that generally occurs south of Interstate 8, west of Highway 85, and east of the Copper and Cabeza Prieta mountains. The Cabeza Prieta population is found primarily on federally-managed lands, including the Cabeza Prieta NWR; Organ Pipe Cactus NM; and the Barry M. Goldwater Range, a tactical aviation training range complex of which the eastern portion (Barry M. Goldwater Range-East) is administered by the U.S. Air Force and the western portion (Barry M. Goldwater Range-West) is administered by the U.S. Marine Corps. The range of the Cabeza Prieta population also includes some Bureau of Land Management (BLM) land, private land, and state trust land.
Kofa	A nonessential experimental population that is found primarily on federally-managed lands, including the Kofa NWR; U.S. Army Yuma Proving Ground; and lands managed by the BLM. The population also ranges onto private and state lands and lands of the Colorado River Indian tribes. The 2015 range is shown in Figure 1. The population occurs within the larger designated nonessential experimental population area which is located in southwestern Arizona in an area north of Interstate 8 and south of Interstate 10, bounded by the Colorado River on the west and Interstate 10 on the east; and an area south of Interstate 8, bounded by Highway 85 on the west, Interstates 10 and 19 on the east, and the U.S.-Mexico border on the south (U.S. Fish and Wildlife Service 2011a).
Sauceda	A nonessential experimental population initiated in December, 2015 by release of Sonoran pronghorn in the Barry M. Goldwater Range East, east of Highway 85. This population is too new to describe a current range; however, the area is bounded by Interstate 8 to the north, Highway 15 to the

east, Highway 85 to the west, and Highway 86 to the south. This population occurs within the larger designated nonessential experimental population area which is located in southwestern Arizona in an area north of Interstate 8 and south of Interstate 10, bounded by the Colorado River on the west and Interstate 10 on the east; and an area south of Interstate 8, bounded by Highway 85 on the west, Interstates 10 and 19 on the east, and the U.S.-Mexico border on the south (U.S. Fish and Wildlife Service 2011a).

Quitovac A population occurring in northwestern Sonora, Mexico south and east of Mexico Highway 8 and west and north of Caborca, Sonora, near Quitovac, Sonora, Mexico.

Pinacate A population occurring in northwestern Sonora, Mexico, in the El Pinacate y Gran Desierto de Altar Biosphere Reserve of northwestern Sonora, Mexico.

These four populations are predominantly geographically isolated due to barriers, including roads and fences. Mexico Highway 2 and associated right-of-way fencing and a portion of the international boundary fence (pedestrian fence only) act as barriers to movement between the Pinacate and U.S. subpopulations (U.S. Fish and Wildlife Service 2002). Sonoran pronghorn habitat in Mexico is bisected by Highway 8 and associated fences; however, it is unknown how complete a barrier Highway 8 is to pronghorn movements (U.S. Fish and Wildlife Service 2002). Historically these barriers were not present and genetic and demographic interchange between pronghorn in Sonora and Arizona likely occurred.

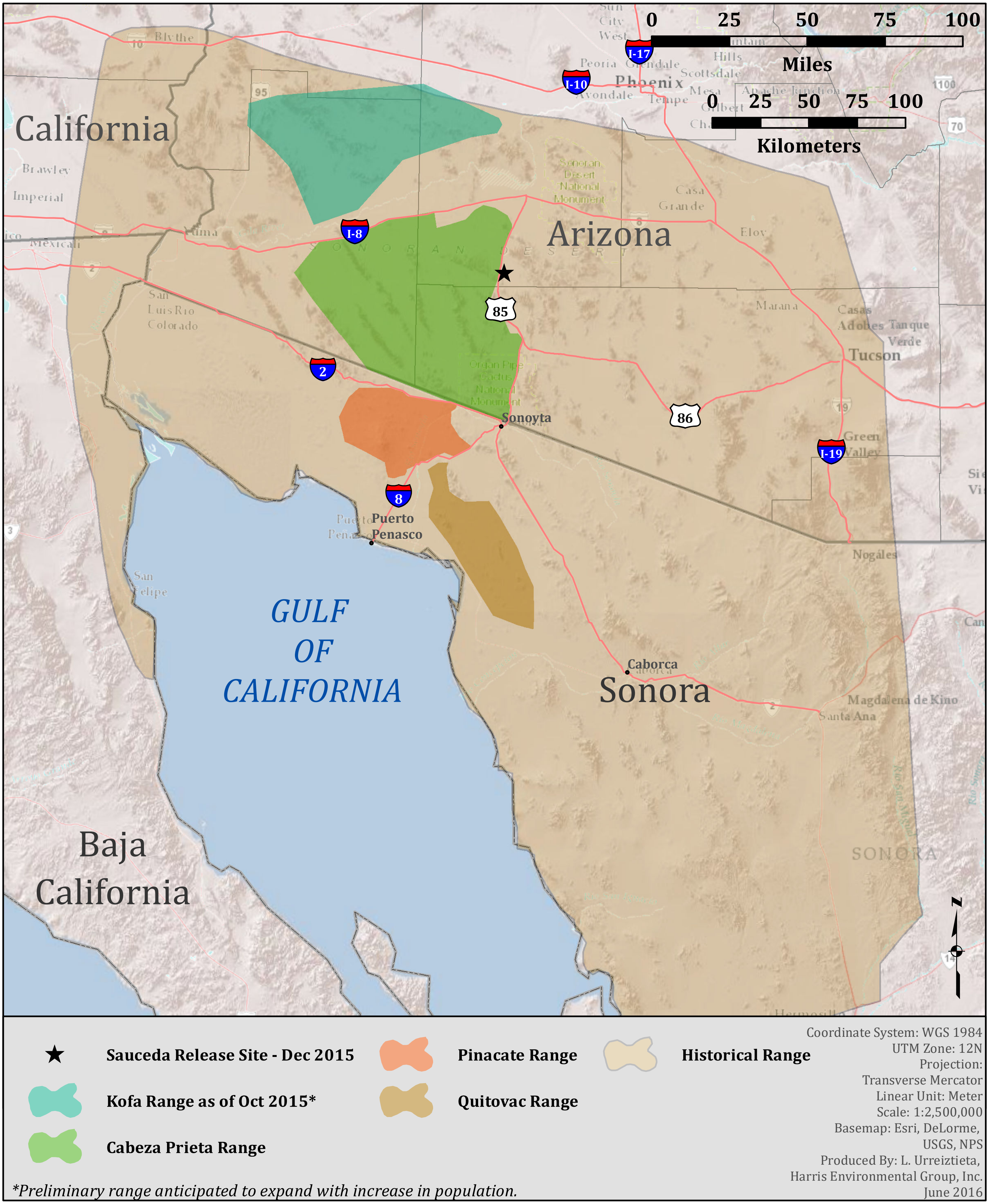

Figure 1. Current (2016) and historical ranges of Sonoran pronghorn in the U.S. and Mexico. The historical range is based on reconstruction by FWS (2010a). The current range is based on radio-collared pronghorn locations and other observations (current as of January 2016 for Pinacate, Quitovac, and Cabeza Prieta and October 2015 for Kofa). The December 2015 release site for the Sauceda population is depicted; however, as of May 2016, too few months of movement data exist for this population to depict its range.

Historical Population Trends

Before European settlement, an estimated 35 million pronghorn inhabited North America, but by 1924 the range-wide population of all pronghorn had decreased to less than 20,000 animals (O'Gara 1978). Associated with European settlement was widespread shooting of pronghorn for meat, recreation, and to reduce potential competition with domestic livestock (Brown and Ockenfels 2007). In 1540, a group of organized hunters near Pachuca Hidalgo, Mexico, reported the capture of 600 pronghorn and deer (Comisión Nacional de Areas Naturales Protegidas 2009). Four hundred years later, only 1,500 surviving pronghorn of three subspecies (*A. a. sonoriensis, A. a. mexicana,* and *A. a. peninsularis*) live in Mexico (Comisión Nacional de Areas Naturales Protegidas 2009). In Arizona, widespread decline of pronghorn began in the mid-to late-1800s. Domestic livestock competed with pronghorn for forage, and fencing to manage livestock introduced barriers to pronghorn movement throughout their range (Brown and Ockenfels 2007). Domestic livestock altered the vegetation of southeastern Arizona, causing changes in species composition and vegetation structure by increasing the abundance of shrubs such as mesquite (*Prosopis* spp.) (Bahr 1991). Brown and Ockenfels (2007) stated, “Indeed, the filling in of the land with mesquites, junipers, acacias, and other woody plants is the single-most reason why pronghorn are not widespread in Arizona today.” Severe, extended drought occurred throughout the region in the 1890s, when cattle numbers were at their peak, resulting in overgrazing (Bahr 1991).

By the 1920s, Sonoran pronghorn had declined to an estimated 100 animals in the U.S. (Table 1). No accurate data of Sonoran pronghorn populations exists prior to the 1920s to estimate the extent of the decline. The population oscillated between an estimated 50 to 100 animals from the 1920s up through the mid-1980s. By 1994, the U.S. population of Sonoran pronghorn had rebounded to an estimated 280 animals (Table 2). The population in Sonora, Mexico, was about 600 animals in 1925, but declined by almost half by 1993 (Table 1).

Recent Population Trends - Arizona

Estimating population size of Sonoran pronghorn is inherently difficult due to a number of factors, including dense vegetation in some areas, large size of the survey area, and length of survey (multi-day surveys are required). The AGFD began conducting biennial aerial surveys for Sonoran pronghorn in 1992 in Arizona. The AGFD first began surveying populations in Sonora, Mexico, using the same techniques as in Arizona in 1993, but did not survey populations again until 2000. Initially, populations were estimated with DISTANCE, a computer program that constructs population estimates by adjusting counts by the probability that detecting a group of animals decreases with distance from the surveyor (Laake et al. 1993). However, the coefficient of variation for these population estimates was considered too high (U.S. Fish and Wildlife Service 2002). From 1996 to 1998, the agencies used the Lincoln-Peterson Index, a mark-and-recapture method (Davis and Winstead 1980), to estimate the detection probability before adjusting counts. However, biologists observed that larger groups were more likely to be seen than small groups or singletons and the estimator did not include a correction for this bias, and as a result, population estimates may have been inflated (U.S. Fish and Wildlife Service 2002). Population size and 95% confidence intervals were estimated using a sighting probability model (Samuel and Pollock 1981) previously developed for Sonoran pronghorn (Bright et al. 2001). In 1998 a sightability model that could account for potential group-size bias was derived. This sightability model was determined to be the best population estimator because it corrects for group size bias, is more conservative than the Lincoln-Peterson Index, and has a low coefficient of variation (U.S. Fish and Wildlife Service 2002). The Recovery Team used the sightability model to revise population estimates for 1992-2000 (Bright et al. 2001). Population estimates for 1992 and later (Table 2) are based on this sightability model.

With the exception of 1994, Sonoran pronghorn in the U.S. declined from 1992 to 2000. The decline in numbers from 1992 to 2000 is supported by other survey data, including high adult mortality, low fawn survival and recruitment, and smaller average herd sizes (U.S. Fish and Wildlife Service 2002). A drought occurred between June 1995 and August 1997 during which 23 of 27 months had below-average rainfall and nine of 16 collared pronghorn (56%) died (Bright and Hervert 2005).

During the summer of 2002, between 1 June and 13 August, 4 out of 5 (80%) of collared pronghorn died. These animals were found intact, with no evidence of predation or scavenging. The authors suggested that because there was no evidence of predation and the rumens were full of chain fruit cholla fruits, the deaths were likely from malnutrition, starvation, and dehydration. The evidence supporting death by malnutrition was based on direct observations of deteriorating pronghorn health/condition in live animals and inspection of bone marrow, which was consistent with starving animals (J. Hervert, pers. com. 2015).The U.S. population declined from an estimated 99 animals in 2000, to an estimated 21 animals in 2002 (Table 2). In response to this decline, FWS and partners enacted instensive conservation measures. The measures included: 1) construction and operation of five forage enhancement (irrigation) plots (three on the Cabeza Prieta NWR, one on the BMGR East, and on BMGR West) to enhance fawn survival; 2) supplemental feeding; 3) construction of water sources; 4) establishment of a captive breeding pens at Cabeza Prieta and Kofa NWRs; and 5) initiation of the establishment of wild nonessential experimental populations on Kofa NWR and BMGR East (east of Highway 85). Since 2002, the wild endangered population in Arizona has rebounded to 202 animals in Arizona (as of December 2014).

Recent Population Trends – Mexico

Populations in Mexico declined during the 2002 drought, but not as severely as the population in Arizona (Table 2). Addtionally, between 2004 and 2011, populations in Mexico declined from

683 animals to 241 animals (Bright and Hervert 2011, Bright et al. 2011). This estimate of population decline in Mexico was primarily influenced by declines in the Quitovac population, which declined from 625 in 2004 to 189 in 2011, while the Pinacate population remained stable during the same time period (Table 2). The specific cause of this decline is unknown, but drought is highly suspected. However, the estimate for the Quitovac population in December of 2013 had increased to 434 individuals, over double the 2011 estimate; and nearly doubled again to 862 in 2015 (Table 2). In the Pinacate area, estimates have fluctuated widely and ranged from a low of 25 in 2002 to a high of 122 in 2014 (Table 2).

Table 1. Summary of population estimates from literature and field surveys for wild Sonoran pronghorn prior to use of standard aerial surveys and a sightability model.

Date	Population estimate		Source
	Arizona, U.S.	Sonora, Mexico	
1925	105	595 in Sonora	(Nelson 1925)
1941[a]	60	-	(Nichol 1941)
1957	<1,000	-	(Halloran 1957)
1957	-	>1,000 in NW Sonora	(Villa 1958)
1968	50	-	(Monson 1968)
1968-1974	50-150	-	(Carr 1971)
1981	100-150	250-350 in Mexico	(Arizona Game and Fish Department 1981)
1984	85-100	-	(Arizona Game and Fish Department 1986)
1993	-	313 in Mexico	(Snow 1994)

[a] Population estimate for southwestern Arizona, excluding Organ Pipe Cactus NM.

Table 2. Wild and captive Sonoran pronghorn estimates after adoption of standard field surveys and sightability model for wild population estimations. Numbers in parentheses are 95% confidence intervals.

Year	Sonora, Mexico (Pinacate)	Sonora, Mexico (Quitovac)	Arizona, U.S. (Cabeza wild)	Arizona, U.S. (Nonessential Experimental Population wild)	Arizona, U.S. (Captive)[a]
1992	-	-	179 (147-234)[b]		-
1994	-	-	282 (205-489)[b]		-
1996	-	-	130 (114-154)[b]		-
1998	-	-	142 (125-167)[b]		-
2000	34 (27-48)[c]	311 (261-397)[c]	99 (69-392)[b]		-
2001	-	-	-		-
2002	25 (21-33)[c]	260 (216-335)[c]	21 (18-33)[b]		-
2003	-	-	-		-
2004	59 (32-171)[c]	624 (454-2079)[c]	58 (40-175)[b]		7[d]
2005	-	-	-		15[d]
2006	67 (54-195)[c]	567 (445-1530)[c]	68 (52-117)[b]		25[d]
2007	50 (36-162)[c]	354 (327-852)[c]	-		37[d]
2008	-	-	68[b]		51[d]
2009	101 (57-321)[c]	381 (268-1158)[c]	-		73[d]
2010	-	-	76 (58-210)[b]		70[e]
2011	52 (32-183)[f]	189 (168-435)[f]	-		75[g]
2012	-	-	159 (111-432)[h]		98[i]
2013	No survey[f]	434 (376-1105)[f]	-	9[j]	117[k]
2014	122 (79-464)[f]		202 (171-334)[h]	30[j]	119[l]
2015	117 (98-224)[f]	862 (759-2129)[f]			130[m]
2016				70 at Kofa[n] 26 at Sauceda	

[a] including Cabeza Prieta NWR pen 2004-present; and Kofa NWR pen 2011- present; [b]Bright and Hervert (2011);

[c]Bright et al. (2011); [d] U.S. Fish and Wildlife Service (2010b);[e] Sonoran Pronghorn Recovery Team (2010); [f] J. Bright, AGFD, personal communication, 2016; [g] Sonoran Pronghorn Recovery Team (2011);[h]J. Bright, AGFD, personal communication, 2016; [i]Sonoran Pronghorn Recovery Team (2012); [j] Sonoran Pronghorn Recovery Team (2015a); [k] Sonoran Pronghorn Recovery Team (2013); [l] Sonoran Pronghorn Recovery Team (2014); [m]Sonoran Pronghorn Recovery Team (2015b). [n] Jim Atkinson, AGFD personal communication, 2016.

Life History and Ecology

Diet

Sonoran pronghorn forage on a variety of plant species. Fecal pellets collected from 1994-1998 included 132 different plant taxa (Hervert et al. 2000). Sonoran pronghorn browse on palo verde (*Parkinsonia microphylla*), mesquite (*Prosopsis* spp.), ironwood (*Olneya tesota*), chain fruit cholla *(Cylindropuntia fulgida)*, an annual plantain (*Plantago* spp.), the lavender-flowered four o'clock (*Ambronia villosa*), and desert broom-rape, (*Orobanche multiflora*) (U.S. Fish and Wildlife Service 1998*)*. Sonoran pronghorn also forage on white ratany *(Krameria grayi),* silverbush *(Ditaxis* spp.), spurge *(Euphorbia* spp.), marigold *(Baileya* spp.), noseburn *(Stillingia linearifolia),* wire-lettuce *(Stephanomeria pauciflora),* white bursage *(Ambrosia dumosa),* blazing star *(Mentzelia* spp), and ocotillo leaves *(Fouquieria splendens*) (U.S. Fish and Wildlife Service 1998*).* Other forage species include triangle-leaf bursage (*Ambrosia deltoidea*), mistletoe *(Phoradendron* spp.), false filaree *(Erodium texanum),* poverty weed *(Monolepis nuttalliana),* wooly plantain *(Plantago insularis),* wild carrot *(Daucus pusillus),* and Arizona blanket-flower *(Gaillardia arizonica)* (Hughes 1991). The following species are also heavily used: careless weed *(Amaranthus palmeri)*, ragweed *(Ambrosia* spp.), astralgalus (*Astragalus* spp.), brome *(Bromus* spp.), and broom snakeweed *(Guterrezia sarothrae*) (U.S. Fish and Wildlife Service 1998*).* Important forbs include buckwheat (*Eriogonum* spp.), milkvetch (*Astragalus* spp.), and borage (*Borago* spp.) species (Hervert et al. 2000).

Diet composition varies between years and seasons. Fecal analysis completed from 1974 to 1977 by AGFD indicated that the Sonoran pronghorn diet consisted of 69% forbs, 22% shrubs, 7% cacti, and 0.4% grasses (U.S. Fish and Wildlife Service 1998). In contrast, Hughes (1991a) reported a diet with a much higher proportion of cacti (44%), and fewer forbs (33%), with 11% shrubs, 11% trees, and 0.4% grasses. Between 1994 and 1998, browse made up the highest percentage of pronghorn diets (43%-53%) in all seasons except wet summer, when they composed 28% of the diet (Hervert et al. 2000). Forbs made up the main component of the diet in wet summers (42%) when they were both available and succulent (Hervert et al. 2000). Forbs are a preferred diet item when they are available as they are highly nutritious and provide preformed water (Hervert et al. 2000). Cacti made up 7-14% of the diet, depending on the season, and grasses made up 3-13% of the diet, depending on season (Hervert et al. 2000). In Mexico, Sonoran pronghorn consume a diet based on 69% forbs, 22% shrubs, 7% cactus, and 2% grasses (Comisión Nacional de Areas Naturales Protegidas 2009).

Water Use

Early accounts of Sonoran pronghorn stated that they can acquire all the water they need from preformed water contained in their forage and metabolic water (water produced as a by-product of metabolizing their food). However, a detailed analysis of preformed water and metabolic water available from the forage species of Sonoran pronghorn concluded that water intake from forage is not adequate to meet their minimum water requirements (Fox 1997, Fox et al. 2000a). Similarly, American pronghorn in the moister environment of grasslands of Perry Mesa, Arizona, were unable to meet water requirements through dietary water alone in any season (Tluczek 2012). Feeding at night and early in the morning when plant moisture is at its highest was also insufficient to meet water requirements (Tluczek 2012). However, the desert pronghorn (Sonoran and peninsular pronghorn) seem to get some water from morning dew in some areas (Brown and Ockenfels 2007). The use of morning dew by Sonoran pronghorn is an assumption made by early naturalists and not documented by scientific study. The assumption was made because Sonoran pronghorn occurred in good numbers along the Sonora and Baja California coasts without the benefit of free water (D. Brown, Arizona State University, personal communication, 2013). Sonoran pronghorn do obtain water from vegetation, and it has been hypothesized that they met their water requirements from cacti and morning dew in areas subject to coastal dew, such as along the Sonoran coast from Rocky Point Puerto Peñasco to Bahia Kino (D. Brown, Arizona State University, personal communication, 2013). Sonoran pronghorn subsistence in this area without water is mentioned in several old investigative reports, and this ability would only increase as one proceeded southward along the coast because humidity is higher (D. Brown, Arizona State University, personal communication, 2013). Alternatively, these pronghorn may have historically used the riparian areas along the Rio Sonoyta or ephemeral washes, and persisted under different climatic conditions than they do currently (J. Bright, AGFD, personal communication, 2014). Neither of these hypotheses has been tested, and it is unknown how Sonoran pronghorn historically survived in areas receiving so little precipitation per year. Sonoran pronghorn have been documented using man-made water sources (Morgart et al. 2005).

Home Range and Movement

Home-range size for individual Sonoran pronghorn in Arizona estimated using locations of radio-collared pronghorn varied from 43-2,873 km^2 (17-1,109 mi^2), with an average of 511 ± 665.3 SD km^2 (197 ± 257 mi^2) (Hervert et al. 2005). These home range sizes are much larger than have been reported for other subspecies of pronghorn; the large home ranges estimated for Sonoran pronghorn likely indicate that resources are widely dispersed throughout the landscape (Hervert et al. 2005). Sonoran pronghorn in the northwestern part of their range in Arizona (Cabeza Prieta population) moved up to 130 km (81 miles [mi]) each year between hot-season habitats and cool-season habitats (Hervert et al. 2000). This study was conducted before many water sources and forage enhancement plots were constructed. It is unknown if the construction of these new water sources and forage enhancement plots have influenced seasonal movements.

Sonoran pronghorn have been documented to wander long-distances, particularly pen-raised and released individuals. This wandering behavior in is thought to occur in pen-raised animals because they do not have the landscape familiarty and social structure possessed by wild born animals. For example, one buck released in 2008, (#851) moved 217 miles from March 1 to June 10 (AGFD, unpublished data 2008).

While some monitoring of Sonoran pronghorn has occurred in Sonora, less is known about their home range and movements in Mexico.

Social Structure

Pronghorn live in herds of mixed sexes, with group sizes largest in winter in populations that congregate on distinct winter ranges (Byers 1997). Herding is an adaptation to reduce the risk of predation, and may reflect eons of selection to detect predators, even those that are now extinct (Byers 1997). In years when succulent forage is more widespread, Sonoran pronghorn are generally in smaller, but more numerous and widespread groups. In years of poor and limited forage, pronghorn are in fewer, larger groups, concentrated in the few areas where green forage persists (Bright et al. 2011). Average group sizes of Sonoran pronghorn observed in winter survey transects in Arizona were 5.1 ±2.85 in 2006, 7.3 ± 7.97 in 2008, and 5.7 ± 3.23 in 2010 (Bright and Hervert 2011). Group sizes ranging from 1-21 animals have been observed (Bright and Hervert 2011). Average group sizes of Sonoran pronghorn observed in winter survey flights in Mexico conducted between 2000 and 2009 ranged from 3.4 to 12.0 individuals (Bright et al. 2011). In 2015, group sizes as large as 50 were observed in Sonora (C. Weise, FWS, personal communication, 2015); however, group sizes this large are exceptional and only follow years of above average rainfall.

Recruitment

Pronghorn are polygamous. Females usually become sexually mature at 16 months of age but occasionally conceive at approximately 5 months of age (O'Gara 1978). Males become sexually mature at one year of age (O'Gara 1978). The gestation period in captivity averages 252 days (O'Gara 1978). Twins are more common than single births (O'Gara 1978).

Rut (the mating season of ruminant animals) in most pronghorn subspecies occurs during July, August, and September, and females primarily give birth from February through May (U.S. Fish and Wildlife Service 1998). Birthing appears to coincide with spring forage abundance (U.S. Fish and Wildlife Service 1998). Mating of Sonoran pronghorn was observed from 16 to 30 June in the Cabeza Prieta captive breeding pen (Wilson et al. 2008). In this pen, Sonoran pronghorn originally captured in Arizona gave birth from mid-February to early March, while those originally captured in Sonora, Mexico, gave birth in mid to late March (Wilson et al. 2008). Sonoran pronghorn observed in the wild typically give birth in mid-February to April (Bright and Hervert 2005). Sonoran pronghorn in Mexico breed in September and October.

The high maternal investment in development of offspring (i.e., lengthy gestation, twinning, high fetus biomass to female mass, rapid fawn growth, early weaning) may be an evolutionary adaptation to predation (Byers 1997). Pronghorn fawns suckle almost exclusively through the first month of life. The females initiate the weaning process as early as 4 weeks and by 12 weeks fawns are fully weaned, but nursing has been observed as late as September (Byers 1997). Most pronghorn fawns grow rapidly in the presence of nutritious forage and adequate moisture, and, by about 45 days of age, fawns are able to easily outrun even the fleetest of predators (Byers 1997).

Estimates of Sonoran pronghorn fawn recruitment per 100 females varies from 0-78 fawns per 100 females (Bright and Hervert 2005). Hervert et al. (2000) correlated years of high fawn recruitment with high forb production. The length of time between winter and summer rains was inversely correlated with fawn survival in Sonoran pronghorn (Bright and Hervert 2005). Most fawn mortalities did not occur until fawns were 3-5 months of age, during May and June (Bright and Hervert 2005). The authors suggested delayed onset of summer rains results in poor milk production, scarce forage, and increased mortality rates of fawns (Bright and Hervert 2005).

Survivorship

Longevity for pronghorn is reported as 10 years in the wild and 12 years in captivity (Carey and Judge 2000). Excluding the extreme year of 2002, annual mortality rates of collared adult Sonoran pronghorn in Arizona average 13% in wet years and 30% in dry years (Bright and Hervert 2005). During the extreme drought in summer of 2002, adult mortality was 83% in Arizona (Bright and Hervert 2005). From 1995 to 2002, adult mortality, including capture-related mortality, averaged 28% annually, ranging from 11% to 83% (Bright and Hervert 2005). Of 32 mortalities documented in Arizona from 1995-2002, 12 were from predation, 5 from capture-related mortality, 4 from drought-related factors (i.e., malnutrition, starvation, or dehydration), and 11 from unknown causes (Bright and Hervert 2005).

Habitat Characteristics

Soils

Sonoran pronghorn are associated with specific soil associations. Soil association affects moisture retention and vegetation growth. Soil association (Gunsight-Rillito-Chuckwalla) was one of the most important explanatory variables for Sonoran pronghorn in a classification and regression tree (CART) model and logistic regression analysis of Sonoran pronghorn use areas (O'Brien et al. 2005).

Topography

Pronghorn are prey animals that rely on keen eyesight and swift running to escape from predators. These adaptations are most suited to terrain that is relatively flat and open. Sonoran pronghorn appear to prefer gentle slopes and hills, where the paloverde-chain fruit cholla vegetation association occurs, and use flat slopes in proportion to their availability (Hervert et al. 2005). Hervert et al. (2005) found that Sonoran pronghorn avoided rugged slopes and mountains. However, more recently, Sonoran pronghorn have occassionally been observed in mountainous terrain. Of 3,219 radio-collared locations of Sonoran pronghorn in the U.S. collected from 1994-2002, only 10% were in areas with slopes >20% (O'Brien et al. 2005).

Vegetation Communities and Structure

Sonoran pronghorn are found exclusively in the Sonoran Desertscrub Biome. Sonoran Desertscrub Biome is a relatively recent desert that has a bimodal rainfall pattern, which allows for greater structural diversity than in the Great Basin, Mojave, and Chihuahuan deserts (Turner and Brown 1994). The Sonoran Desert is in the western half of the state of Sonora, Mexico, and in large areas of southeastern California, southwestern Arizona, and the Baja California peninsula (Turner and Brown 1994). Sonoran pronghorn are in two of the five subdivisions of the Sonoran Desert: the Lower Colorado River Valley Subdivision and the Arizona Upland Subdivision (deVos and Miller 2005, Hervert et al. 2005). Historically, pronghorn may have occurred in Gulf Coast and Plains of Sonora subdivisions in Sonora. Genetic analysis of museum specimens found in these subdivisions may help determine if these pronghorn were Sonoran or peninsular pronghorn.

The Lower Colorado River Valley Subdivision (Figure 2) is the largest and most arid subdivision of the Sonoran Desert extending from Palm Springs, California, in the west, to Needles, California, in the north; southeast to Tucson, Arizona, and around the Gulf of California to near the southern border of Baja California and south of Caborca, Mexico, in Sonora (Turner and Brown 1994). Within the Lower Colorado River Valley subdivision, Sonoran pronghorn are typically in the most widespread vegetation series of the subdivision, the Creosote-White Bursage series, which is characterized by low open stands of widely spaced creosotebush (*Larrea tridentata*) and white bursage (Turner and Brown 1994). The Creosote-White Bursage series offers sparsely-vegetated, flat, open spaces that are ideal for swift running and visual detection of predators. This series also supports numerous forbs in cool, wet seasons. Sonoran pronghorn prefer the Creosote-White Bursage series when abundant forage is available, such as during extremely wet years (deVos and Miller 2005, Hervert et al. 2005). Intermixed throughout this series are ephemeral desert washes that support the more diverse Mixed Scrub Series that includes blue palo verde, ironwood, desert lavender (*Hyptis emoryi*), and jojoba (*Simmondsia chinensis)* (Turner and Brown 1994).

Figure 2. Sonoran pronghorn habitat in Lower Colorado River Valley Subdivision in the King Valley, Arizona, U.S. Photo courtesy Christa Weise, FWS.

In contrast to the Lower Colorado River Valley subdivision, the Arizona Upland Subdivision (Figure 3) is the best watered and least desert-like in North America (Turner and Brown 1994). The vegetation is largely arboreal and dominated by leguminous trees such as foothill paloverde, ironwood, mesquites, and cat-claw acacia (*Acacia greggii*) (Turner and Brown 1994). The Paloverde-Cacti-Mixed Scrub Series is dominated by foothill paloverde and saguaro cactus (*Carnegiea gigantea*), the latter becoming more prevalent with increasing elevation. Ironwood is common in this series on bajadas (broad slopes at the foot of mountains) but excluded from cold valley floors because of its frost intolerance. Creosotebush also occurs as a low, shrubby layer. Cacti form an important element, and Engelmann prickly pear (*Opuntia engelmannii*), saguaro, cane cholla (*Cylindropuntia imbricata*), and chain fruit cholla are only a few of the cacti species found. Other plant species include whitethorn acacia (*Acacia constricta*), limber bush (*Jatropha cardiophylla*), ocotillo, jojoba, and fairy feather duster (*Calliandra eriophylla*) (Turner and Brown 1994).

Figure 3. Sonoran pronghorn habitat in Arizona Upland Subdivision in Arizona, U.S. Photo courtesy John Hervert, AGFD.

Within the Paloverde-Cacti-Mixed Scrub Series, Hervert et al. (2005) found Sonoran pronghorn prefer areas with chain fruit cholla, which they called a "palo verde chainfruit cholla association," (Figure 4) in all seasons over other areas. This plant community consisted of creosote, palo verde, ironwood, saguaro, organ pipe cactus *(Stenocereus thurberi)*, ocotillo, staghorn cholla (*Cylindropuntia versicolor*), buckhorn cholla (*Cylindropuntia acanthocarpa*), teddybear cholla (*Cylindropuntia bigelovii*), and chain fruit cholla. During the eight years of study from 1994 to 2002, Sonoran pronghorn used the "palo verde chainfruit cholla association" in greater proportion than its availability in every season except the winter of 1997-1998, when rainfall was 11cm (4.3 inches [in]) above the long-term normal (Hervert et al. 2005). Sonoran pronghorn in the "palo verde chainfruit cholla association" had smaller home ranges than in other vegetation associations, indicating the habitat quality may be better and pronghorn do not need to travel as far to gain needed resources (Hervert et al. 2005). Hervert et al. (2005) attributed the preference for the "palo verde chainfruit cholla association" to the availability of chain fruit cholla fruits and the preformed water they provide.

Figure 4. "Palo verde chainfruit cholla association" in Arizona, U.S. Photo courtesy John Hervert, AGFD.

Sonoran pronghorn are also associated with washes more than expected based on availability during all seasons and all range conditions (Hervert et al. 2005). These washes support vegetation that is more structurally diverse than their surroundings regardless of vegetation type, and provide thermal cover (i.e., shade and cooler temperatures). They also retain quality forage longer than other areas. Washes are likely to be especially important to Sonoran pronghorn during the hot and dry season.

In Sonora, Mexico, the Sonoran pronghorn distribution is composed primarily of the Sonoran Desert Lower Colorado River Valley Subdivision (97%). Sonoran pronghorn are found in low dunes, sandy meadows, low hill areas, and basaltic areas (Comisión Nacional de Areas Naturales Protegidas 2009). Sonoran pronghorn in the Pinacate area inhabit the extensive sand flats and volcanic cinder flats, as well as the loose soil patches interspersed within the lava fields in Pinacate (Bright et al. 2011). The Quitovac area is characterized by arid granitic and volcanic mountain ranges and slopes, semi-stabilized interior and coastal dunes, and sandy plains with elevations from 12m to 999m (39 ft to 3277 ft) (Pate 2014). The most important landscape features for Sonoran pronghorn habitat in the Quitovac area are semi-stabilized dune fields ("medanos" in Spanish) (Figure 5) which contain the highest diversity of annual plants, staple forage for pronghorn (Castillo 1999; Bright et al. 2011). Pate (2014) found terrain substrate was one of the best predictors of Sonoran pronghorn use in a habitat model constructed for the

Quitovac area; and of thirteen terrain substrate types, the four that most predicted suitability in the model were three medanos substrate types and sandy bajadas. Other terrain substrate types included bedrock/mountain, upper bajada, lower bajada, sandy flat, coastal dunes, mine, and non-medanos sand area (Figure 6). The Nature Conservancy Sonoran Desert Ecoregion Vegetation map depicts four vegetation associations for the Quitovac area: palo verde-mixed cacti desert scrub, torchwood-limber bush desert scrub, creosote bush-bursage desert scrub, and coastal/interior dunes and plains (Marshall et al. 2000; Pate 2014). Vegetation in the Pinacate and Quitovac areas is typical of the Sonoran Desert and includes creosotebush, bursage (*Ambrosia spp*.), saguaro cactus, paloverde, and chollas (*Opuntia spp*.) (Bright et al. 2011). Pate (2014) found presence of chain fruit cholla stands one of the most important predictors of habitat suitability in the Quitovac area during late spring.

Figure 5. Medano habitat in Sonora, Mexico. Photo courtesy Ami Pate, Organ Pipe NM.

Figure 6. Sonoran pronghorn in non-medanos habitat in Sonora, Mexico. Photo courtesy Ami Pate, Organ Pipe NM.

Sonoran pronghorn also use playas when forbs are abundant (U.S. Fish and Wildlife Service 1998). Some of the sandy areas within the range of Sonoran pronghorn, such as Pinta Sands, the Mohawk Dunes west of the Mohawk Mountains, and the west side of the Aguila Mountains, provide a greater variety of seasonal vegetation than other areas within their range. These areas are open and provide annuals, grasses, and shrubs for forage, particularly in the spring (U.S. Fish and Wildlife Service 1998). These dunes are important for forage in the spring when annuals are present, but become less important as summer approaches and the annuals desiccate. These areas lack sufficient woody vegetation to provide thermal cover in hot weather (U.S. Fish and Wildlife Service 1998).

Sonoran pronghorn selection for vegetation communities varies with season, precipitation, and temperature. They prefer washes and areas with chain fruit cholla during dry conditions when the thermal cover and preformed water are necessary to escape heat and meet water needs (Hervert et al. 2000, 2005). Females with fawns are more selective for “palo verde chain fruit cholla association” than females without fawns (Hervert et al. 2000). Although the taller and denser vegetation structure of these vegetation communities appears to provide more thermal cover, this same feature also likely makes it more difficult for pronghorn to detect predators and to run swiftly to escape predation. As a result, adult pronghorn mortality is apparently greater in these dense vegetation communities. Hervert et al. (2005) tracked 35 radio-collared Sonoran pronghorn and documented that 75% of the predation mortality occurred in the “palo verde chainfruit cholla association” even though Sonoran pronghorn only used this habitat association 48% of the time. In contrast, the collared Sonoran pronghorn used other vegetation communities 52% of the time where only 25% of the mortality occurred (Hervert et al. 2005). Although the sample sizes in this study were small (12 mortalities) the results concur with the field observations of other biologists working with Sonoran pronghorn. In contrast, the “creosote-bursage series” has more open vegetation structure, which provides greater opportunities to run from predators. It also appears to offer high quality forage in wet years. However, in hot seasons it does not provide cover from heat as do washes, or preformed water as does the “palo verde chainfruit cholla association.”

Forage Quality

Using information on plant species selected for foraging by Sonoran pronghorn from previous studies, Fox (1997) reported plant species selected by Sonoran pronghorn are higher in preformed water and some nutrients than those plants not selected for foraging. Sonoran pronghorn forage on plant species that have lower lipid content, and higher neutral detergent fiber and acid detergent fiber than non-forage species (Fox et al. 2000a). No difference in crude protein or nitrogen free extract between forage species and non-forage species was reported (Fox et al. 2000a). Fox et al (2000b) developed models of diets consumed by Sonoran pronghorn based on field collection of forage plants and published literature. Diet models for Sonoran pronghorn on the Cabeza Prieta NWR were deficient in 5 of 11 minerals (i.e., sodium, phosphorus, copper, zinc, selenium), and these mineral deficiencies could hinder growth and health of the population (Fox 1997, Fox et al. 2000b).

Habitat disturbance may increase forage quality, at least temporarily. Sonoran pronghorn appear to be attracted to sites disturbed by military operations (Krausman et al. 2005), presumably because of increased production of forbs and other annual species in these areas. Areas burned from military activities are also used more than expected by Sonoran pronghorn (Krausman et al. 2005). It is unknown if repeated burning from military activities would continue to provide a greater abundance or of forbs and grasses over time.

Succulent Foods

Forage containing large amounts of moisture is believed to be important to Sonoran pronghorn when free water is limited. Chain fruit cholla is considered a particularly important plant species in the Arizona Upland because the fruit has high quantities of preformed water (up to 85% water by weight) and cholla retain a high moisture content even during the hot dry summer when surface water is unavailable to pronghorn (Fox 1997). Fruits of the chain fruit cholla are a major source of water during hot, dry conditions (Hervert et al. 2005). However, chain fruit cholla is low in protein (Hughes 1991a). Pronghorn that died during the drought of 2002 had rumens full of fruit of chain fruit cholla, indicating that the fruit was not meeting their nutritional requirements (Hervert et al. 2005). Cholla density was one of the most important variables contributing to a Sonoran pronghorn habitat model using Normalized Difference Vegetation Index (NDVI) and locations of GPS-collared Sonoran pronghorn obtained in late spring in the Quitovac area (Figure 7) (Pate 2014).

Figure 7. Sonoran pronghorn herd among chain fruit cholla on semi-stabilized sand dunes in Sonora, Mexico. Photo courtesy John Hervert, AGFD.

Water Availability and Access

Even in years with above-average rainfall, pronghorn select areas that are less than 10 km (6.2 mi) from water (deVos and Miller 2005). Historically, rivers that flowed within Sonoran pronghorn habitat included the Gila River near the northern edge of their range, the Colorado River, the Rio Sonoyta in Mexico, and the Rio Sonora in Mexico. These rivers were potentially important in the survival of Sonoran pronghorn (U.S. Fish and Wildlife Service 1998). Historical descriptions of these rivers suggest a greenbelt existed that could have provided water and green forage during a time of year when food and water resources were limited in the rest of the range

(U.S. Fish and Wildlife Service 1998). These rivers (except the Colorado) are now dry or ephemeral, and support little to no native riparian vegetation usable as forage by Sonoran pronghorn. Sonoran pronghorn have been unable to reach the Gila and Rio Sonoyta rivers since the construction of Interstate 8, State Route 85, and Mexican Highways 2 and 8 (U.S. Fish and Wildlife Service 2014). The drying of the Gila River in Arizona and other rivers in Sonora may have been a significant cause of the Sonoran pronghorn population decline (Carr 1972 *in* U.S. Fish and Wildlife Service 1998).

<u>Natural water sources</u>
Other natural water sources include playas (ephemeral lakes), springs, seeps, and tinajas (rainfall-recharged ephemeral catchments collected in depressions in rocks formed by scouring water). Morgart et al. (2005) reported natural water sources available to Sonoran pronghorn in southwestern Arizona include playas, tinajas, and ephemeral pools created by runoff from heavy rain. More than five dozen documented tinajas occur on Organ Pipe Cactus NM and additional tinajas occur on Cabeza Prieta NWR (U.S. Fish and Wildlife Service 2006, National Park Service 2010). Virtually all the tinajas on Cabeza Prieta NWR have been developed to hold more water, although some have filled with silt and no longer hold water (U.S. Fish and Wildlife Service 2006). Generally, tinajas hold water anywhere from a few days to many months and will run dry if there is no subsequent precipitation (J. Atkinson, FWS, personal communication, 2013). Pronghorn will use these tinajas after rains have occurred, when they provide small pools of water in bajadas and similar habitats (hills, small drainages). Pronghorn likely use tinajas or any other source of standing water during the summer months if they are close and have access to them. However, most of the tinajas, especially the large, developed tinajas such as Heart Tank, are in mountainous areas unsuitable for pronghorn (J. Hervert, AGFD, personal communication, 2013).

Quitobaquito pond and springs is by far the largest water source (natural or artificial) available to Sonoran pronghorn in the current endangered U.S. range. The springs are natural and feed the pond, which is a human "development" dating back to at least 1860. There are no records of pronghorn ever visiting the site although there are a few sight records and telemetry locations of pronghorn within 1.2 km (2 mi) from it. (T. Tibbitts, Organ Pipe Cactus NM, personal communication, 2013). Quitobaquito pond is in an area with suitable topography and vegetation for Sonoran pronghorn; immediately west of Quitobaquito are vast stands of chain fruit cholla. However, Mexico Highway 2 runs about 152 m (500 ft) south of the pond, and has heavy traffic, which may repel pronghorn from the site (T. Tibbitts Organ Pipe Cactus N M, personal communication, 2013). Biologists at Organ Pipe Cactus NM operated camera traps at Quitobaquito in the late 1990s, and occasionally in 2010-2013, but no pronghorn have been photographed. In early 2015, a University of Arizona trail camera documented one pronghorn walking a road approximately 850 meters (0.52 mile) east of Quitobaquito. The animal was not documented at the pond, and within a day or two was about 15 km east of the area.

There are other natural waters available to pronghorn, but they are ephemeral tinajas, in places like Acuna Valley, the margins of the Puerto Blanco and Bates Mountains, and Kino Tinaja, where pronghorn use was documented via game camera in 1997 (T. Tibbitts, Organ Pipe Cactus NM, personal communication, 2015). Ephemeral water sources such as these do not provide water during critical dry periods, however. Dripping Springs and Wild Horse Tank have water, but are located on rocky slopes where pronghorn are not likely to occur (T. Tibbitts, Organ Pipe Cactus NM, personal communication, 2013).

Springs on Cabeza Prieta NWR include Agua Dulce Spring, a natural seep in the southeast corner of Cabeza Prieta NWR, which was once thought to be perennial (U.S. Fish and Wildlife Service 2006). It is not known if Sonoran pronghorn used this area historically. Currently, the refuge believes the spring is no longer a source of surface water due to a reduction in the water table. Sonoran pronghorn are not known to range in that vicinity recently, which may be due to the frequent and likely heavy use of that area by cross border activities (J. Atkinson, FWS, personal communication, 2013).

There are no natural waters in the King Valley (Kofa population) that are accessible to pronghorn. The only natural waters are tinajas that are in areas considered too rugged for pronghorn to use (Christa Weise, FWS, personal communication, 2014).

Natural water sources in Mexico include Papagos stream and Tinajas de los Chivos stream on the west side of El Pinacate Biosphere Reserve, and the pond of Vidrios Viejos located on the northern part of the reserve. These have been used as a natural water source in the past (Federico Godínez Leal, El Pinacate Biosphere Reserve, personal communication, 2015). Notes from Sonoran pronghorn telemetry flights indicated that rain sufficient to cause the Rio Sonoyta to flow had fallen in July 2008, and there was rain water in several playas in September 2008 (Bright et al. 2011).

Developed waters

Man-made water sources include charcos (earthen livestock tanks), guzzlers, craters created by military activities, and water catchments (that feed water into a trough) created for Sonoran pronghorn and other wildlife. Within the Cabeza Prieta population area, as of 2016, 14 stand-alone developed waters and five waters associated with forage enhancement plots (three on Cabeza Prieta NWR and two on BMGR) have been developed for Sonoran pronghorn. However, only two of the five waters associated with the plots are reliably filled. Of the 14 stand-alone developed waters, 10 waters occur on Cabeza Prieta NWR including two within non-wilderness and eight within core pronghorn use areas in wilderness. Four developed waters occur on BMGR, two on the East and two on the West. Pronghorn have been observed routinely using these catchments and the FWS and Recovery Team believe they are essential components of pronghorn recovery (U.S. Fish and Wildlife Service 2014). The standard storage capacity for newer water catchments for Sonoran pronghorn is at least 41,640 liters (11,000 gallons) (U.S. Fish and Wildlife Service 2014). In addition to these water sources designed for pronghorn, occasional pronghorn use is suspected at some of the waters developed for desert bighorn sheep, including Heart Tank, Bassarisc, and possibly North Pinta on the Cabeza Prieta NWR (J. Atkinson, FWS, personal communication, 2013). Over the years, Organ Pipe Cactus NM has had five "temporary" artificial water sources available to pronghorn. Pronghorn use has never been documented at any of them (T. Tibbitts, Organ Pipe Cactus NM, personal communication, 2013). The only one of these five currently functioning is "3-Jack Tank," which was established in April 2013. It was placed in a pronghorn high-use area, based on many years of telemetry and visual monitoring. It consists of two 3,785 liter (1,000-gallon) tanks plumbed to a trough. Unfortunately, in late 2012 and early 2013, illegal roads were created passing near the site, which may have precluded use by pronghorn. As of May 2014, no pronghorn have been photographed at the tank (T. Tibbitts, Organ Pipe Cactus NM, personal communication, 2013).

Within the Kofa population area, five water sources for Sonoran pronghorn have been developed in the King Valley of the Kofa NWR since 2012. Additionally, Sonoran pronghorn have been documented using ponds in the King Valley on the Yuma Proving Ground. No permanent waters have been developed for Sonoran pronghorn within the Sauceda population area as of February 2016; however, three temporary waters for Sonoran pronghorn have been established and a number of waters for deer and sheep already exist.

In Sonora, staff of the El Pinacate Biosphere Reserve installed nine water tanks (2 in the Quitovac and 7 in Pinacate population areas) for Sonoran pronghorn in 2015, although pronghorn use of these waters has not been documented likely due to cattle exclusion fences around the waters. The cattle fence is pronghorn-friendly, in that the bottom wire is sufficiently high for pronghorn to move under; however, it is thought that the fences may enclose too small of an area to allow pronghorn to escape from predators. Some tanks are installed at ground level and some are above the ground.

Habitat Area

To meet the home range and movement needs described in the life history section above, Sonoran pronghorn need large expanses of habitat. The amount of habitat needed has not been studied or estimated, but is likely to be thousands of km^2 (thousands of mi^2), considering home-range size for individual pronghorn in Arizona varies from 43-2,873 km^2 (17- 1109 mi^2), with an average of 511 ± 665.3 km^2 (197 ± 257 mi^2) (Hervert et al. 2005). Patchy precipitation throughout the range of the subspecies results in a continuously shifting distribution of forage and water. Large expanses of habitat are needed for Sonoran pronghorn to have some area with seasonally suitable habitat available to them at any one time.

Habitat Connectivity

Those large expanses of habitat required by pronghorn need to be free of barriers to enable pronghorn to move freely between areas as water and forage conditions change. Although the need for habitat connectivity has not been quantified, areas of pronghorn habitat need to incorporate a variety of vegetation communities and water sources. Maintaining habitat connectivity within each population is critical to the recovery of Sonoran pronghorn. Sonoran pronghorn would also likely benefit from creating habitat connectivity between or among populations.

Areas with Modeling of Potential Habitat

O'Brien et al. (2005) used landscape level Classification and Regression Tree and logistic regression models to assess potential Sonoran pronghorn habitat in southwestern Arizona within their current and historical range as a means of identifying potential locations for establishing a second U.S. Sonoran pronghorn herd. The models did not include any areas of historical habitat outside of southwestern Arizona, such as southeastern California, Baja California, Sonora, or the far eastern historical distribution of Sonoran pronghorn in Arizona. Both models identified greater than 12,000 km^2 (4,632 mi^2) of potential habitat (O'Brien et al. 2005). The largest blocks of potential habitat outside of the current range, which were identified by both models, were the Ranegras and Harquahala plains and King Valley at Kofa NWR north of Interstate 8; Sentinel Plain and other areas to the west between Interstate 8 and the Gila River; and areas south of Interstate 8 and immediately west of Highway 85. The models also identified a large potential habitat block east of Highway 85 and south of Interstate 8.

Clark et al. (2013) analyzed three areas in southeastern California and one area in Baja California as potential reintroduction sites for pronghorn. They evaluated 13 factors such as vegetation structure, water and forage availability, disturbance level and barriers, historical records of occurrence, and land protection status. The Chuckwalla Bench area in Imperial County California and the Tres Pozos area in Baja California ranked highest, with suitable amounts of forage, water, and land protection able to support a population of 50-150 pronghorn (Sonoran or peninsular pronghorn) in each area.

Pate (2014) conducted a habitat suitability model for the Quitovac population using: 1) terrain substrate - thirteen terrain classes representing distinct habitat types and substrates for vegetation associations that acted as surrogates for detailed vegetation data; 2) Sonora vegetation associations from The Nature Conservancy Sonoran desert ecoregion map (Marshall et al. 2000); 3) chain fruit cholla cactus stands; 4) terrain ruggedness; 5) road density; and 6) seasonal habitat quality data derived from remote sensing Normalized Difference Vegetation Index (NDVI); and 7) habitat use data from locations recorded by aerial surveys and GPS telemetry (Figure 8). She used MaxEnt software version 3.3.3k (http://www.cs.princeton.edu/schapire/maxent/) to build a habitat suitability model from 2000-2013 pronghorn location data (314 points from aerial surveys and 2,594 from GPS telemetry). The environmental variable that best predicted habitat suitability when used in isolation was terrain substrate, and out of the terrain substrate categories, the four that best predicted habitat suitability were the three categories of areas with semi-stabilized sand dunes and sandy bajadas. However, when variables were tested by omitting them from models, cholla was determined to be the most important variable to the model fit. Pate (2014) also created three seasonal models using a NDVI variable as a surrogate for habitat quality/forage availability for January 2006, August 29 - October 15, 2006, and March 22 - May 8, 2006. The January 2006 and September/October 2006 models better predicted SPH habitat use than the non-temporal model.

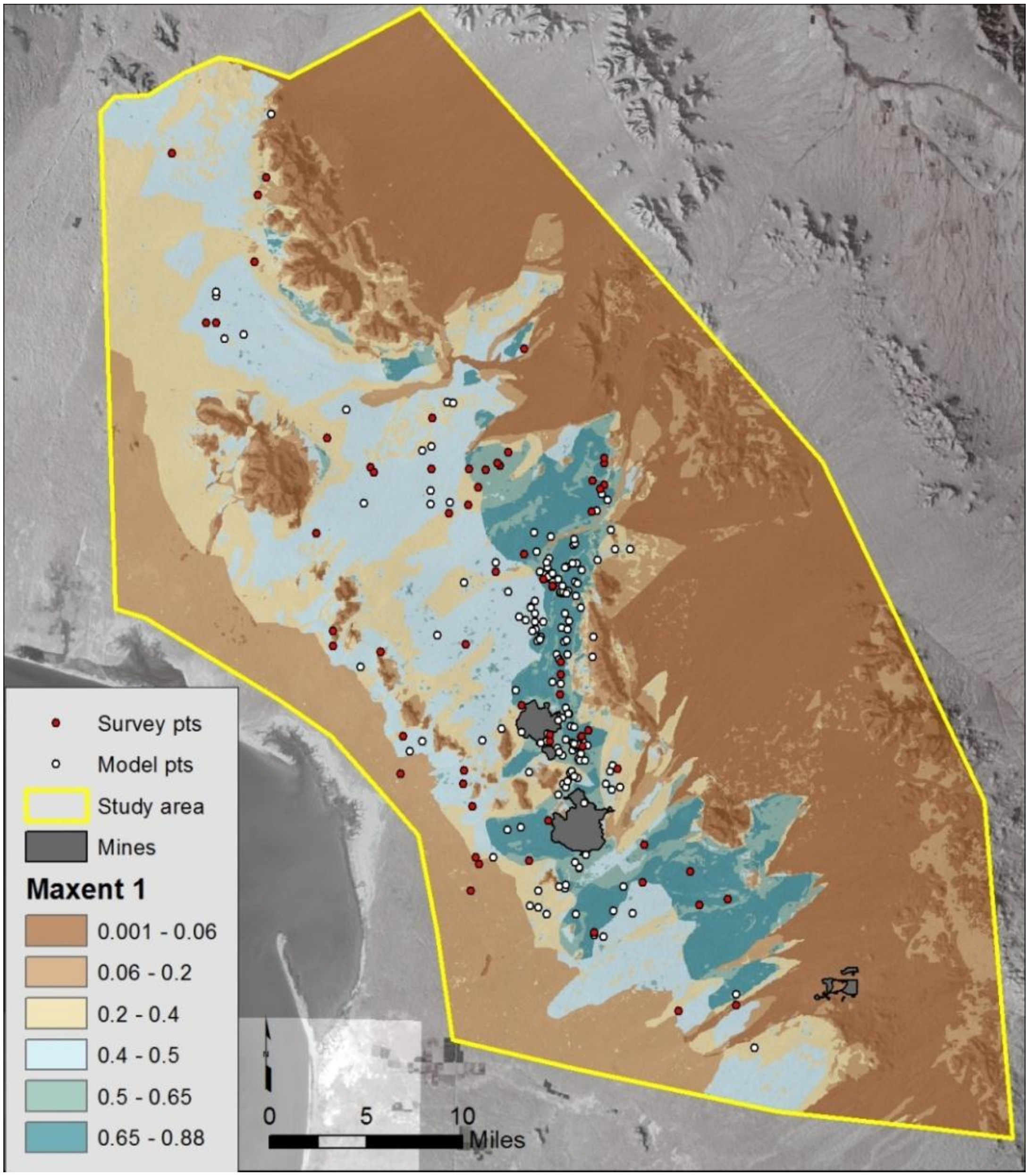

Figure 8. Sonoran pronghorn habitat suitability model for Quitovac population in Sonora, Mexico. Numbers indicate probability of occurrence of Sonoran pronghorn (figure from Pate 2014).

Key ecological attributes

Key ecological attributes are the most important life history and habitat characteristics essential for the conservation of the Sonoran pronghorn. The Recovery Team developed a list of key ecological attributes based on published studies, reports, and expert judgment. The list was developed during an expert workshop held 25-28 June, 2013. The list of key ecological attributes is not an exhaustive list of all life history and habitat needs, but only those that the team felt are so important that if they are degraded, extirpation of a population may occur. The eleven key ecological attributes and justification for their inclusion are as follows:

Habitat attributes:

1. **Amount of habitat.** As discussed previously in *home range and movement* and *habitat area*, Sonoran pronghorn require large areas to make seasonal movements to meet their resource needs as environmental conditions and the availability of forage and water change.
2. **Habitat connectivity.** As discussed in *habitat connectivity,* a large amount of habitat would not benefit pronghorn if habitat gaps or barriers prevent them from moving between areas as conditions change. Therefore the team determined habitat connectivity is also important to Sonoran pronghorn.
3. **Forage quality.** The expert team felt forage quality is one of the most important elements of Sonoran pronghorn habitat because Sonoran pronghorn need high quality forage to meet their diet needs. See the *diet* and *forage quality* sections above for information on vegetation species used by Sonoran pronghorn and factors influencing forage quality.
4. **Succulent foods.** Forage containing large amounts of moisture is believed to be important to Sonoran pronghorn when free water is limited. Chain-fruit cholla is considered a particularly important plant species in the Arizona Upland because the fruit has high quantities of preformed water (up to 85% water by weight) and cholla retain a high moisture content even during the hot dry summer when surface water is unavailable to pronghorn (Fox 1997).
5. **Availability of water**. As discussed in *Water Use,* Sonoran pronghorn require water and use water sources. As discussed in *Water Availability and Access*, drying of historical natural water sources in the current range of Sonoran pronghorn has limited the availability of water essential to the species survival.
6. **Access to water**. Physical barriers and human disturbance are preventing Sonoran pronghorn from using many natural and developed water sources. Sonoran pronghorn must be able to get to water in order to use it.
7. **Variety of vegetation communities and structure.** Because different vegetation communities provide different advantages and disadvantages to pronghorn depending on conditions, the Recovery Team identified Sonoran pronghorn as needing a variety of vegetation communities, with a variety of vegetation structures, to meet their needs as

conditions change temporally and spatially. Having a variety of vegetation communities available to pronghorn enables them to move to different areas as precipitation, temperature, predation pressure, and forage availability change.

Population attributes (Please see the population viability analysis (PVA) (Appendix D) for a detailed analysis of the relationship of population attributes of each population to probability of extinction. The Recovery Team identified the following population attributes as most important in determining long-term survival of Sonoran pronghorn, and justifications are found in the PVA):

8. **Population size.**
9. **Recruitment.**
10. **Survival.**

Other attributes:

11. **Low perceived threat from humans.** The converse of this key ecological attribute, human disturbance, is discussed as a threat, below.

Critical Habitat

Critical habitat has not been designated for Sonoran pronghorn. Section 10(j)(2)(c)(ii) of the ESA precludes the designation of critical habitat for nonessential experimental populations.

Reasons for Listing/Threats Assessment

Because most life history and habitat characteristics naturally vary over space and time, the Recovery Team subjectively determined an acceptable range of variation for each key ecological attribute. The Recovery Team determined, based on expert knowledge, which key ecological attributes are not within an acceptable range of variation and identified them as stressors to the Sonoran pronghorn. Next, the Recovery Team listed the past, present, and future sources of each stressor. The Recovery Team also developed conceptual models showing the relationships between the stressors and their sources (Appendix A). These relationships developed by the team form the basis of the threats discussion below.

The FWS uses five factors to determine threats to a species under Section 4(a)(1) of the ESA. The five factors are considered in determining if a species should be listed as threatened or endangered, and are also used to determine if the species should be downlisted or delisted. Those factors include: a) 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) inadequacy of existing regulatory mechanisms; and e) other natural or manmade factors affecting its continued existence. Because the Sonoran pronghorn was included on the list of endangered species under the ESA through the “grandfather clause”, no analysis of the five factors was conducted when the species was listed. A five factor analysis was included in the 2002 supplement and amendment to the 1998 Recovery Plan and is updated here due to new information on threats to the species. To be consistent with listing, downlisting, and delisting procedures and terminology, the stressors to Sonoran pronghorn identified by the Recovery Team in the conceptual modeling effort are listed below by each of the five ESA listing factors (Table 3).

The stressors and sources of each stressor to Sonoran pronghorn are based on the expert opinion of the Recovery Team. The relationships of some of the stressors to Sonoran pronghorn are well-studied. However, some have not yet been studied and need to be tested to determine to what degree the potential stressors are affecting Sonoran pronghorn. The relationships discussed below and shown graphically in Appendix A should be viewed as working hypotheses that are essential to develop recovery criteria and recovery actions, but in some cases are in need of testing.

Table 3. Summary of threats (stressors and sources) to Sonoran pronghorn by ESA Listing Factor.

ESA Listing Factor	Stressor	Source
A: Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range	Habitat Loss	Mining
		Agriculture
		Livestock Grazing
		Renewable Energy
	Habitat Fragmentation	Habitat Conversion
		Physical Barriers
		Human Disturbance
	Multiple stressors and contributing factor to multiple sources (Reduced availability of water, low annual rainfall, frequency and severity of drought, reduced forage quality, thermal stress)	Climate Change
	Reduced Access to Water	Physical Barriers
		Human Disturbance
		Inadequate Distribution
	Reduced Availability of Water	Low Annual Rainfall
		Increased Frequency and Severity of Drought
		Altered Runoff Patterns
	Reduced Forage Quality	Low Annual Rainfall
		Increased Frequency and Severity of Drought
		Livestock Grazing
		Extreme Heat
		Altered Hydrology
		Altered Fire Regimes
		Increased Cover of Creosotebush
		Invasive Plants
		Erosion
		Lack of Pollination
	Altered Habitat Structure	Fire
		Livestock Grazing
		Military Training

ESA Listing Factor	Stressor	Source
		Renewable Energy
		Mining
		Illegal Extraction
B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes	None	N/A
C: Disease or predation	Predation	Native Predators
	Disease	Interaction with Cattle
	Lack of Genetic Diversity	Barriers to Dispersal and Small Population Size
D: Inadequacy of Existing Regulatory Mechanisms	None	N/A
E: Other Natural or Manmade Factors Affecting Its Continued Existence	Human Disturbance	Border Activities
		Recreation
		Military Activities
		Land Management Activities
		Mining, Ranching, and Agriculture
	High Mortality Rates	Drowning in Canals
		Entanglement in Fences
		Vehicle Collision
		Thermal Stress
		Poaching
		Capture -related mortality
		Military Activities
	Catastrophic Events	Lack of Redundancy of Populations
		Small Population Size

ESA Listing Factor A: Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

This listing factor includes most of the major stressors to Sonoran pronghorn, including habitat loss, habitat fragmentation, reduced forage quality, and changes in habitat structure.

Habitat Loss

Historically, most of the habitat for Sonoran pronghorn has been lost, fragmented, or excluded from use as a result of urbanization, agriculture, railroad and highway development, and grazing practices (Appendix A). Presently, Sonoran pronghorn only occupy approximately 12% of their historical range. Because nearly all occupied Sonoran pronghorn habitat in the range of the Cabeza Prieta population is in federal ownership and therefore protected from destruction that would jeopardize the species' existence by the ESA, current and future habitat loss is only a minor threat to this population. The habitat of the Pinacate population in Sonora is also protected from most sources of habitat loss by the Reserva de la Biosfera de El Pinacate y Gran Desierto de Altar (El Pinacate Biosphere Reserve). However, some land uses, such as agriculture, are allowed in the El Pinacate Biosphere Reserve that may result in loss and fragmentation of habitat.

The Kofa population could be threatened by habitat loss, but most lands have some level of protection from habitat loss. Lands managed by FWS in the Kofa population area comprise 23% of the area, including Kofa NWR (2691.2 km^2 [1,039.1 mi^2]), Imperial NWR (75.1 km^2 [29.0 mi^2]), and Cibola NWR (45.6 km^2 [17.6 mi^2]; U.S. Fish and Wildlife Service 2010a). These FWS lands are managed for wildlife habitat and are primarily protected from habitat loss. BLM lands are managed for multiple uses and comprise 43% of the Kofa area; they are managed by two offices: the Yuma Field Office in the Colorado River District and the Lower Sonoran Field Office in the Phoenix District (U.S. Fish and Wildlife Service 2010b). Department of Defense lands in the Kofa area comprise 27.1% of the area (U.S. Fish and Wildlife Service 2010b). State lands (4.6% of the Kofa area) include 9.1 km^2 (3.5 mi^2) of AGFD lands (Painted Rock Wildlife Area, managed for wildlife habitat) and 558.4 km^2 (215.6 mi^2) of State Trust Lands, managed to maximize revenue for state schools. Bureau of Reclamation lands, tribal lands, and private lands comprise only 2.8% of the area (U.S. Fish and Wildlife Service 2010b).

The Sauceda population could also be threatened by habitat loss, but has some level of protection. The majority of land (53%) in the Sauceda population area is managed by the Tohono O'Odham Nation (U.S. Fish and Wildlife Service 2010b). BLM lands are managed for multiple uses and comprise 23% of the Sauceda area; they are managed by the Lower Sonoran Field Office in the Phoenix District (U.S. Fish and Wildlife Service 2010b). Department of Defense lands in the Sauceda area comprise 21% of the area (U.S. Fish and Wildlife Service 2010b). State of Arizona, county, and private lands comprise 3% of the area (U.S. Fish and Wildlife Service 2010b).

In contrast to the other three existing populations, the Quitovac population is entirely on lands with little protection from habitat alteration. Some of the land is private land and some of the land is ejidos (communally-owned lands). Habitat loss is the greatest stressor to this population, which is the largest of the five existing Sonoran pronghorn populations.

Mining

Mining is probably the most significant current and potential source of habitat loss for the Quitovac population. There are two mining operations currently affecting this population. The largest operation, La Herradura, is an open pit gold mine. When the La Herradura project was initiated in 2000, it was little more than 3.2 km^2 (1.2 mi^2) on the southwest side of the Juan Alvarez Ejido. At that size, the project offered posed little risk to the conservation of the pronghorn and its habitat. The mine has expanded in a southeasterly and northwesterly direction and currently occupies approximately 41.63 km^2 (16.07 mi^2) of Sonoran pronghorn habitat and continues to expand rapidly (Figures 9 and 10). The area occupied by the mine formerly contained habitat with a high probability of occupancy by Sonoran pronghorn (Figure 8). A second open pit operation, a new mining project called Nochebuena, was initiated approximately 15 km (9 mi) southeast of La Herradura in 2011. The mining operation removes all vegetation from the land (Figures 11 and 12). Sonoran pronghorn habitat use in 2006 was seasonally concentrated in areas around the La Herradura mine, within habitat that was converted to mining operations after 2006 (Pate 2014). However, the mine does practice restoration, and Sonoran pronghorn have been observed using areas replanted with cactus. The mining company has expressed an interest in working with Comisión de Ecologia y Desarrollo Sustentable del Estado de Sonora (CEDES) on conservation of Sonoran pronghorn (Cristina Melendez, CEDES, personal communication 2013). Factors leading to mine expansion include a high price of gold, improved mining technology, availability of materials, and lack of or weak regulations and/or enforcement of those regulations. Land protection laws favor economic uses over species conservation; this contributes to rapid expansion of the mines and loss of Sonoran pronghorn habitat. In addition, incentives to protect land in the area are lacking. The effects of this mine expansion have not been thoroughly evaluated due to limited information and limited access to the site.

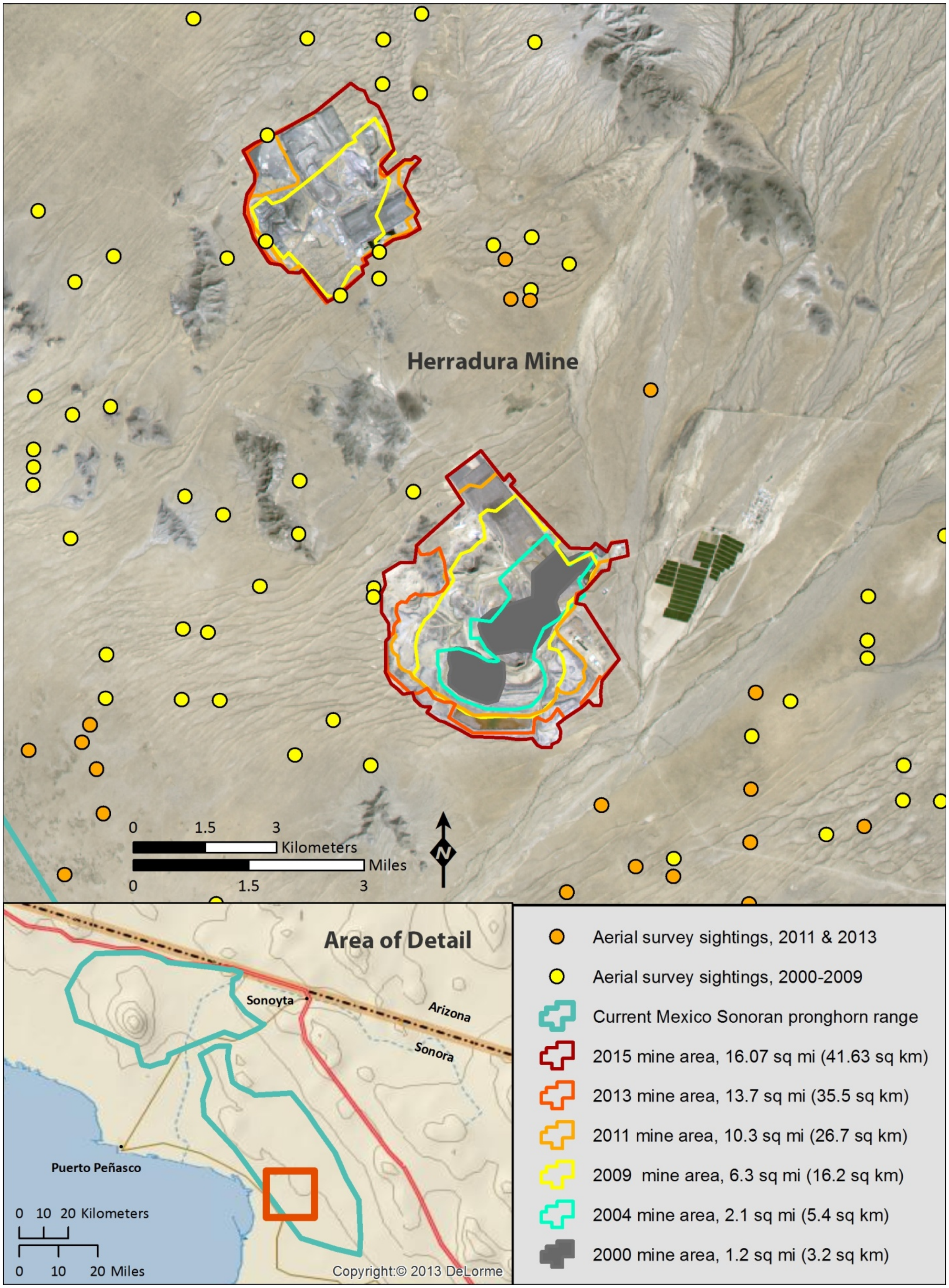

Figure 9. La Herradura Mine expansion and Sonoran pronghorn locations, Sonora, Mexico.

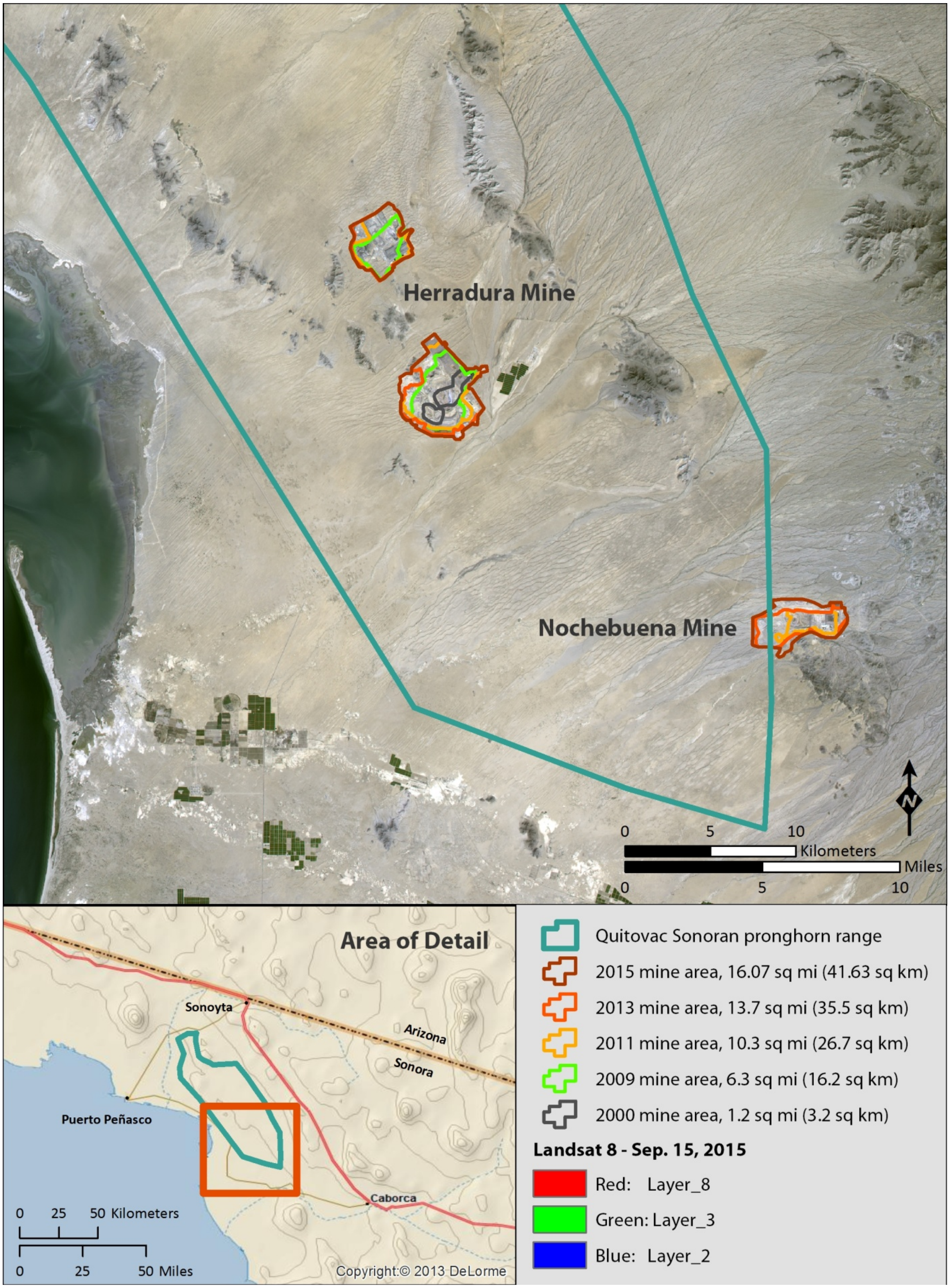

Figure 10. Additional mine (Nochebuena) near La Herradura in Sonora, Mexico.

Figure 11. La Herradura gold mine, Sonora, Mexico. Photo courtesy Ami Pate.

Figure 12. Mine tailings in Quitovac population area, Sonora, Mexico. Photo courtesy Ami Pate, Organ Pipe NM.

Mining could also occur on BLM land, but only poses a minor threat to the populations at Cabeza Prieta, Kofa, and possibly Sauceda. Mining operations have the potential to cause habitat loss through vegetation clearing on the mine site, and construction of infrastructure in support of mining operations, such as roads, power lines, and water supplies. On BLM-managed lands, mining occurs pursuant to the Mining Law of 1872 (30U.S.C. 21 *et seq.*). Under this Act, U.S. citizens and businesses are free to prospect for hard rock (locatable) minerals, such as silver, gold, copper, and platinum, among others, on the public domain open to such activities. If in the course of exploration, a valuable mineral deposit is discovered, a mining claim can then be filed, giving the claimant the exclusive possessory right to develop that prospect. The BLM regulates surface activities associated with mining on BLM-administered lands, which are subject to federal laws, regulations, and policies. In addition to the 1872 Mining Law, overall guidance on the management of mineral resources is defined by: the Mineral Leasing Act of 1920, the Mineral Materials Act of 1947, the Domestic Minerals Program Extension Act of 1953, the Mining and Minerals Policy Act of 1970, the Federal Land Policy and Management Act of 1976, the National Materials and Minerals Policy, Research and Development Act of 1980, BLM's Minerals Resources Policy of May 29, 1984, and the Energy Policy Act of 2005. Section 302 of Federal Land Policy and Management Act of 1976 directs the Secretary to manage public lands under the principles of multiple use and sustained yield in accordance with land use plans developed under the Act. Mining activities must generally conform to BLM Resource Management Plans (RMP), which are subject to the National Environmental Policy Act (NEPA). Notable exceptions from the NEPA process include casual use (e.g., hand tools) and notice level locatable minerals activities (e.g., mechanized earth moving equipment, less than 2 ha (5 ac) of surface disturbance and less than 1,000 tons of presumed ore) conducted pursuant to 43 Code of Federal Regulations (CFR) 3809. However, operations greater than casual use level conducted on lands or waters known to contain proposed or listed species or their proposed or listed critical habitat, require Plans of Operations [43 CFR 3809.11(c)(6)], which are subject to NEPA review. Exemption from the NEPA process for some mining operations does not extend to exemption from the ESA.

According to BLM's Land and Mineral Legacy Rehost 2000 System (LR2000), as of September 2014 there were approximately 500 mining claims within the BLM-managed Sonoran pronghorn habitat. The majority of claims are casual use claims, but 29 of them are Notice Level claims: six managed by the Lower Sonoran Field Office and 23 managed by the Yuma Field Office. These 80 ha (197.63 ac) of Notice Level claims have been authorized under a Plan of Operation or Notice Level activity within the Kofa reintroduction area. In addition to these 29 claims, the Yuma Field Office also has had three pending Notice Level authorizations which total an additional 39 ha (96.5 ac). The current largest mining claim within Kofa population area totals 6 ha (15 ac) and is run by Fancher-Luxor, but is not currently in operation.

Agriculture

Agriculture is a source of habitat loss for the Quitovac population, as the Quitovac area has much private and communal (ejido) land and very few regulations to prevent conversion of habitat to agriculture. Sonoran pronghorn habitat could also be lost to agriculture in the Pinacate population area, but to a much lesser extent than in the Quitovac area. Although the Pinacate population is in a biosphere reserve, some agriculture is allowed. Agriculture is prohibited in the nucleus zone of the bioreserve, but in the buffer areas outside the nucleus zone there is less habitat protection and agricultural activities occur on ejidos and private lands (Areas Naturales Protegidas 1995). Agricultural activities are expensive to operate due to the costs of pumping and transporting water, and operate at a subsistence level on ejidos and private farms (Areas Naturales Protegidas 1995). Ejidos and private farms obtain agriculture permits for planting areas that range between 30 and 40 ha (74 and 98 ac) for the production of livestock forage, including alfalfa, wheat, and other forage. However, lack of access to water and dysfunctional hydrologic infrastructure has limited development of agriculture in the bioreserve (Areas Naturales Protegidas 1995). The Cabeza Prieta, Kofa, and Sauceda populations occur primarily on public lands and are therefore protected from most major sources of habitat loss.

Livestock Grazing

Historical livestock grazing, and to a lesser extent current livestock grazing, has caused loss of habitat for Sonoran pronghorn. Historical livestock grazing was extensive and severe (causing erosion of soil, soil compaction, changes in composition of flora and fauna, and an increase of woody shrubs) and destroyed habitat for pronghorn throughout their range (Brown and Ockenfels 2007). Domestic livestock altered the vegetation of southeastern Arizona and northeastern Sonora, Mexico, causing changes in species composition and vegetation structure by increasing the abundance of shrubs such as mesquite (Bahr 1991). It is likely those changes also occurred in southwestern Arizona and northwestern Sonora in the range of Sonoran pronghorn. Cattle numbers were at their peak in the 1890s when severe, extended drought occurred throughout the region, which exacerbated the effects of the already severe overgrazing (Bahr 1991). Habitat alteration (caused in part by livestock grazing) was a leading cause in the decline in Sonoran pronghorn numbers (Wright and deVos 1986). Changes were so severe as to result in complete loss of habitat over a substantial portion of the Sonoran pronghorn’s historical range. Accurate figures describing livestock numbers in the historical range of Sonoran pronghorn are sparse, but Rutman (1997) cites estimates of 1,000 head of burros and horses in 1942 on the southern half of Organ Pipe Cactus NM, and as many as 3,000 cattle on the monument at one time. Current livestock grazing is not a continued source of habitat loss in most areas, but may reduce forage quality and habitat structure (see discussions under “reduced forage quality” and “altered habitat structure” sections below).

Renewable Energy

The Sonoran Solar project has been permitted on BLM land but has not been built because there is not a power purchase agreement in place. The project is outside the 2015 range of Sonoran pronghorn but is within the Sonoran pronghorn nonessential experimental population area. The Maricopa Solar Park also is outside the 2015 range of Sonoran pronghorn but is within the nonessential experimental population area. This project is pending a permit but has been put on hold by the applicant. Solar energy zones from the BLM National Solar Preliminary Environmental Impact Statement are areas now identified in BLM resource management plans for utility scale solar development. The Preliminary National Solar Preliminary Environmental Impact Statement identified two Solar Energy Zones in Arizona (Brenda and Gillespie). One of these, the Gillespie, is within the nonessential experimental population area. These two proposed Solar Energy Zones in Arizona encompass 2,616 ha (6,465 ac) (Bureau of Land Management 2012b). There are no active applications or otherwise pending projects on any Arizona Solar Energy Zones at this time (Lane Cowger, BLM, personal communication, 2014). In addition, the Restoration Design Energy Project was an Arizona planning initiative. It identified an additional Solar Energy Zone (Agua Caliente) as well as 77,699 ha (192,000 ac) of renewable energy development areas, lands potentially suitable for renewable energy, not just solar (Bureau of Land Management 2012b). The Maricopa Solar Park mentioned above is mostly in one of these renewable energy development areas. There are no other active applications in renewable energy development areas.

Habitat Fragmentation

Sonoran pronghorn habitat may be fragmented by habitat conversion, physical barriers, and human disturbance. Physical barriers that fragment Sonoran pronghorn habitat include border infrastructure, fences along roads and for livestock management, paved roads, railroads, canals, transmission corridors, and mines. Human disturbance may also prevent pronghorn from using an area, and areas with extensive human use may function as a barrier to pronghorn despite otherwise suitable habitat conditions.

Fragmentation Caused by Habitat Conversion

Incompatible land uses such as mining or agriculture may fragment the Sonoran pronghorn habitat in the Quitovac area into isolated patches. Fragmentation is caused by the same sources as for “habitat loss” discussed above (mining, agriculture, and livestock grazing). The La Herradura mine, in particular, occupies approximately 25 square kilometers of formerly prime Sonoran pronghorn habitat for the Quitovac population. The band of high suitability habitat is narrow, and if the mine is expanded across this band, it may become a barrier between the high suitability habitat on the south end of the range and the high suitability areas farther north (Figure 8) (Pate 2014). In addition, the La Herradura and Nochebuena mines are connected by a 10 m (33 ft) wide access road that causes habitat disturbance up to 20 m (66 ft) on either side of the road and divides the area of pronghorn habitat into two sections. These two mining projects are located in a natural movement corridor for Sonoran pronghorn. If the Sonoran pronghorn population in this area were split into two populations by mining, each population would likely suffer from the deleterious effects of small, isolated population size such as loss of allelic diversity, inbreeding, and demographic losses due to random and catastrophic events. Additionally, the current population moves across its entire current range in search of forage that may shift locations from year to year and from season to season in response to sporadic rainfall patterns. If the area is further fragmented by the mines, pronghorn may no longer be able to make these movements resulting in reduced access to suitable habitat.

Habitat for all the other populations could also be fragmented by conversion to other land uses; however, because these populations primary occur on federally managed lands, land uses changes are more regulated. Pinacate population could also be fragmented by agriculture and livestock grazing and associated fences. Although each of these sources of habitat conversion is less severe than in Quitovac, the Pinacate population is smaller and less resilient to stressors such as habitat fragmentation. Although historical habitat conversion was one of the major causes of Sonoran pronghorn population declines throughout its range, currently very little habitat conversion occurs in the U.S. endangered population (Cabeza Prieta) because most of it is federally-owned and managed for Sonoran pronghorn under the ESA. The nonessential experimental population area is also mostly federally-owned and managed.

Fragmentation Caused by Physical Barriers

Physical barriers to pronghorn movement include fences, highways, canals, railroads, and transmission lines. Fences, in particular, are a barrier because pronghorn are reluctant to jump fences. If they do attempt to cross a fence, they normally will try to crawl under it. Fences with a bottom strand less than 41 cm (16 in) from the ground are impassible to pronghorn (Brown and Ockenfels 2007). A fence needs to have a smooth bottom wire, have the bottom wire at least 41 cm (preferably 51-56 cm [20-22 in]), above the ground, and have no more than two stays between posts to be passable for pronghorn (Brown and Ockenfels 2007). Many barbed-wire fences and all woven-wire (e.g., field fence or sheep fence) fences are impassable to pronghorn. Most fences within the range of Sonoran pronghorn are along roads or for livestock management. Fences occur within the range of all populations, but the Cabeza Prieta population is relatively contiguous (U.S. Fish and Wildlife Service 2006) and some former barriers (e.g., fencing between Organ Pipe Cactus NM, Cabeza Prieta NWR, BLM, and BMGR) have been removed or modified to allow passage by pronghorn. Fences have also been removed or modified in El Pinacate Biosphere Reserve. The international border fence between Mexico and Organ Pipe Cactus NM and Cabeza Prieta NWR is primarily a vehicle barrier fence that is passable by pronghorn.

Highways are also significant major barriers, particularly when accompanied by right-of-way fencing and high traffic volume. Pronghorn that succeed in crossing fences into right-of-ways may not easily cross fencing to exit the right-of-way and can become trapped and susceptible to being hit by vehicles. Observations of Sonoran pronghorn crossing highways are rare, and those that do cross are at risk of being hit by vehicles, as documented along U.S. Interstate 8, Arizona Highway 85, and Mexico Highway 8 (see section *Vehicle Collisions*, below, for more information).

Only one occurrence of a Sonoran pronghorn crossing U.S. Interstate 8 has been documented (Phelps 1981). Documentation of Sonoran pronghorn crossing Highway 85 was very rare prior to pronghorn releases from the captive breeding pen (just 1 occurrence was documented in 1996 [U.S. Fish and Wildlife Service 1998, U.S. Fish and Wildlife Service 2002]). However, since 2013 a number of collared pronghorn released from the pen have been documented to cross Highway 85 within Organ Pipe Cactus NM where no right-of-way fencing exists along the highway (Jim Atkinson, Cabeza Prieta NWR, personal communication 2016). In 2013, a release pen was constructed in the Valley of the Ajo on Organ Pipe Cactus NM about two miles west of Highway 85. Some animals released from this pen crossed Highway 85 to the east and subsequently returned to the west. Additionally, in 2008, a radio-collared buck (#851) recently released from the pen at Cabeza Prieta NWR crossed Highway 85 within BMGR where right-of-way fencing exists (U.S. Fish and Wildlife Service 2010b).

Documentation of Sonoran pronghorn crossing Mexico Highway 8 is rare. In January 1991 a pregnant Sonoran pronghorn female was found dead just a few hours after it had been killed by a mountain lion at the base of a small hill in the San Francisco Sierra foothills; this same animal had been radio collared in the El Pinacate Biosphere Reserve west of Mexico Highway 8 and the corpse was found east of Mexico Highway 8, indicating the individual must have successfully crossed the highway (Castillo 1999). Only two other reliable records of Sonoran pronghorn crossing Mexico Highway 8 were recorded prior to 1999 (Castillo 1999). Unconfirmed reports of Sonoran pronghorn crossing Mexico Highway 8 are occasionally received from residents of Puerto Peñasco (U.S. Fish and Wildlife Service 2002), although no radio-collared Sonoran pronghorn have ever been recorded crossing this highway (U.S. Fish and Wildlife Service 2002; J. Bright, AGFD, personal communication, 2015).

Mexico Highway 2 is also a barrier to Sonoran pronghorn movement, and documentation of Sonoran pronghorn crossing this highway is limited. In 1999 the El Pinacate Biosphere Reserve staff observed a group of five animals (three juveniles and two adults) crossing this highway (Castillo 1999). In 2008, one radio-collared buck (#851) recently released from the breeding pen at Cabeza Prieta NWR crossed Mexico Highway 2 multiple times (AGFD, unpublished data 2008). Construction of two underpasses along Highway 2 in 2013 is hoped to facilitate safe crossing by Sonoran pronghorn (for more details, see the *Recent Conservation Programs and Management Efforts for Sonoran Pronghorn in Mexico* section).

While Sonoran pronghorn have not been documented to use underpasses, American pronghorn have been documented to use highway underpasses, but use is low (Plumb et al. 2003, Sawyer and LeBeau 2011). Sawyer and Rodgers (2015) found American pronghorn strongly preferred overpasses to underpasses in one study in Wyoming. Over three years of the study, 90 percent of pronghorn traveled over the highway (n=22,710) and only 10 percent moved under (n=2,546). Prior to overpass and underpass construction (2005 – 2012), the total number of mule deer and pronghorn wildlife vehicle collisions was 662, with an average of 85 per year. Of those, only 9 percent involved pronghorn. By the third year following overpass and underpass construction, pronghorn-vehicle collisions were completely eliminated. Without overpasses, the Recovery Team considers highways to be barriers to Sonoran pronghorn movement.

Canals also pose significant major barriers, and those pronghorn that do attempt to cross canals may drown. Canals have been the cause of seven Sonoran pronghorn deaths since 2008 and pose significant barriers to the Cabeza Prieta and Kofa populations (see section *Drowning in canals*, below, for more information). Railroads and transmission lines may also be barriers to Sonoran pronghorn movement, but their influence on Sonoran pronghorn movement has not been described. No estimates of the length of any barriers within any of the management units are available.

Habitat Fragmentation Created by Human Disturbance

Human disturbance may prevent Sonoran pronghorn from entering an area and therefore may essentially fragment habitat. For example, human disturbance may prevent pronghorn from reaching water sources. Actions that may cause human disturbance and evidence for their influence on Sonoran pronghorn are discussed further under Listing Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence.

<u>Climate Change</u>

Our analyses under the ESA include consideration of ongoing and projected changes in climate. The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). “Climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (Intergovernmental Panel on Climate Change 2007). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (Intergovernmental Panel on Climate Change 2007). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (Intergovernmental Panel on Climate Change 2007). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

For the Southwestern U.S., Garfin et al. (2013) predict the following influences of climate change:

1. Warming is expected to continue, with longer and hotter heat waves in summer.
2. Average precipitation will decrease in the southern Southwest and perhaps increase in northern Southwest.
3. Precipitation extremes in winter will become more frequent and more intense. Precipitation extremes in summer have not been adequately studied.
4. Late-season snowpack will continue to decrease.
5. Declines in river flow and soil moisture will continue.
6. Flooding will become more frequent and intense in some seasons and some parts of the Southwest, and less frequent and intense in other seasons and locations.
7. Droughts in parts of the Southwest will become hotter, more severe, and more frequent

Strittholt et al. (2012) analyzed average annual temperature projections, seasonal summer temperature (July–September), and winter temperature (January–March) as simulated by the ECHAM5-driven RegCM3 models for the Sonoran Desert Ecoregion specifically. Results show that the ecoregion is expected to undergo general warming over the entire region with a > 2° Celsius increase by 2060 in some locations, particularly in the southwestern portion of the ecoregion. Average summer temperatures are expected to increase, but greater increases are projected to occur during the winter months.

Climate change is a likely contributor to the stressors of increased frequency and severity of drought, low annual rainfall, and extreme heat discussed in the sections on “reduced availability of water” and “reduced forage quality”. It is also a likely contributor to the stressor of thermal stress, a contributor to high mortality rates discussed under “ESA Listing Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence.”

Reduced Availability of Water

The most significant potential impact of global climate change on Sonoran pronghorn is its potential to increase the frequency and severity of drought. More dry days, warming temperatures, and increased evapotranspiration are expected to result in more severe drought in the Southwestern United States (Gershunov 2013). Future droughts are expected to become more frequent and severe, with 100-year droughts common in the second half of this century (Gershunov 2013). Drought was the factor causing extreme mortality of Sonoran pronghorn in 2002, and as discussed in the life history section above, drought is the most important predictor of survivorship and recruitment. Similarly, global climate change could cause annual rainfall to lessen. Precipitation is projected to drop by five percent by century's end (relative to average precipitation over the last three decades of the 20th century) for much of Arizona and New Mexico, based on results from 18 global climate models (Seager et al. 2007). A ten percent decline could occur over the southern half of Arizona based on these estimates (Seager et al. 2007). Winter storms could enter the western United States in a more northerly position, bypassing the Southwest more often than it currently does. Summer precipitation may also decrease, but is more difficult to predict (Lenart 2008). Specifically in the Sonoran Desert Ecoregion (the only ecoregion where Sonoran pronghorn occur) GCM-driven RegCM3 regional climate model projections show significant declines in annual precipitation during the time period of 2015 to 2030 with severe drought occurring in some areas (Strittholt et al. 2012). Over the 2045–2060 timeframe, precipitation is projected to slightly increase over historical levels in parts of the eastern portion of the ecoregion (the portion of the ecoregion where pronghorn are less likely to occur), particularly during the fall (October–December) (Strittholt et al. 2012).

Other factors contributing to reduced availability of water include the historical drying of the Gila and Sonoyta Rivers following European settlement of the region. In addition, altered runoff patterns resulting from development, agriculture, soil compaction, and other anthropogenic influences on watersheds may cause flows to natural and surface-fed man-made water sources to be of greater intensity but occur less regularly. This pattern may result in water sources drying out between storms.

The ability of current water developments to supply reliable water as the climate changes is unknown. Reductions in annual rainfall, coupled with hotter temperatures are likely to bring higher evaporation rates, much as they do during summer compared to winter. As a result, dry spells between rains can have more severe impacts on the landscape, especially in spring and summer (Lenart 2008). It is likely that some smaller existing water sources may dry out in spring and summer. While the region is expected to dry out, it paradoxically is likely to see larger, more destructive flooding. Because warm air holds more water vapor than cooler air, climate models project a future increase in atmospheric water vapor along with the increase in global temperature (Lenart 2008, Garfin 2013). This creates conditions that potentially could lead to bigger and more frequent floods by causing more intense, heavy rainfall events (Lenart 2008). Intense rainfall events are more likely to carry rainwater quickly away from the area in intense floods, with less water reaching the aquifers or remaining as semi-permanent water. MAPSS models for the Sonoran Desert Ecoregion predict surface runoff will slightly increase over the near term, and slightly decrease over the 2045–2060 time frame (Strittholt 2012). The decrease in runoff would result in less water in many water developments.

Reduced Access to Water

Access to water is limited by two primary sources 1) barriers between Sonoran pronghorn and water sources, and 2) inadequate distribution of water, making it too far for individuals to travel to get to water. Physical barriers may exist due to the development of fences, paved roads, railroads, canals, transmission corridors, mines, border infrastructure, military infrastructure, dense stands of salt cedar (*Tamarix ramossisima*) along the Sonoyta River in Sonora, and human disturbance. Barriers between Sonoran pronghorn and water sources may have been a source of historical population declines as pronghorn were no longer able to access the Rio Sonoyta or Gila rivers. These rivers are now mostly dry. Current barriers exist between pronghorn and occasional flowing sections of the Rio Sonoyta, springs, or man-made water sources (see discussion of barriers under “Habitat fragmentation” above for more information on the types of physical barriers impenetrable by pronghorn). Human disturbance may also prevent Sonoran pronghorn from accessing water sources currently available (see “human disturbance” below for a discussion of human disturbance). In addition, the limited distribution of water sources force Sonoran pronghorn to travel long distances to get to water.

Reduced Forage Quality

Sonoran pronghorn need quality forage to meet their nutritional needs and fawns are particularly vulnerable to low-quality forage. In years with poor winter rainfall, the nutritional quality of forage may be insufficient to keep fawns alive (Bright and Hervert 2005). Therefore, the Recovery Team has hypothesized that poor quality forage may be a stressor to Sonoran pronghorn. The Recovery Team has indicated that sources of reduced forage quality are an increase in the frequency and severity of drought, low annual rainfall, altered hydrology, extreme heat, erosion, fire, invasive plants, increase of creosotebush, lack of pollination of forage plants, and livestock grazing (Appendix A).

Since 2005, the Recovery Team has attempted to reduce the effects of reduced forage quality in the Cabeza and Kofa populations by providing irrigated forage, hay, and water. Reduced forage quantity was not determined to be a threat by the Recovery Team experts.

Low annual rainfall

Low annual rainfall reduces the amount of quality forage available to Sonoran pronghorn. Low winter precipitation results in sparse growth of forbs in the spring, which may negatively impact the condition of lactating females and their nursing fawns (Bright and Hervert 2005). The timing of precipitation may also affect forage quality. Bright and Hervert (2005) found the number of fawns recruited was inversely correlated to the number of days between the last winter rain and the first summer rain and suggested delayed onset of summer rains results in scarce forage and increases the mortality rates.

Changes in the magnitude, frequency, or timing of precipitation and increases in temperature and atmospheric concentrations of carbon dioxide as a result of global climate change will likely affect soil organisms, vegetation composition, and ecosystem processes in Southwestern deserts (Fleishman et al. 2013). These changes would affect the quantity and species composition of forage available to Sonoran pronghorn. Highly variable precipitation can also affect forage quality because it would result in large fluctuations of nutrients in soils and plants (Fleishman et al. 2013). Strittholt (2012) modeled changes to vegetation in the Sonoran Ecoregion that may occur with climate change. They used MAPSS models to predict the types of vegetation that would be supported under the given set of climate and soil conditions without human influence. MAPSS does not take into account human management of natural landscapes or its long term legacy (e.g., water management, logging, grazing, etc.). It only uses climate and soil data to simulate potential vegetation cover. The MAPSS models used by Strittholt (2012) indicate desert subtropical vegetation in the Sonoran Desert Ecoregion is likely to decreases in cover by 1934 ha (4,780 ac) from 2045-2060. They discussed potential effects of climate change on the Sonoran Desert Ecoregion:

The model projections show very dry annual and summer conditions during the 2020s, and slightly wetter conditions around 2050 (although still drier than historic mean). Winter precipitation increases slightly over both time periods. Winter and warm season rainfall influence germination and distribution of many Sonoran Desert plant species. With warmer, somewhat drier conditions, desert subtropical vegetation, such as creosotebush-white bursage in the Colorado Desert of California and southwestern Arizona, is projected to expand in the 2015–2030 time period, but then recede in 2045–2060 replaced by an expansion of semi-desert C4 grasses (see Glossary). Even this drought resistant community has limits. Creosotebush is susceptible to prolonged drought and its distribution is correlated with winter precipitation (Marshall 1995, Munson et al. 2011). Munson et al. (2011), in a study of the effects of climate variability on Sonoran Desert vegetation communities over the last century, found that the cover of creosotebush decreased with increased aridity and a decrease in winter precipitation (below 135 mm). They also noted that in years with high temperatures the cover of foothills paloverde and ocotillo decreased and cacti increased in the Arizona Upland. Recent drought in the early 2000s also caused nearly complete mortality of white bursage and other subshrubs in the California portion of the Sonoran and Mojave Deserts (McAuliffe et al 2010).

Increased frequency and severity of drought

Drought limits the availability of quality forage and water. During the extreme drought of 2002, four out of five (80%) of collared Sonoran pronghorn in Arizona died, and the population declined to 21 individuals (Bright and Hervert 2005). Nutritious forage was largely unavailable or dry, and the mortalities were likely due to lack of quality forage (Bright and Hervert 2005). In addition, drought may contribute to mortalities from predation because pronghorn use denser vegetation types to obtain moist vegetation and thermal cover during drought, but they are more susceptible to predation in these areas (Bright and Hervert 2005). The primary source of increased frequency and severity of drought is climate change (see *climate change* and *reduced availability of water* sections above for discussion and citations). In the last 20 years, extreme drought (less than 50% of average annual rainfall) has occurred three times, with one event spanning two years (1995-1996), throughout the Arizona range of Sonoran pronghorn. Staff of Cabeza Prieta NWR evaluated rainfall averages from Organ Pipe Cactus NM, Ajo, and Tacna weather stations (Western Regional Climate Center 2014). Rainfall data from 1969 - 2003 indicate average annual rainfall is 17.7 cm (6.97 in) for the three sites (Cabeza Prieta NWR unpublished data). Annual rainfall was less than 50% of this average in 1995 (8.7 cm [3.43 in]), in 1996 (8.15 cm [3.21 in]), in 2002 (4.22 cm [1.66 in]), and in 2009 (6.76 cm [2.66 in]; Cabeza Prieta NWR unpublished data).

Livestock Grazing

Livestock grazing can cause reductions in forage quality by altering forage species abundance and composition. Cattle may compete with Sonoran pronghorn for forage; however, no studies have focused on dietary competition of cattle with the Sonoran subspecies of pronghorn, therefore we do not know the extent to which this may occur in areas where Sonoran pronghorn and cattle overlap. Yoakum (2004) reviewed the relationships of pronghorn (other subspecies) to livestock. Impact of livestock grazing on pronghorn habitat are complex, including modification of plant biomass, species compositions, and structure. He reviewed studies of dietary overlap of cattle with other subspecies of pronghorn (none were available for the Sonoran subspecies). Of these 13 studies, three found a high (>25%) overlap of forbs, and two found a high overlap of shrubs. Overlap of forbs ranged from 0.2 -19.0%, and overlap of shrubs ranged from 0-39%. Overlap of grasses (which are not reported to be a significant portion of Sonoran pronghorn diets) ranged from 0-46.3%, with only one study reporting overlap >10%. The vegetation and pronghorn diet in these study areas differ considerably from that in the range of the Sonoran pronghorn. Competition between pronghorn and cattle can potentially occur on a seasonal basis or during drought conditions and has been reported in New Mexico and Texas (Yoakum 2004). Kie et al. (1994) suggest indirect impacts include “ 1) gradual reductions in the vigor of some plants and in the amount and quality of forage produced, 2) elimination or reduction of the ability of forage plants to reproduce, 3) elimination of locally important cover types and replacement by less favorable types or communities, either by direct actions over time or by changing the rate of natural succession process, and 4) general alterations and reduction in the kinds, qualities and amounts of preferred or otherwise important plants through selective grazing or browsing or other activities.” Yoakum (2004) stated “Possibly the greatest impact of livestock grazing on pronghorn populations has been changes in plant succession and intensive foraging on fawning areas.” To what extent any of these effects reported in other pronghorn subspecies occur in the range of the Sonoran pronghorn species remains unknown.

Displacement of pronghorn by cattle has not been studied in Sonoran pronghorn. Based on other subspecies, it appears possible but unlikely, as Yoakum (2004) reports most of nine studies focusing on pronghorn/cattle interactions have reported on nonaggressive association, although one study reported pronghorn avoid pastures with cattle.

For more information on historical livestock grazing, which likely had severe impacts on forage quality, see the livestock grazing source of “habitat loss” above. Livestock grazing is no longer permitted on the Cabeza Prieta NWR, BMGR, Organ Pipe Cactus NM, or Kofa NWR. The BMGR was closed to livestock use in 1941 (Executive Order 8892), although trespass grazing occurred, at least sporadically, until the late 1970s (U.S. Fish and Wildlife Service 2006). Cattle were removed from Organ Pipe Cactus NM in 1978 (U.S. Fish and Wildlife Service 1998) and Cabeza Prieta NWR in 1981 when the last permit expired (U.S. Fish and Wildlife Service 2006). However, trespass cattle, horses, and burros from BLM, the Tohono O’odham Nation, private lands, and Mexico continue to graze the closed areas.

Burros, in particular, appear to be expanding in numbers, particularly in the BMGR (east of Highway 85), and have caused observable damage to native vegetation (U.S. Department of the Air Force and U.S. Department of the Navy 2012). Competition for forage between burros and Sonoran pronghorn has not been studied, but diet of burros at Sheldon NWR in Nevada overlapped 25% with American pronghorn (6.8% overlap of shrubs, 8.8% overlap of forbs, and 9.9% of grasses). Trespass burros in the area do not fall under Wild Free-Roaming Horses and Burros Act of 1971, as amended. To be considered "wild" and therefore covered under The Act, the animals had to have been documented in the area at the time The Act was passed. Because donkeys or horses were not observed in the area at that time, no herd area was established. Therefore, any cattle, horses, or donkeys not authorized under a grazing permit are in fact considered to be "estrays" and in trespass. Trespass livestock are covered under 43 CFR Subpart 4150, which has provisions for their removal. Burros also occur in El Pinacate Biosphere Reserve mainly on the mountainous part of the area. The Bioreserve has been working to control the population of these equines and is trying to eradicate them from the area.

Livestock grazing on BLM-administered land is an accepted and valid use under the Taylor Grazing Act of 1934, the Federal Land Policy and Management Act of 1976, and the Public Rangelands Improvement Act of 1978. Under these Acts public rangeland is managed to meet Standards of Rangeland Health (43 CFR 4180), and are subject to ESA Section 7 consultation with FWS. BLM livestock grazing allotments may be issued as perennial, ephemeral, or a combination of perennial-ephemeral. Perennial allotments have an authorized base herd stocking rate that may be grazed annually on the allotment. On ephemeral allotments, authorization for grazing is discretionary, based on forage conditions and other factors. Permittees with perennial-ephemeral allotments may graze their base herd each year, and apply to graze additional animals based on annual forage conditions.

Allotments within the range of the Cabeza Prieta pronghorn population are the Cameron, Coyote Flat II, and the Childs allotments. The Coyote Flat II and Childs allotments, which are east of the Cameron, are available for livestock grazing. The Coyote Flat II Allotment permits 31 cattle on a year-round basis, while the Childs Allotment authorizes 320 cattle on a year round basis. Both allotments are designated as perennial/ephemeral, which means that, when conditions warrant (a robust ephemeral bloom is present due to substantial rainfall) permittees can apply to turn out additional cattle for a limited time. In 2004, the BLM amended the Lower Gila South RMP to discontinue livestock grazing on the Cameron Allotment, which is directly east and adjacent to the Cabeza Prieta NWR, and manage it in a manner that emphasizes Sonoran pronghorn recovery (U.S. Fish and Wildlife Service 2004). The BLM upheld the closure of the Cameron Allotment to livestock grazing in its 2012 Lower Sonoran Record of Decision and Approved RMP, and continues to coordinate efforts with Cabeza Prieta NWR to address and manage Sonoran pronghorn habitat on BLM lands (Bureau of Land Management 2012a).

RMP revisions in 2010 for Yuma Field Office and 2012 for Lower Sonoran Field Office show 28 BLM grazing allotments were included in the Kofa portion of the nonessential experimental population area: 20 active allotments, and 8 closed allotments (Bureau of Land Management 2010, 2012). All 28 allotments contained at least some potential habitat according to the CART model (O'Brien et al. 2005, U.S. Fish and Wildlife Service 2010a). About 27 % of the Kofa portion of the nonessential experimental population area (Area A in U.S. Fish and Wildlife Service 2010a) occurs within BLM livestock grazing allotments (Figure 13). RMP revisions in 2012 for Lower Sonoran Field Office show portions of four open BLM ephemeral and perennial/ephemeral grazing allotments (Stout, Bighorn, Childs, and Santa Rosa) in the Sauceda portion of the nonessential experimental population area; other BLM managed lands within the Sauceda portion of the nonessential experimental population are not allocated for grazing (Sonoran Desert National Monument). About 8% of the Sauceda portion of the nonessential experimental population area occurs within BLM livestock grazing allotments. It is too soon to tell if Sonoran pronghorn recently released on the BMGR will disperse to these allotments.

Livestock grazing also occurs in the Quitovac area and the El Pinacate Biosphere Reserve. Although we have no estimate of the number of livestock in Quitovac, there are approximately 250 cattle in the El Pinacate Biosphere Reserve. The Recovery Team is not aware of quantitative evaluations, but field observations suggest grazing impacts are severe in some areas occupied by the Quitovac population.

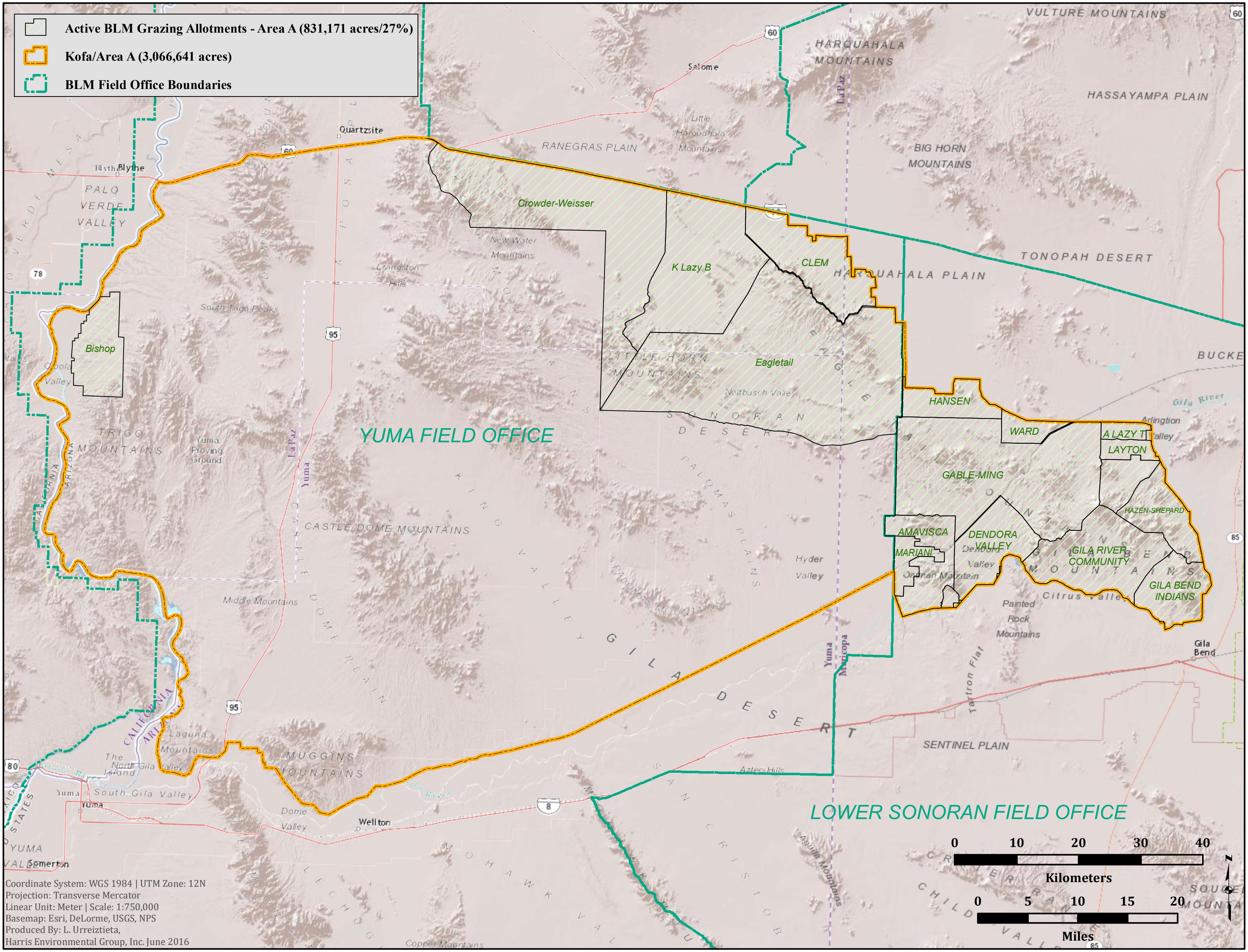

Figure 13. BLM grazing allotments within the Kofa portion of the nonessential population area (Area A in FWS 2010a), Arizona, U.S.

Extreme heat

Extreme heat can also kill quality forage or prevent growth of quality forage. Extreme heat is believed to be caused by climate change, as discussed in the “Climate Change” section above. Extreme heat desiccates forage plants in washes and increases the potential for fire.

Altered hydrology

Changes in hydrology may reduce the water available to forage species even if precipitation is suitable. Hydrology may be altered by roads and development and other impervious surfaces. Hydrology may also be altered by trails and routes used by human and drug traffickers as well as by border enforcement efforts and recreational off-road driving, including off-road racing near Rocky Point in Sonora. By increasing soil compaction and altering runoff patterns, roads, building, trails, and routes may cause rainwater runoff to flow more quickly rather than penetrate the soil and provide for growth of forbs. They may also cause sheet flows to be redirected.

Altered Fire Regimes

Fires burn creosotebush, which is a very competitive species, and create openings for plants that are more valuable as forage for pronghorn. On the other hand, in spring after average winter rains, growth of forbs (pronghorn forage) is typically tallest and most dense around and under creosote, because of the creosote’s shading effect creating a slightly cooler/moister microclimate. In the first year or two after a fire, the remaining ash increases nutrient levels in the soil, resulting in higher quality forage, if it rains. These post-fire conditions may improve Sonoran pronghorn recruitment for a few years.

Fire can be beneficial initially, but has the potential to become harmful in the long run by increasing invasive species (e.g., buffelgrass [*Pennisetum ciliare*], fountain grass [*Pennisetum setaceum*], and schismus grass [*Schismus barbatus* or *S. arabicus*]). Fire can also have adverse effects by causing mortality of ironwood, mesquite, paloverde, and other desertscrub trees/shrubs, which provide thermal cover and browse. The Sonoran desert is not considered a fire-adapted ecosystem and some of these invasive species provide fine fuels that may encourage more frequent and larger fires, perpetuating a cycle of fire and spread of invasive species (Arizona-Sonora Desert Museum 2013, 2014a, 2014b).

However, the historical role of fire in the Sonoran Desert may have been underestimated. Early newspaper accounts documented large fires in Sonoran desertscrub areas in the eastern portion of the historical range of Sonoran pronghorn, such as the Avra Valley and near Redrock, prior to cattle being ubiquitous on the landscape (Bahr 1991, Brown and Glinski 2009). These fires were sporadic and made possible by the large flush of annual grasses and forbs after wet winters and largely ceased after approximately 1890. The fires returned, again at infrequent intervals, after 1975, when cattle were no longer ubiquitous in the desert and when winter rains brought a flush of spring annuals, such as an event along the Florence Highway that occurred in the 1980s (D. Brown, Arizona State University, personal communication, 2013). The first of these more recent fires was attributed to red brome, and a concern was raised that annual exotics were bringing a new threat to the Sonoran Desert. Since then, however, fires within the Sonoran Desert have been also been attributed to other annual plants, including native annuals such as plantains (*Plantago sp.)* and *Hordeum sp.* (D. Brown, Arizona State University, personal communication, 2013). The AGFD consulted with the Tohono O'odham Nation prior to initiating the first Sonoran pronghorn forage plots for the Air Force. During these discussions tribal members described using fire as a tool to clear unwanted vegetation to facilitate planting crops (J. Hervert, AGFD, personal communication, 2013).These historical fires may have occurred in areas of creosotebush and in grassland areas within the Sonoran Desert. An old photo shows a fire in creosotebush-dominated landscapes taken on the stagecoach route between Gila Bend and Ajo (D. Brown, Arizona State University, personal communication, 2013).

The role of fire in Sonoran pronghorn habitat is complex, and its beneficial or detrimental effects on forage and Sonoran pronghorn remain unknown.

Increase in Creosotebush

Creosotebush may be more dominant now compared to 100-200 years ago due in part to a lack of fire, coupled with cattle grazing (J. Hervert, AGFD, personal communication, 2013). Cattle grazing removed fine fuels such as grasses, contributing to the lack of fire. Creosotebush is not fire tolerant and the removal or reduction of grasses may have inhibited natural and human caused fires that would kill creosotebush. As a result, creosotebush dominance may be increasing, resulting in a conversion of vegetation to associations less favorable for pronghorn (J. Hervert, AGFD, personal communication, 2013).

Invasive plants

Invasive plant species that are currently established within the range of Sonoran pronghorn and which could compete with forage plants include Sahara mustard, Schismus grass, red brome, fountain grass and buffelgrass. Each of these invasive species could affect Sonoran pronghorn forage through direct competition, alteration of the fire regime, or by depleting soil fertility.
As of 2016, invasive plants are not thought to be a significant threat to Sonoran pronghorn but monitoring is warranted to ensure this potential threat does not increase. Sahara mustard is most abundant in the Lower Colorado River Valley of Arizona. It grows very fast, smothering native herbaceous plants and competing with shrubs for light and soil moisture (Arizona-Sonora Desert Museum 2014b). However, although it may threaten native forage plants, it can be used as forage by Sonoran pronghorn. Sahara mustard has a high oxalic acid content (Arizona-Sonora Desert Museum 2014b), which may affect its nutritional value. Schismus grass is an annual grass native to southern Europe, northern Africa, and the Near East and now is widely distributed in areas with Mediterranean climates (California Invasive Plant Council 2014). In Sonoran pronghorn range it is abundant in the Lower Colorado River Valley. It is particularly abundant where grazing, off-road-vehicle use, or construction of linear corridors has reduced shrub cover and disturbed the soil (California Invasive Plant Council 2014). Red brome is an introduced, early

emerging annual grass that is native to the Mediterranean region; it is now widely distributed in patches across Western States (U.S. Department of Agriculture 2012). It is not abundant in the Lower Colorado River Valley portions of the range, but is common in parts of Arizona Upland. Red brome is a fine-fuel source that decomposes slowly and greatly increases the fire potential, intensity, and burn speed in areas where it has invaded (U.S. Department of Agriculture 2012). As with red brome, fountain grass is most abundant in Arizona Upland, and less abundant in Lower Colorado River Valley. Fountain grass can form dense stands and aggressively competes with native species, especially perennial grasses and seasonal annuals, for space, water, and nutrients (Arizona-Sonora Desert Museum 2014a). Fountain grass is adapted to fire and provides fuel that can spread fire (Arizona-Sonora Desert Museum 2014a).

Buffelgrass is most common along highways in the Arizona Upland areas in Arizona and Sonora, but is expanding into lower, hotter, drier desertscrub in the Lower Colorado River Valley to the west (Van Devender and Dimmit 2006). It was fairly well controlled in Organ Pipe Cactus NM from the mid-1990s to mid 2000s, but efforts were curtailed due to border-related security concerns and it has expanded since then. Also during that time, buffelgrass advanced from being established mainly on flat terrain with deep soils, to colonizing rocky slopes as well. Organ Pipe Cactus NM also has been conducting volunteer-run surveys for buffelgrass since the mid 1990s; in 2011, buffelgrass was reported at 208 sites and more than 11,000 plants were removed in the surveyed area (Rutman 2011). Most of these sites (48.1%) contained single plants or small patches of less than ten plants. A small percentage (2.4%) of sites were large, containing more than 1,000 plants (Rutman 2011). Large stands exist in some traditional pronghorn use areas like Acuna Valley, Pozo Nuevo area, and the west slopes of Bates Mountains (Tim Tibbitts, Organ Pipe Cactus NM, personal communication, 2015). On Cabeza Prieta NWR, buffelgrass is distributed sporadically, but one or two wet seasons will allow it to increase significantly. It is present along the Camino (Cholla Pass, Papago Well, and Growler Valley Trail) (Tim Tibbitts, Organ Pipe Cactus NM, personal communication, 2015). In Sonora, it is distributed continuously along Mexico Hwy 2, but is less common away from roads (Van Devender and Dimmit 2006).

This plant crowds out native plants of similar size and competes for water, which can weaken and kill larger desert plants (Arizona-Sonora Desert Museum 2013). This plant spreads fire rapidly through non-fire adapted ecosystems. There is also growing evidence that buffelgrass depletes soil fertility in a decade or so then dies and leaves behind a sterile wasteland (Arizona-Sonora Desert Museum 2013). Current and historical planting of buffelgrass in Sonora for livestock has heavily altered some vegetation communities in the state. Van Devender and Dimmit (2006) found very little evidence of buffelgrass burning when it is interspersed in natural vegetation in Arizona, but found in Sonora, where roadside buffelgrass is typically much denser than in Arizona, roadsides burn intensely and often. Outside of roadside areas, heavy cattle grazing appears to have effectively controlled buffelgrass in Sonora (Van Devender and Dimmitt 2006).

Erosion

Erosion may damage or destroy forage. Sources of erosion include trails and routes, illegal off-highway vehicle use, off-highway races, highways, and land use changes within the same watersheds as Sonoran pronghorn habitat, as well as heavy grazing in Sonora.

Lack of pollination

The Recovery Team brainstormed potential causes of reduced forage while conducting conceptual modeling of threats (Appendix A). One hypothesized cause of reduced availability of forage species for Sonoran pronghorn may be lack of pollination. The Recovery Team also hypothesized that lack of pollination is caused by a reduction in the number of pollinators, primarily insects. The existence, severity, and scope of this potential stressor across the range of Sonoran pronghorn are unknown.

Altered Habitat Structure

Vegetation structure is also critical to Sonoran pronghorn survival. While Sonoran pronghorn need open areas to visually detect predators, they also need areas of dense vegetation that provide hiding cover for fawning, and thermal cover to shelter them from the hottest temperatures of the year. Therefore a mosaic of open and densely vegetated areas is necessary to meet the needs of Sonoran pronghorn. That mosaic must provide the correct vegetation structure in the right places to support this highly nomadic species. In general, vegetation structure is becoming too dense due to invasion of shrubs in most places, although in some areas hiding cover and thermal cover have apparently become limiting (J. Hervert, AGFD, personal communication, 2014).

Fire

As discussed in the reduced forage quality section above, the Sonoran Desert is widely believed to have evolved without fire (Arizona-Sonora Desert Museum 2013; 2014a; 2014b). Fire in Arizona Upland portions of the Sonoran Desert was considered historically uncommon due to the lack of fine fuels. Some Sonoran Desert plants, cactus in particular, and some perennial trees and shrubs are intolerant of fire and are killed wherever fire occurs. Nonnative perennial and annual plants that have increased fine fuels have allowed fire to become a much more frequent event in parts of the Sonoran Desert (Arizona-Sonora Desert Museum 2013;2014a;2014b). These fires create a more open vegetation structure, and reduce the vertical diversity of plants present (Krausman et al. 2005). In some areas, this opening of vegetation structure would benefit pronghorn by providing greater visual openness that enables detection and escape from predators. After large fires in 2005, staff of BMGR noticed pronghorn were using the burned areas, in part due to the increased visual openness caused by the fire, which enables detection of predators from long distances (A. Alvidrez, BMGR, personal communication, 2014). Krausman et al. (2005) reported that Sonoran pronghorn used blocks that had some fire damage significantly more than they used unburned blocks, and 46% of l,203 locations of Sonoran pronghorn occurred in blocks that had been burned.

However, fire could also be detrimental to pronghorn habitat by reducing or eliminating thermal cover and reducing or eliminating hiding cover for fawns and does. Sonoran pronghorn recruitment has been low in burned areas on the BMGR, and it has been hypothesized that the open vegetation structure of burned areas has increased predation pressure on fawns (J. Hervert, AGFD, personal communication, 2013).

Fire can therefore be a threat or a benefit to vegetation structure depending on where and when it occurs. Careful consideration of the mosaic of vegetation structures needed for various seasonal needs of pronghorn are needed in evaluating the effects of fire.

Livestock Grazing

Excessive livestock grazing can encourage shrub growth, which creates conditions where vegetation is too dense for pronghorn to be able to see predators (Brown and Ockenfels 2007). Cattle may compete with Sonoran pronghorn for preferred thermal cover; however, no studies have focused on this topic, therefore we do not know the extent to which this may occur in areas where Sonoran pronghorn and cattle overlap. In American pronghorn, cattle have been reported to displace does from fawning areas (McNay and O'Gara 1982), although it is not known if it is due to direct interference or alteration of vegetation. In one study on the effects of cattle exclusion on vegetation hiding cover for American pronghorn on the Anderson Mesa in Northern Arizona, areas where cattle were excluded had 8% more vegetation cover when measured 5m from random sample points, but no difference was found when cover was measured at 10m or 25m from sample points. The vegetation in this study is different than that in Sonoran pronghorn range so it is uknown if cattle grazing affects hiding cover for Sonoran pronghorn fawning. For more information on where livestock grazing occurs in Sonoran pronghorn habitat, see the livestock grazing section under reduced forage quality, above.

Military training

Military training operations may cause fire or modify habitat. Removal of shrubby vegetation creates a more open habitat structure, which may be beneficial or detrimental to pronghorn depending on where it occurs. On all of BMGR East (including outside of current pronghorn range), about 5,594 ha (13,822 ac) have moderate to complete surface disturbance. About 48,995 ha (121,069 ac) have negligible to low disturbance. The remaining 371,190 ha (917,230 ac) of BMGR East are undisturbed by military activities.

Each year BMGR has wildland fires that are typically only associated with military training targets and the surrounding vegetation. In a given year, BMGR East has 15 to 30 fires and most are about approximately 0.04 ha (0.1 ac). These fires usually burn themselves out quickly (A. Alvidrez, BMGR, personal communication, 2014). However, in the summer of 2005, BMGR East had two large complex fires that burned 15,974 ha (39,472 ac) of pronghorn habitat. After the wildland fires, BMGR staff noticed that pronghorn used the burned areas, likely for the post-fire vegetation flush and the visual openness allowing detection of predators from long distances (A. Alvidrez, BMGR, personal communication, 2014).

Renewable energy

Although only large renewable energy developments are likely to remove significant habitat (see habitat loss section), installation of power lines and other structures associated with renewable energy creates visual barriers for pronghorn, altering the physiognomy of the habitat. These structures may limit the ability of pronghorn to detect and flee from predators.

Mining

Conceptual modeling conducted by the Recovery Team hypothesized that mining can indirectly alter vegetation structure in Sonoran pronghorn habitat adjacent to the mines. The Recovery Team hypothesizes that mining may alter runoff patterns and create more dense vegetation in some areas. The Recovery Team conceptual models also hypothesize that pumping of groundwater for mines may lower water tables which will impact vegetation. In addition, mining activities often introduce invasive species through mineral transportation to and from the mine.

An additional impact of mining is the salvage and relocation of individual plants to areas outside the mining footprint at La Herradura. These relocated plants may compete with the established plants in native vegetation communities for space and nutrients. The impact may be large because hundreds of thousands of individual plants have been introduced to thousands of hectares of habitat bordering the mine, resulting in modification of vegetation composition and structure.

Illegal extraction

Illegal extraction of native vegetation, particularly mesquite and ironwood, occurs frequently in the El Pinacate Biosphere Reserve. In some areas of Pinacate, arroyos have lost all xeroriparian (ephemeral drainage) vegetation and are now denuded (Areas Naturales Protegidas 1995). Cholla is also illegally exploited for fencing, and visitors to the biosphere reserve often illegally take cactus (Areas Naturales Protegidas 1995). These illegal extractions have altered the vegetation composition and structure of the biosphere reserve in some places.

ESA Listing Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

After listing in 1967, take of Sonoran pronghorn became a prohibited activity in the U.S. under the ESA. Additionally, Arizona state statutes, including A.R.S. 17-314 and Commission Rules, effectively prohibit recreational hunting of the Sonoran pronghorn. In Sonora it is illegal to hunt Sonoran pronghorn under the General Wildlife Law because they are listed as a species-at-risk under Norma Oficial Mexicana-059 (NOM-059-SEMARNAT-2010). Sonoran pronghorn are not hunted commercially or recreationally in either country.

Both aerial and ground surveys are conducted for scientific purposes by agencies in both Mexico and the U.S. and may result in temporary disturbance to pronghorn. Additionally, both wild and pen-raised Sonoran pronghorn are periodically captured, restrained, have blood drawn, and outfitted with radio telemetry collars for research studies and relocations. Currently, wild pronghorn are infrequently captured. In contrast, pen-raised pronghorn are regularly handled, as they must be captured to release them from the breeding pens. Capture -related mortality has occurred during capture of wild and pen-raised pronghorn. As a result, changes to the capture protocol for both wild and captive animals have been implemented and capture -related mortality has been greatly reduced. Research and management is strictly regulated pursuant to section 10 of the ESA.

No take of wild Sonoran pronghorn for educational purposes occurs.

ESA Listing Factor C: Disease or predation

<u>Predation</u>

Predation accounts for 37% of adult Sonoran pronghorn mortalities observed from 1995–2002 (Bright and Hervert 2005). Of 12 mortalities attributed to predation, 6 were from coyotes (*Canis latrans*), three from bobcats (*Lynx rufus*), two from mountain lions (*Puma concolor*), and one from an undetermined predator (Bright and Hervert 2005). Most predation has occurred in winter when coyotes hunt in packs (Bright and Hervert 2005). Fatalities from predation were more common in the “paloverde chainfruit cholla association”than would be expected based on availability of the associations. Of predation fatalities documented, 75% occurred in “paloverde chainfruit cholla association” This association has tall, dense vegetation that may place pronghorn at a disadvantage because they cannot easily see or flee from predators (Bright and Hervert 2005).

Coyote predation has been reported as a major cause of fawn mortality in other pronghorn subspecies, and coyotes are thought to prey heavily on Sonoran pronghorn fawns. The evidence for this is mostly inferred and consists primarily of several observations during aerial telemetry surveys of females with a newborn fawn(s) and one or more coyotes nearby. Subsequent surveys one to two weeks later located the female but only one or no fawns (Arizona Game and Fish Department Sonoran pronghorn weekly radio telemetry forms, 1994-2001) (U.S. Fish and Wildlife Service 2006). However, it was not reported as a primary factor in mortality of Sonoran pronghorn fawns during the 1995-2002 investigation when nutritional factors appeared more important (Bright and Hervert 2005). Sonoran pronghorn females with fawns use washes, which are also preferred by bobcats primarily during dry conditions, but it has not been determined if bobcat predation is responsible for fawn fatalities (Bright and Hervert 2005).

Since 2005, the Recovery Team has noticed higher fawn mortality than expected. This is especially true in the burned areas of the Tactical Ranges where the cover fawns may use to avoid predation has been removed by fire. The causes of these fatalities have not been investigated; however, increases in fawn mortality may be due to a variety of factors, including reduced cover on the military tactical ranges due to wildland fires, reduced forage quality and environmental conditions due to climate change, increased cover of invasive vegetation, and increased predation rates.

Disease

Diseases documented in Sonoran pronghorn include bluetongue and epizootic hemorrhagic disease (U.S. Fish and Wildlife Service 2010b). Blood samples from five Sonoran pronghorn captured in December 2000 were evaluated by the Arizona Veterinary Diagnostic Lab at the University of Arizona (UA) for evidence of epizootics. All five samples tested positive for bluetongue and epizootic hemorrhagic disease antibodies (U.S. Fish and Wildlife Service 2002).

Bluetongue, or catarrhal fever, is caused by the pathogenic virus *Orbivirus*. The disease typically causes death only in cases where the infected animal is weak or stressed. Hosts include domestic cattle. It is transmitted by biting flies or gnats (*Culicoides* spp) (Thomas 1981). The *Culicoides* vector requires damp, humid substrates for larval development and adult emergence, a condition that may only exist in Sonoran pronghorn habitat around some dirt stock tanks or in wet years when water persists in playas and other natural collection basins for extended periods (U.S. Fish and Wildlife Service 2010b). Epizootic hemorrhagic disease is caused by a similar *Orbivirus* that is closely related to the bluetongue virus. Susceptible hosts include all ruminants, including white-tailed deer, which are highly susceptible to infection, and cattle, which rarely show signs of the disease (Thomas 1981). An adult male pronghorn fatality in the captive breeding pen at Cabeza Prieta NWR on 9 August 2007 during the monsoon season was attributed to epizootic hemorrhagic disease (Sonoran Pronghorn Recovery Team 2007). Like bluetongue, the vector for transmission of epizootic hemorrhagic disease are *Culicoides* biting flies or gnats, which require a humid substrate (e.g., weedy margin of a stock tank) to complete its life cycle. Adults emerge during the hot and humid monsoon season (Sonoran Pronghorn Recovery Team 2007).

Potential disease transmission between cattle and pronghorn is possible where they coexist. Any Sonoran pronghorn that are handled (such as during capture operations) in the U.S. are vaccinated, but not in Mexico, where cattle and pronghorn have been observed using the same water sources.

Lack Of Genetic Diversity

Effects of prolonged isolation, population crash, and ensuing bottleneck experienced by Sonoran pronghorn likely caused a loss of genetic diversity. While bottlenecks and loss of genetic diversity can negatively impact breeding success, recruitment, and survival, recent studies have indicated that the current genetic diversity of sampled Sonoran pronghorn populations is within acceptable parameters.

In one older study, Sonoran pronghorn exhibited lower levels of genetic diversity than all other subspecies of pronghorn, except the peninsular pronghorn, which was not measured (Stephen et al. 2005). In that study, the Sonoran pronghorn population in the U.S. had lower diversity than the Sonoran pronghorn population in Mexico. Both populations exhibited low levels of haplotypic and allelic diversity (Stephen et al. 2005). Average number of alleles per locus measured by Stephen et al. (2005) was 4.4 for both Mexican and U.S. populations of Sonoran pronghorn. In contrast, the average number of alleles per locus for other pronghorn subspecies ranged from 4.6 to 8.6 (Stephen et al. 2005). Heterozygosity was 0.573 in Mexico and 0.502 in the U.S for Sonoran pronghorn; but ranged from 0.583 to 0.734 in other subspecies (Stephen et al. 2005).

More recently, Munguia-Vega et al. (2013) analyzed microsatellite loci from Sonoran and peninsular pronghorn. The data indicated a lower mean observed heterozygosity for peninsular pronghorn than for Sonoran pronghorn (0.31 and 0.48, respectively), and lower mean number of alleles per locus for peninsular pronghorn versus Sonoran pronghorn (2.050 and 4.86, respectively). The data for Sonoran pronghorn indicated that all of the loci for Sonoran pronghorn were polymorphic (Munguia-Vega et al. 2013). The mean number of alleles per locus was 4.86 (range 2–8), and observed heterozygosity ranged from 0.13 to 0.78 (mean 0.48) (Munguia-Vega et al. 2013). They did not find significant linkage disequilibrium among loci pairs, and no loci deviated significantly from Hardy–Weinberg equilibrium (Munguia-Vega et al. 2013).

Culver and Vaughn (2015) of the Arizona Cooperative Fish and Wildlife Research Unit and the University of Arizona investigated genetic diversity, inbreeding, effective population size, and relatedness within both captive and recently re-established wild populations. They found observed heterozygosity for Sonoran pronghorn in 10 population segments ranged from 0.54 for scats collected from Barry M. Goldwater Range East to 0.68 for animals sampled during captures in the South Pen at Cabeza Prieta NWR and at the Kofa NWR pen. Allelic richness ranged from

1.85 for scats collected from Barry M. Goldwater Range East to 3.77 for animal released at Kofa NWR. Eight samples were obtained from Mexico but may not have sampled both Quitovac and Pinacate populations. This study did not find evidence of significant inbreeding, but did find an increase in inbreeding in the captive population at Cabeza Prieta NWR from 2009-2012.

These studies indicate that although genetic diversity of Sonoran pronghorn is less than other subspecies in the U.S., the subspecies is more genetically diverse than the peninsular pronghorn, and genetic diversity in Sonoran pronghorn within the U.S. is not currently low enough to be an immediate concern. However, more samples are needed to adequately assess genetic diversity, particularly in the wild Arizona population and the Quitovac and Pinacate populations of Mexico. In addition, continued monitoring of the trend in genetic diversity is needed to determine if it is declining, and therefore a threat to the subspecies or individual populations.

ESA Listing Factor D: Inadequacy of Existing Regulatory Mechanisms

The Sonoran pronghorn and its habitat are generally protected by numerous laws throughout its range. In some cases laws may not be adequate to prevent habitat loss and fragmentation; however, the larger threat is lack of funding and enforcement of existing laws. Therefore, the FWS generally does not consider lack of existing regulatory mechanisms a primary threat to Sonoran pronghorn.

All subspecies of *Antilocapra americana* are listed on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix 1, but only populations in Mexico are included (Convention on International Trade in Endangered Species of Wild Flora and Fauna 2014). CITES is a treaty established to prevent international trade that may be detrimental to the survival of plants and animals. Generally, both import and export permits are required from the importing and exporting countries before an Appendix I species may be shipped, and Appendix I species may not be exported for primarily commercial purposes. CITES permits may not be issued if the export will be detrimental to the survival of the species or if the specimens were not legally acquired. However, CITES does not itself regulate take or domestic trade.

<u>Laws Protecting Sonoran Pronghorn In The U.S.</u>

The Sonoran pronghorn has been federally protected in the U.S. since 1967 and is protected by the ESA. Pursuant to the ESA, it is unlawful to import or export, take, possess, or sell any endangered or threatened species. Under section 7 of the ESA, federal agencies must consult with U.S. Fish and Wildlife Service on their proposed actions that may affect the endangered Sonoran pronghorn. Any Sonoran pronghorn that occur outside of the nonessential experimental population in the U.S. are considered endangered. Habitat for the endangered population in the U.S. is primarily federally-owned and includes the Cabeza Prieta NWR, Organ Pipe NM, the BMGR, and BLM-administered lands.

Sonoran pronghorn are also on AGFD's list of "Species of Greatest Conservation Need" (Arizona Game and Fish Department 2012). The subspecies is protected by Arizona State Arizona state law (A.R.S. 17-314), and anyone convicted of unlawfully wounding or killing, or unlawfully possessing an endangered species of wildlife may be subject to civil action by the Arizona Game and Fish Commission in the form of license revocation and/or recovery of a minimum sum.

Nonessential Experimental Populations

The reintroduced Sonoran pronghorn at Kofa and Sauceda are designated as a nonessential experimental population under section 10(j) of the ESA (U.S. Fish and Wildlife Service 2011a). Under section 10(j) of the ESA, the Secretary of the Department of the Interior can reestablish populations outside the species' current range and designate them as ‘‘experimental.’’ With the experimental population designation, the relevant population is treated as threatened for purposes of section 9 of the Act, regardless of the species' designation elsewhere in its range. Threatened designation allows discretion in devising management programs and special regulations for such a population. For the purposes of section 7 of the ESA, FWS treats members of a nonessential experimental population as a threatened species when the nonessential experimental population is located within a National Wildlife Refuge or unit of the National Park Service, and section 7(a)(1) and the consultation requirements of section 7(a)(2) of the Act apply. Section 7(a)(1) requires all federal agencies to use their authorities to carry out programs for the conservation of listed species. Section 7(a)(2) requires that federal agencies, in consultation with the Service, ensure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of a listed species. When nonessential experimental populations are located outside a National Wildlife Refuge or National Park Service unit, then for the purposes of section 7, FWS treats the members of the population as proposed for listing, and only two provisions of section 7 apply—section 7(a)(1) and section 7(a)(4). Section 7(a)(4) requires federal agencies to confer (rather than consult) with the Service on actions that are likely to jeopardize the continued existence of a species proposed to be listed. The results of a conference are in the form of conservation recommendations that are optional as the agencies carry out, fund, or authorize activities. Because the nonessential experimental population is, by definition, not essential to the continued existence of the species then the effects of proposed actions on the nonessential experimental population will generally not rise to the level of jeopardizing the continued existence of the species. As a result, a formal conference will likely never be required for Sonoran pronghorn established within the nonessential experimental population area. Nonetheless, the BLM has additional requirements in their policy manual (Manual 6840) that direct them to confer with the FWS on actions or activities that are likely to adversely affect the species. A map showing Sonoran pronghorn ESA status for section 7 consultation purposes is shown in Appendix B.

Laws Protecting Sonoran Pronghorn In Mexico

In Mexico, there are a number of laws and regulations that directly or indirectly protect pronghorn. Some of these laws are discussed below.

The Norma Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo (NOM-059-SEMARNAT-2010), is a list of endangered species in Mexico. This law has no direct restriction regarding the protection of the listed species, but it includes the criteria for including, excluding, or changing the risk category for species or populations on the list, and it is related with other instruments of environmental protection. It has 4 categories:

- Probably extinct in the wild. (E – "Probablemente extinta en el medio Silvestre")
- Endangered (P - "En Peligro de extinción")
- Threatened (A - "Amenazadas")
- Subject to special protection (Pr - "Sujetas a protección especial")

The pronghorn is listed as Endangered on this list. This listing is for the entire species and therefore includes all subspecies within Mexico, including the Sonoran, peninsular, and Mexican pronghorn (Secretaría de Medio Ambiente y Recursos Naturales 2010).

In July 2014, the Priority Species List (*ACUERDO por el que se da a conocer la lista de especies y poblaciones prioritarias para la conservación*) of Mexico was published. It is not necessarily a list of species at risk, but rather a list of important species developed to promote efforts to maximize resources in conservation. Species may be considered important because, for example, they require large amounts of intact habitat, are charismatic, or are important to the public. Conservation of these species will enable conservation of many other associated species and biological communities. One of the priority species on this list is the pronghorn, including all the subspecies in Mexico. The list was created in accordance with the General Wildlife Law (see below) to promote the development of projects for the conservation and recovery of priority species.

The General Wildlife Law (Ley General de Vida Silvestre [LGVS]; SEMARNAT 2000) has several restrictions that only apply to species at risk (i.e. species listed in the NOM-059-SEMARNAT-2010), depending on their risk status. For example, it has strict provisions on the collection and capture of threatened and endangered species. It also contains general provisions on the sustainable use of wildlife; incentives for land owners; cooperation among federal, state, and municipal governments and private individuals; wildlife diseases; ethical use of wildlife; restrictions on exotic species, wildlife research and rehabilitation centers; wildlife use by indigenous people; environmental education; species at risk and their critical habitat; reintroduction and translocation protocols; scientific collection permits; control of nuisance species; and law enforcement investigations and citations (Valdez et al. 2006). Additionally, under the LGVS, critical habitat for species at risk can be established. Critical habitat is habitat that requires special management and protection due to its importance to the survival of species at risk.

In addition, Federal Penal Law (Código Penal Federal) includes Artículo 420, which, among other things, assigns a fine and/or prison for illegally trafficking, capturing, transporting, or exporting species at risk (those listed in the NOM-059-SEMARNAT-2010) or species considered in international treaties signed by Mexico (i.e. CITES). Penalties increase in cases involving illegal activities in natural protected areas (e.g., El Pinacate Biosphere Reserve).

The General Act for Ecological Balance and Protection of the Environment (Ley General Del Equilibrio Ecológico y Protección al Ambiente [LGEEPA]) can protect habitat for pronghorn through ecological land zoning, environmental impact assessments, and establishment of natural protected areas. Exploration, extraction, and mining of minerals (as occurs at the La Herradura Mine) are among the activities requiring an environmental impact assessment (Szekely et al. 2005). Natural protected areas can be one of eight types: biosphere reserves, national parks, natural monuments, areas for the protection of natural resources, areas for the protection of flora and fauna, sanctuaries, state parks and reserves, and ecological preservation zones in population areas.

A recent federal law, Ley Federal de Responsabilidad Ambiental (Environmental Responsibility Law), recognizes damages to the environment and charges responsible parties for reparations and compensation of said damages. Its function is to protect, preserve, and restore the environment and ecological equilibrium, and to guarantee human rights to a healthy environment for the development and well-being of people. This law offers some opportunities to implement Sonoran pronghorn habitat restoration actions.

The State of Sonora also has a law that provides general protection for wildlife. The law of The Ecological Balance of The State of Sonora (Ley del equilibrio ecológico del estado de Sonora) aims to encourage sustainable development and provides some protection of wildlife and habitat.

ESA Listing Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence

Human Disturbance

Human disturbance is defined here as the effects of the presence of humans, vehicles, and aircraft on Sonoran pronghorn. Human disturbance has the potential to affect the physiology, behavior, and ultimately, populations of Sonoran pronghorn. Available research evaluating physiological impacts of human stressors on wild animal populations indicates that the responses of species are variable (Manci et al. 1988, Larkin 1996, Radle 1998, Kaseloo and Tyson 2004, Stankowich 2008). For example, physiological effects of noise on wildlife can include stresses to neural, endocrine, digestive, cardiovascular, and immune systems as well as reproductive function, causing changes such as increased blood pressure, available glucose, and blood levels of corticosteroids (Manci et al. 1988, Kaseloo and Tyson 2004, Keay et al. 2006). Sonoran pronghorn could experience physiological stress without exhibiting overt behavioral responses, making evaluation of human disturbance difficult. The occurrence of physiological stress in the absence of behavioral indicators of stress has been demonstrated in other species. For example, investigators have recorded heart rate increases in wildlife in response to auditory or visual disturbance in the absence of overt behavioral responses (Cherkovich and Tatoyan 1973).

Behavioral responses to human disturbance can include flight and changes to activity budgets. It has been well documented that human presence can disturb animals, causing them to unnecessarily expend energy avoiding people (Kerley et al. 2002) or increasing the likelihood of fatal encounters with humans (Kerley et al. 2002). Range abandonment has been documented in response to human disturbance (Jorgenson 1988). Behavioral responses may also include altered time budgets; increased time spent fleeing or being vigilant reduces the time available for foraging or other important activities. For example, activity budgets of elk were altered during off-road recreation treatments, including increased travel time during most treatments, which reduced time spent feeding or resting (Naylor et al. 2009). Responses to human disturbance are similar to predation risk in that both human disturbance and predation divert time and energy from other fitness-enhancing activities such as feeding, parental care, or mating displays (Frid and Dill 2002). The risk-disturbance hypothesis states that prey species may trade food for safety as they shift activity toward safer, but less rewarding food patches or heighten vigilance at the expense of feeding efficiency (Frid and Dill 2002). For example, mule deer have been observed to spend less time foraging, or abandon foraging in a patch before the forage is all utilized, and are more vigilant in risky areas (Altendorf et al. 2001). Human disturbance can also disturb social structure in some ungulates by decreasing group size and by causing groups to spend more time in vigilant behaviors and in larger groups than they would exhibit in the absence of human disturbance (Manor and Saltz 2003).

To have an effect on population size, physiological and behavioral responses to human disturbance must ultimately affect survival and productivity, and to date, no research efforts have supported or refuted population level impacts on Sonoran pronghorn from physiological stress. Bright and Hervert (2005) and deVos and Miller (2005) suggest that at some point, increased energetic costs resulting from a stress-related increase in metabolic rate, reduced foraging efficiency due to interrupted feeding, and alarm and flight responses could threaten survival and productivity if the disturbance is stressful enough and chronic.

Studies of captive pronghorn, other than the Sonoran subspecies, have reported that they are sensitive to disturbance such as human presence and vehicular noise. Human disturbance (e.g., a person walking or running past pronghorn in an enclosed pen, a motorcycle driving past, a truck driving past, a truck blowing its horn while driving past, or a person entering a holding pen) caused increased heart-rates in American pronghorn in 0.2 ha (0.5 ac) holding pens (Workman 1992). The highest heart rates occurred in female pronghorn in response to a person entering a holding pen, or a truck driving past while sounding the horn. The lowest heart rates occurred when a motorcycle or truck was driven past their pen. Pronghorn were more sensitive to helicopters, particularly those flying at low levels or hovering, than fixed wing aircraft. Luz and Smith (1976) observed pronghorn reactions to overhead helicopter flights, which suggested mild disturbance (muscle tensing and interruption of grazing) by helicopter noise levels at approximately 60 A-weighted decibels (dBA) and strong reaction (running) at approximately 77 dBA.

Sources of human disturbance in the Sonoran pronghorn range are varied. The primary sources of human disturbance identified by the Recovery Team include border activities, military activities, mining, recreation, land management activities, ranching activities, and agricultural activities. Border activities, including both cross-border violator and U.S. Border Patrol (USBP) activities, appears to be the most widespread source of increased human presence near the endangered U.S. population of Sonoran pronghorn. There is anecdotal evidence that pronghorn are avoiding areas of high cross-border violator traffic and law enforcement activities. For example, in spring of 2009, AGFD reported that they believe that three does with fawns abandoned the Granite Forage Enhancement Plot due to the high amount of USBP activity at the site (J. Hervert, AGFD, personal communication, 2009). The does were later observed at Organ Pipe Cactus NM; however, the fawns died (J. Hervert, AGFD, personal communication, 2009). Instances such as these are more likely to occur during periods of poor range conditions when the impacts are likely exacerbated, regardless of the source of disturbance or impact on the pronghorn.

Staff at Organ Pipe Cactus NM observed potential disturbance events and pronghorn responses. Potential disturbance events were considered to be: 1) Fixed-wing aircraft flying within 1 mile laterally, below 1000 ft above ground level; 2) rotary-wing aircraft flying within 1.5 mile laterally, below 2000 ft above ground level; 3) motor vehicles approaching within 1 mile; 4) pedestrians approaching within 0.5 mile; or 5) predators noted within 500 ft. During this study they recorded six potential disturbance events and four visible responses by pronghorn (vigilance stance or running) during 1,500 minutes of observation in nine observation periods. By summing disturbances over all observation periods (1,500 minutes), Organ Pipe Cactus NM staff calculated the average rate of potential disturbances, and the average rate of pronghorn responses. During these observation periods, Sonoran pronghorn experienced some form of border-related potential disturbance once every 4 hours of observation. The pronghorn responded to the disturbances by running or becoming vigilant once every 6 hours 15 minutes of observation. Vehicles approaching within one mile occurred once every 12 hours 30 minutes of observation. Half of these vehicle approaches resulted in the pronghorn running, but for the other half, the driver was contacted by radio and advised to drive slowly (< 16 km per hour [10 mph]) past the observation area. These observations led to speculation that the high levels of illegal border-related traffic in the area, and subsequent interdiction efforts, may have been sufficient to inhibit use of the area and 3-Jack Tank (a water development built for Sonoran pronghorn) by Sonoran pronghorn (Organ Pipe Cactus NM 2013).

Preliminary information from a study on the effects of human disturbance on Sonoran pronghorn indicates that pronghorn consistently exhibit visible responses to human activity, particularly to vehicles traveling on a road within several kilometers. Although some instances have been noted where a Sonoran pronghorn did not exhibit a visible response (for example, one buck did not appear disturbed by three vehicles driving at least 40 km per hour (25 mph) about 1.5 km [0.93 mi] away); most observations indicate that Sonoran pronghorn stand vigilant or run from the stimulus. In some cases the response was to disturbances at a great distance. For example, eight Sonoran pronghorn were observed running a short distance and displaying vigilant behavior towards utility vehicle noise that was 3.4 km (2.1 mi) away. In other cases, the Sonoran pronghorn appeared to expend considerable energy fleeing from the disturbance. For example, eight Sonoran pronghorn were observed running from several trucks traveling fast (> 25 mph). The pronghorn were initially vigilant when the vehicles were 1.3 km (0.8 mi) away but soon started running, travelling over 3.6 km (2.2 mi) in under five minutes until they were out of sight of the observers (S. Doerries, University of Arizona, personal communication, 2014).

Military activity is another source of human disturbance. Landon et al. (2003) evaluated whether Sonoran pronghorn used areas, as defined by noise levels produced by military aircraft, in proportion to their availability on the BMGR. Using 15% of the Arizona Sonoran pronghorn population, they studied pronghorn use of areas with varying sound pressure (ambient sound) levels and found that pronghorn did not use the areas with different ambient sound levels in proportion to their availability. In general, they found that Sonoran pronghorn select areas with the lower noise levels and avoid areas with the higher noise levels; however, they did not consider habitat in their analysis. Whether pronghorn avoid these areas because of the noise or because of some other human-related factor is unknown; however, the various potential factors (i.e. noise levels, human presence, reduced vegetation or cover, disturbance) are interrelated. Krausman et al. (2004) also examined effects of military aircraft and ground-based activities on Sonoran pronghorn at the North and South Tactical Ranges on the BMGR and concluded that military activities, both ground-based and aerial, were associated with some changes in behavior (e.g., from standing to trotting or running, or bedded to standing). On days with stimuli, adult pronghorn bedded more than they foraged (Krausman et al. 2004). On days without stimuli, adult pronghorn foraged more and bedded less. Ground stimuli including the presence of vehicles or people and comprised the majority (65%) of all anthropogenic stimuli. Ground stimuli were associated with 866 instantaneous changes in behavior (39%), with 56 of these changes to trotting or running (2.6%). During direct overflights (less than or equal to 100 m to the side of animals), pronghorn changed behavior (e.g., from bedded to standing, walking to bedded, foraging to bedded) 45 times (41%) with 4 changes from any other activity to trotting or running (3.7 %). During overflights greater than 100 m to the side of animals, pronghorn changed behavior 105 times (34%), with 5 changes to trotting or running (1.6%). In response to stimuli, Krausman et al. (2004) only considered a change in behavior to trotting or running in response to stimuli as biologically significant. The authors concluded that these changes were not likely to be detrimental to the animals; however, sightings of Sonoran pronghorn were biased towards disturbed habitats on the TACs and other areas of military activities, which also corresponded to areas of favorable ephemeral forage production (Krausman et al. 2005). No specific conclusions could be drawn about effects of military activities on fawns during the Krausman et al. (2004) study, but the data suggests that fawns and their mothers may be more sensitive to anthropogenic stimuli than other pronghorn. In general, the study did not detect differences in the behavior of pronghorn with and without military stimuli; however, Krausman et al. (2004) recommends that all ground stimuli and activities that alerts or startles females and their fawns should be terminated.

Pronghorn are also sensitive to the presence of roads, and spend more time vigilant and less time foraging near high traffic roads, indicating that they perceive these roads as risk (Gavin and Komers 2006). Sonoran pronghorn avoid roads, and use areas less than 1 km (0.62 mi) from roads less than expected and more than 5 km (3.1 mi) from roads more than expected (deVos and Miller 2005). Whether the avoidance is due to human or vehicle presence or the road itself is not known.

<u>High Mortality Rates</u>

Drowning in canals

Sonoran pronghorn occasionally drown when they enter irrigation canals and cannot climb back out the steep sides. Prior to 2002, two Sonoran pronghorn were pulled from the Wellton-Mohawk Canal on the northern end of their range (U.S. Fish and Wildlife Service 2002). Since 2008, canals have been the cause of eight pronghorn deaths, including four from the Cabeza Prieta population and four from the Kofa population, all of which were pen-raised. Of the Cabeza Prieta population, three bucks drowned in the Palomas Canal in 2008, and one doe drowned in the Wellton Canal in 2010. Of the Kofa population, two bucks and two does died as a result of the Wellton Mohawk Canal. More specifically, two of nine Sonoran pronghorn released in January 2013 died due to canal-related incidents. One male was pulled out of the Wellton Mohawk Canal that runs from the SW to ENE between the southern Kofa boundary and Interstate 8 on May 16, 2013 and was found dead three days later nearby. Another dead buck was pulled out of the same canal 13.7 km (8.5 mi) east on May 17, 2013. A female was rescued alive from the Wellton Mohawk Canal on May 16, 2013 (along with the male that later died), and was rescued alive again from another canal near Texas Hill on June 20, 2013. She was later seen alive north of Dateland (Christa Weise, FWS, personal communication, 2013). On August

19, 2015, a dead Sonoran pronghorn doe was discovered floating by the Texas Hill 3.9 Pump lift gate of the Wellton Mohawk Canal. The doe was identified as 149.040, a 2-year old released into the Kofa population, from her ear tag and collar. Scratch marks were found along the concreted north side of the canal approximately 500 yards upstream (west) of TH-3.9 Pump lift which appeared to be from a hooved animal (Williford 2015). On April 26, 2016, a doe released from the Kofa breeding pen in January was found drowned in the Wellton Mowhawk Canal.

Fence entanglement

Pronghorn try to go under barbed wire fences rather than jump over them and often get entangled in the bottom wire (Brown and Ockenfels 2007). However, this has not been observed for Sonoran pronghorn.

Vehicle collisions

Documented mortalities of Sonoran pronghorn due to vehicle collisions are sparse. An adult doe was hit and killed by a car on Mexico Highway 2, 5 miles west of Sonoyta (Phelps 1981). Unconfirmed reports by ranchers and ejido landowners between 1989 and 1996 indicated some Sonoran pronghorn may have been hit crossing Mexico Highway 2 (Castillo 1999). In June 1996, a dead, radio-collared Sonoran pronghorn was located approximately 400 m south of U.S. Interstate 8 that may have been struck by a vehicle (U.S. Fish and Wildlife Service 2002, Bright and Hervert 2005). An adult male Sonoran pronghorn was struck and killed by a vehicle near kilometer post 29 on Mexico Highway 8 in July 1996 (Castillo 1999, U.S. Fish and Wildlife Service 2002). A Sonoran pronghorn female and two fawns were observed crossing Highway 85 in Organ Pipe Cactus NM in April 2015. Although not observed, one fawn was hit by southbound traffic on Highway 85 and the remains were found by Organ Pipe Cactus NM staff on April 21, 2015 (Coleman 2015). It is likely that more Sonoran pronghorn have been hit by vehicles, but their injuries or mortality went undetected.

Thermal Stress

Hyperthermia may occur in wild Sonoran pronghorn. Lack of thermal cover due to habitat alterations and warming climate are likely contributing factors.

Poaching

Even though pronghorn hunting has been illegal in Mexico since 1922, there is evidence that indicates that people continue to hunt them (locals continuously report hunting activities, there are empty bullets, and truck tracks that can be found in pronghorn habitat; Comisión Nacional de Areas Naturales Protegidas 2009). It is unknown how much poaching occurs in the Pinacate or Quitovac populations, but it could be significant in Quitovac. Lack of enforcement personnel, lack of land protection status, and lengthy travel from Hermosillo limits the ability of officials to enforce hunting laws. Presence of drug cartels limits vigilance by citizens and biologists.

Bighorn sheep are hunted in the vicinity of Sonoran pronghorn populations in both countries. However, bighorn sheep occupy different habitat and fatalities due to misidentification are not suspected in either the U.S. or Mexico.

Military activities
To date, no pronghorn mortality from military activities has been documented since monitoring began (A. Alvidrez, BMGR East, personal communication, 2014). The BMGR East's pronghorn monitoring program, initiated in 1997,provides standardized scheduling, monitoring, and reporting procedures for Sonoran pronghorn on the North and South Tactical Ranges and Manned Ranges 1, 2, and 4 of the BMGR East, and it establishes precautionary procedures for ground operations. If a pronghorn is detected (through telemetry or visual sighting) within 1.5 km (0.9 mi) of a high explosive (live) target, that target will be closed to ordnance deliveries for the remainder of the day. No deliveries of any kind will be made to any other target within 1.0 km (0.6 mi) of a pronghorn location (A Alvidrez, BMGR East, personal communication, 2014).

Catastrophic Or Stochastic Events
Catastrophic or stochastic events have the potential to cause extirpation of Sonoran pronghorn populations. Although these events are impossible to predict, planning for and management of multiple Sonoran pronghorn populations helps ensure loss of one population does not cause the entire species to go extinct.

Previous and Ongoing Conservation Efforts

Sonoran pronghorn life history characteristics were poorly understood until the end of the last century. By 1998, there was an increase in the knowledge of basic life history characteristics, but even as late as 1992, the status of the Sonoran pronghorn population was not clear. As a result of this lack of basic information, early conservation efforts focused on gathering data on habitat, life history, and population status. In the U.S., more recent conservation efforts have focused on stabilizing and increasing the endangered population, as well as establishing new populations.

Conservation Efforts in the U.S.

Agencies Responsible For Sonoran Pronghorn And Their Habitat In The U.S.

FWS
The primary programs within U.S. Fish and Wildlife Service responsible for Sonoran pronghorn include the National Wildlife Refuge System and Ecological Services. The National Wildlife Refuge System administers a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States. The Ecological Services Program provides national

leadership for the conservation of species and the habitats on which they depend, including species protected by the ESA, the Fish and Wildlife Coordination Act, the Coastal Barrier Resources Protection Act, and the Clean Water Act.

AGFD
The mission of Arizona Game and Fish Department is to conserve Arizona's diverse wildlife resources and manage for safe, compatible outdoor recreation opportunities for current and future generations.

DOD
The mission of the Department of Defense (DOD) is to provide the military forces needed to deter war and to protect the security of our country. DOD installations provide safe and secure locations to realistically test equipment and train personnel to protect American interests. Natural resources and public use are managed to ensure no net loss in the capability of the installation to support its military purposes, and in a manner that is consistent with ecosystem management principles.

BLM
The Bureau of Land Management is committed to manage, protect, and improve lands under their management authority in a manner to serve the needs of the American people for all times. Management is based upon the principles of multiple use and sustained yield of our nation's resources within a framework of environmental responsibility and scientific technology. These resources include recreation, rangelands, timber, minerals, watershed, fish and wildlife, wilderness, air and scenic, scientific and cultural values.

NPS
The National Park Service preserves unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations. The Park Service cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world.

Other Federal Agencies
All federal agencies which conduct activities (including permitting and funding as well as land management) in the range of Sonoran pronghorn in the U.S. are subject to section 7 consultation under the ESA.

Early (1923-2002) Sonoran Pronghorn Conservation Efforts in the U.S.

The first conservation efforts initiated to protect Sonoran pronghorn occurred in 1923, when a special game warden was appointed to patrol the U.S. - Mexico international border to protect pronghorn and bighorn sheep from poaching (Leopold 1959). More important conservation actions for Sonoran pronghorn were the creation of Organ Pipe Cactus NM in 1937, Cabeza Prieta Game Range (now Cabeza Prieta NWR) in 1939, and the creation of the BMGR in 1941

(Phelps 1978). These areas are protected from development and encompass pronghorn habitat within their current endangered range in the U.S. (Wright and deVos 1986, Hervert et al. 2000). Kofa NWR, established in 1939, encompasses 665,400 ac (269,278 ha) and now supports Sonoran pronghorn.

Following the listing of Sonoran pronghorn in 1967, the AGFD initiated a study to collect biological information on the subspecies (Arizona Game and Fish Department 1981). The Recovery Team first met in 1975 (U.S. Fish and Wildlife Service 1998) and produced the first recovery plan for Sonoran pronghorn in 1982 (U.S. Fish and Wildlife Service 1982). The recovery team set a recovery goal of maintaining an average population of 300 Sonoran pronghorn over a 5-year period in the U.S. Actions proposed in the 1982 recovery plan to maintain Sonoran pronghorn numbers included: population surveys, minimizing human disturbance and cattle trespass, understanding life history characteristics and limiting factors, and establishing a captive breeding population for transplant stock to reestablish Sonoran pronghorn into historical habitat. The 1982 recovery plan did not consider any areas outside the current U.S. range at the time.

The first conservation action with the potential to increase Sonoran pronghorn numbers was the removal of cattle on most of the current range of Sonoran pronghorn that began in 1972 and continued into the early 1980s (O'Gara and McCabe 2004). Three studies on life history characteristics of Sonoran pronghorn also were conducted (Wright and deVos 1986, Hughes 1991a, Hervert et al. 2000). In addition, all fences were removed from guzzlers and drinkers on Cabeza Prieta NWR to facilitate their use by pronghorn; and the first fulltime ecologist was employed at Cabeza Prieta NWR (U.S. Fish and Wildlife Service 1998). Two water catchments (Red-tail and Jose Juan charcos) were improved in 1956 for the benefit of Sonoran pronghorn on Cabeza Prieta NWR (Morgart et al. 2005). The Red-tail and Jose Juan charcos were augmented in 1989 with 2,000 gallon tanks with waterlines connecting to newly-installed wildlife drinkers. However, they were not located in areas Sonoran pronghorn use in the summer and are also surrounded by dense mesquite, which inhibit Sonoran pronghorn use. Also in the 1980s an existing surface and trough tank (Charlie Bell) was renovated by the Arizona Desert Bighorn Sheep Society in an area Sonoran pronghorn use when moving to and from Child’s Valley and Growler Valley. Also during this period of time,various studies were conducted to determine what effects military operations on BMGR might have on pronghorn behavior and survival (Krausman et al. 2005).

In the late 1990s and early 2000s, Organ Pipe Cactus NM both removed and modified their fences separating NPS and BLM land. Where livestock grazing was removed from BLM (Cameron Allotment), the fences were removed. Elsewhere (Why/Coyote Flat Allotment), the fences were modified to AGFD standards to facilitate pronghorn movement yet still exclude cattle. In recent years (post-2010) pronghorn have been crossing these boundaries.A systematic population monitoring program was initiated in 1992 to conduct biennial surveys (Snow 1994). Since then, the entire range of Sonoran-pronghorn in the U. S. has been surveyed biennially to obtain population estimates. In 1996, a population viability analysis (PVA) was used to model the probability of Sonoran pronghorn becoming extinct given the conditions in 1996 (Hosack et al. 2002). The PVA revealed that reduced fawn survival (i.e., less than 25%) might affect the population more than reduced adult survival (Hosack et al. 2002).

In 1998, the 1982 Sonoran Pronghorn Recovery Plan was revised (U. S. Fish and Wildlife Service 1998). The 1998 revision updated the recovery criteria based on the results of the PVA and studies on Sonoran pronghorn life history. The recovery criteria in the 1998 plan state that Sonoran pronghorn will be considered for downlisting when there are 300 Sonoran pronghorn in the U.S. population, and a second population is established in the U.S. that remains stable over 5 years, or when numbers are determined to be adequate to sustain a viable population (U.S. Fish and Wildlife Service 1998). In 2002, a supplement and amendment to the 1998 Recovery Plan was published that used the downlisting criteria from the 1998 plan and provided an explanation for why delisting criteria were not practicable at that time (see U.S. Fish and Wildlife Service 2002 for a details).

<u>Recent (2003 to present) Programs and Management Actions in the U.S.</u>

The 1998 recovery plan mentioned that captive breeding and the possibility of reintroductions to areas of historical range should be further investigated. By the end of 2002, these and other proposed recovery actions (e.g.. forage plots, water developments, land-use restrictions) were implemented or were being implemented in the U.S. because over 80% of the Sonoran pronghorn population in the U. S. perished after a severe drought in 2002 (Bright and Hervert 2003).

Supplemental Feeding, Forage Enhancement Plots, and Waters

The 2002 drought prompted the creation of Sonoran pronghorn waters within the Cabeza Prieta population area, and as of 2016, 13 stand-alone developed waters and five waters associated with forage enhancement plots (three on Cabeza Prieta NWR and two on BMGR) have been developed for Sonoran pronghorn (Figure 14). In addition, to improve Sonoran pronghorn access to water, the BLM removed fences from around two earthen charcos. Within the Kofa population area, five water sources for Sonoran pronghorn have been developed in the King Valley of the Kofa NWR since 2012 (Figure 15). No permanent waters have been developed for Sonoran pronghorn within the Sauceda population area as of February 2016; however, three temporary waters for Sonoran pronghorn have been established. See the section on Water Availability and Access for detailed information on the aforementioned Sonoran pronghorn waters.

In 2009, supplemental feeding was implemented at three experimental sites on BMGR East (South Tactical Range) and one site on the Cabeza Prieta NWR (in Child’s Valley at the Charlie Bell forage enhancement plot), and Sonoran pronghorn quickly began feeding at these sites. Based on pronghorn use, one site on BMGR East (Uken Tank) was selected for continued use and the other two sites were discontinued. The Uken and the Child’s Valley sites are still active as of 2016. In 2010, AGFD also established two feed stations at developed waters on BMGR West. In 2012, another feed station was developed on Cabeza Prieta NWR (in Child’s Valley at what is now Morgart Tank). Currently, there are five supplemental feeding sites for the Cabeza Prieta population that are not associated with the pen. These feeding sites are operated on a short-term duration, during the interval between winter and summer rains, and have a localized effect. No supplemental feed is provided for the Kofa, Quitovac, or Pinacate populations (with the exception of at the captive-breeding pen on Kofa NWR). The wild (free ranging) pronghorn learned to use the supplemental feed (baled alfalfa) from pronghorn released from the pen that had joined up with them. In 2009, use of supplemental feed by wild pronghorn was documented within two months of feed station establishment.

In addition to supplemental feeding, Hervert et al. (2001) suggested the creation of forage enhancement plots in key areas of Sonoran pronghorn habitat to increase fawn survival by providing lactating females and foraging fawns access to more succulent and nutritious forage during times of the year with limited rainfall. Since 2002, five forage enhancement plots (Adobe, Lower Well, Charlie Bell; Granite; Devil's Hills (Figure 14) have been established (one in 2002, three in 2005, and one in 2010). As of October 2015, two out of the five are working (Lower Well and Charlie Bell).Sonoran pronghorn took time to learn to use forage enhancement plots, but use them readily now. Each of the forage enhancement plots also provides a source of free-standing water for Sonoran pronghorn. Unfortunately, the Sonoran pronghorn water sources are being tapped for use by undocumented migrants and smugglers, and leakage along the lines prevents water from reaching the forage plots. In addition, the pumps stop working if not used frequently, so frequent maintenance is required.

Recovery actions (primarily water catchments) may be needed within wilderness because approximately half (50.3%) of the current Cabeza Prieta population range is designated wilderness. Within Cabeza Prieta NWR, approximately 93% of the refuge is designated wilderness, and within the Organ Pipe Cactus NM, approximately 95% is designated wilderness. There are few remaining opportunities within the southern half of the current range to implement meaningful recovery actions for Sonoran pronghorn outside of wilderness.

The Gila River was a reliable source of forage and water for Sonoran pronghorn prior to the early 1900s. Recovery actions such as water developments, forage plots, and supplemental feeding of alfalfa function in a similar manner ecologically as the Gila River historically did, however on a much smaller scale. Sonoran pronghorn likely used the river and the associated riparian zone during periods of environmental stress (poor forage conditions and scarce free standing water); only to leave the vicinity of the river bottom after rain changed the environmental conditions. Similarly, Sonoran pronghorn do not use current water developments, forage plots, and supplemental feeding stations after substantial rains. Radio-telemetry data has shown that Sonoran pronghorn often move many miles into adjacent valleys as forage conditions improve. The movement patterns of Sonoran pronghorn remain dependent on forage conditions and have not changed substantially (e.g., they continue to have very large home ranges) since the initiation of active management.

Sonoran pronghorn behavioral response to humans does not appear to have changed since waters, forage enhancement plots, supplemental feeding, and captive breeding have been implemented. Sonoran pronghorn continue to run from humans and do not appear to be habituated to the sound of a truck delivering alfalfa. The Recovery Team suggests examination of survival rates among wild and released Sonoran pronghorn and pronghorn response to human stimuli. Anecdotal observation of pronghorn responses to human presence are subject to interpretation, consequently a more detailed experimental approach is needed.

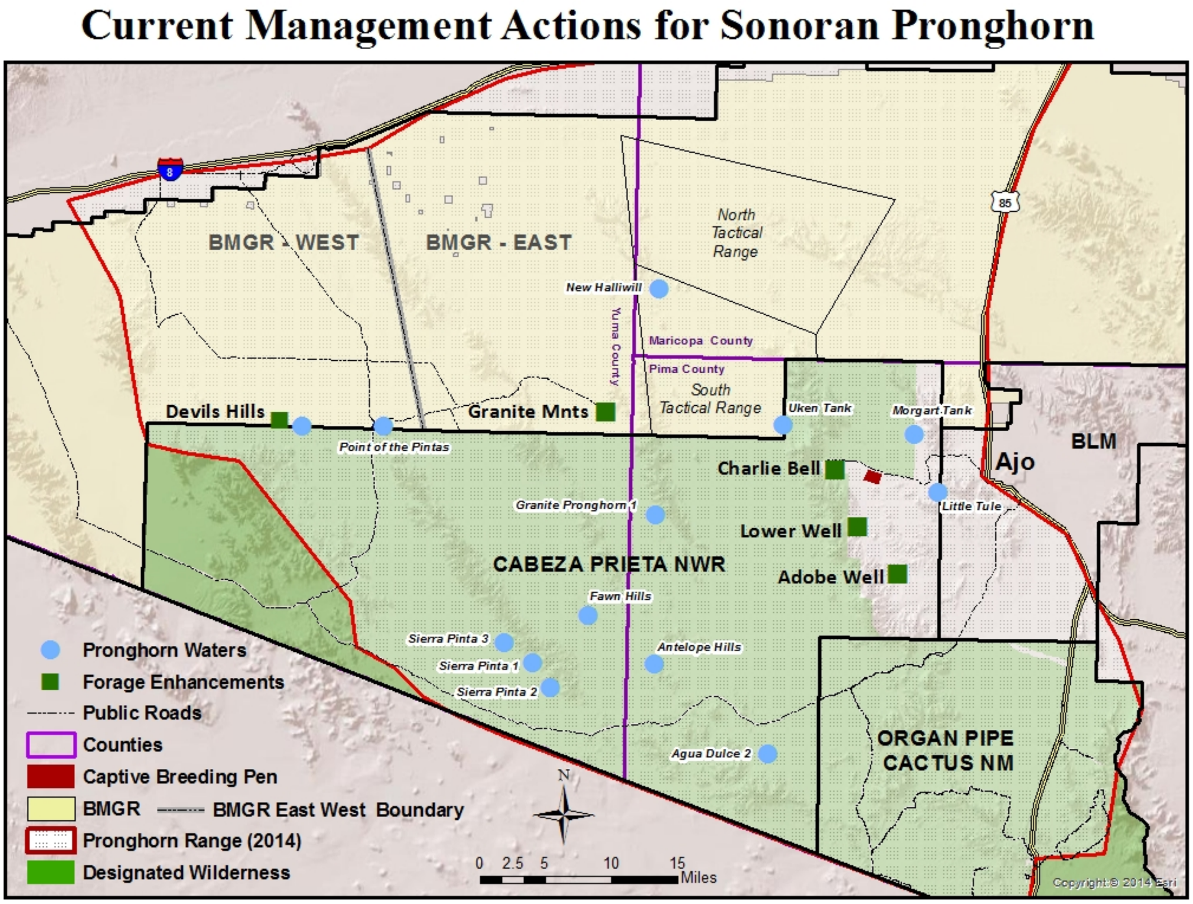

Figure 14. Location of captive breeding pen, waters, and forage enhancement plots in the range of the Cabeza Prieta population, Arizona, U.S.

Captive Breeding

Following the 2002 drought, plans were made to implement a captive-breeding program for Sonoran pronghorn (Arizona Game and Fish Department 2003); the first captive breeding pen (260 ha; 642 ac) was built in 2003 in Cabeza Prieta NWR. One goal of this facility was to produce animals for augmenting the population within the current range, establishing a second population in the U.S., and, upon request, providing return stock to Mexico. The pen was stocked with Sonoran pronghorn from Cabeza Prieta NWR and the Quitovac population in northwestern Sonora, Mexico. The captive breeding program at Cabeza Prieta NWR (Figure 14) is ongoing with 48 animals in the pen as of January 1, 2016 (after captures and before 2016 birthing season). In 2011 a captive breeding pen on Kofa NWR was established (Figure 15). The captive breeding program at Kofa NWR is ongoing with 29 adults in the pen as of January 10, 2016 (after captures and before 2016 birthing season). The number of animals in each pen fluctuates frequently as animals are born and others are captured for releases. From 2006 to 2016, 205

Sonoran pronghorn have been released into the wild from the Cabeza Prieta and Kofa NWR pens (Table 4).

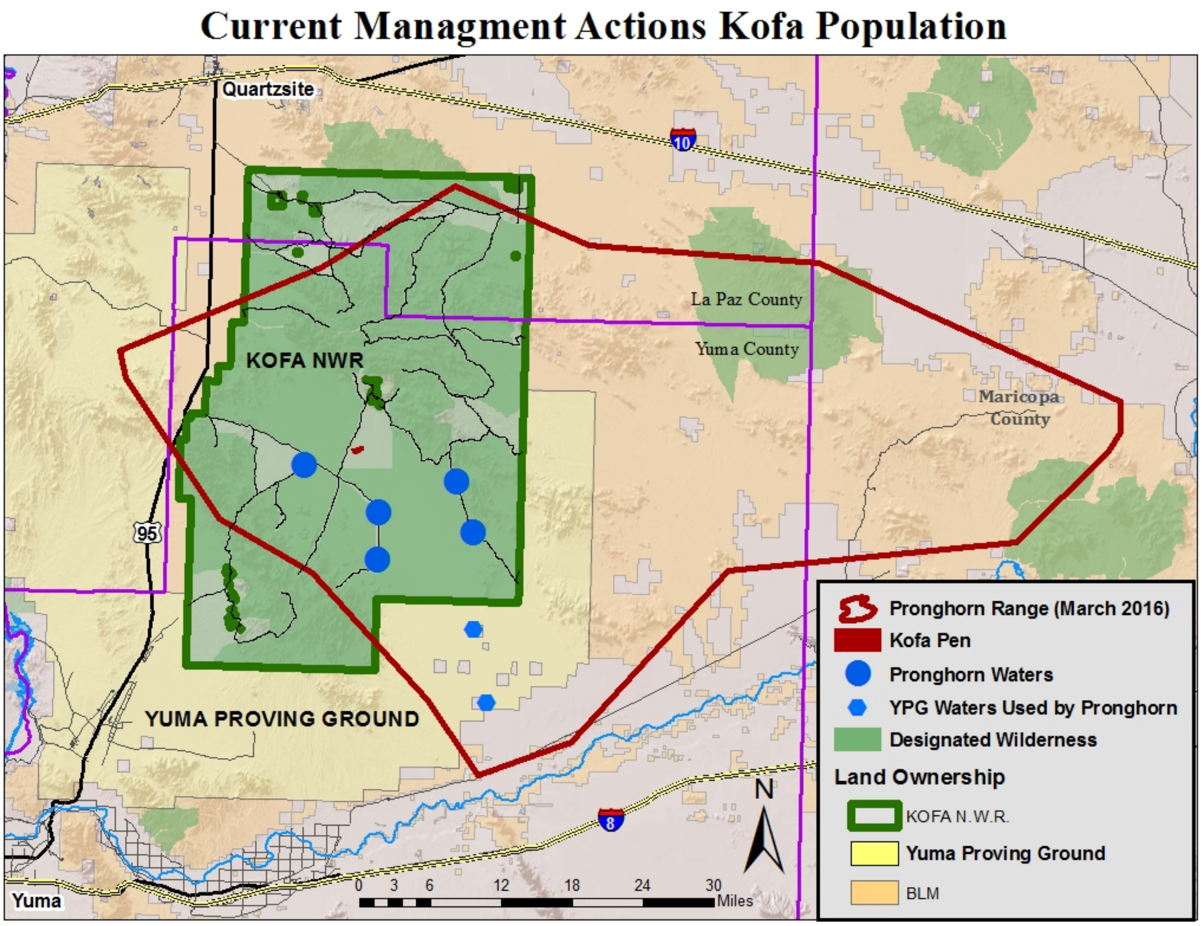

Figure 15. Location of captive breeding pen and waters in the range of the Kofa population, Arizona, U.S.

Table 4. Summary of Sonoran pronghorn releases from captive breeding pens at Cabeza Prieta and Kofa NWRs, Arizona.

Year	Males Released	Females Released	Total Released to Each Management Unit			Total Survived[a]	
			Kofa	Cabeza	Sauceda	Kofa	Cabeza
2006/07	4	0	-	4	-	-	4
2007/08	5	0	-	5	-	-	2
2008/09	9	3	-	12	-	-	7
2009/10	19	4	-	23	-	-	10
2010/11	7	11	-	18	-	-	11
2011/12[b]	7	4	-	11	-	-	8
2012/13	11	7	9	9	-	6	7
2013/2014	22	14	24	12	-	24	10
2014/2015	15	17	21	11	-	15	9
2015/2016	22	25	19	2	26	NA[c]	NA[c]
Total	**121**	**85**	**72**	**107**	**26**	**45**	**68**

[a] Survival is defined by the Recovery Team as released animals surviving until the end of September after their release (about 9 months post-release), meaning they would have survived one summer season. The first release at Sauceda was in December 2015, so no survival information is yet available for that area. [b] The lower number of pronghorn released in 2011/12 reflects the fact that 13 pronghorn captured in the Cabeza Prieta pen were transported to the Kofa pen that year to serve as broodstock animals and were not therefore “released.” [c] No survival information available for 2015/2016 as of February 2016.

Nonessential Experimental Populations

A habitat evaluation was conducted to identify suitable areas for the second population (O'Brien et al. 2005). In 2008, an interdisciplinary team developed and applied screening criteria to evaluate and compare the seven potential areas for establishing additional populations of Sonoran pronghorn (U.S. Fish and Wildlife Service 2010b). The screening criteria were:

1. Size of area (acreage);
2. Forage (quality of forage throughout the area, based on forage conditions current at the time and past rainfall patterns);
3. Water (rainfall patterns, condition and number of existing natural and manmade waters, and suitability for construction of new waters);
4. Degree of habitat fragmentation (by roads, railroads, fences, canals);
5. Degree of disturbance (human disturbance is the primary consideration, may result from recreation, military activities, Border Patrol activities, border crossing by undocumented migrants and smugglers);
6. Logistics (including considerations of access to area for building and maintaining a captive breeding or holding pen, waters, and forage enhancements, communications, and safety); and
7. Other factors (such as presence of predators, competitor abundance, and prevalence of disease).

The seven potential areas for establishing additional populations of Sonoran pronghorn in the U.S. were ranked for each of the screening criteria by the interdisciplinary team, which deliberated as an expert panel. Ranking was conducted on a relative basis. The area with the best or highest qualitative value for a specific criterion was assigned a score of seven. The area with the poorest or lowest qualitative value for a specific criterion was assigned a score of one. The remaining five areas were then scored according to their rank relative to the highest and lowest scored areas. The Kofa area (Area A in FWS [2010]) ranked highest in this screening exercise, receiving 92% of possible points; followed by Sauceda area (Area D in FWS [2010]) with 79% of possible points (U.S. Fish and Wildlife Service 2010b). An environmental assessment was published in 2010 that examined alternatives and resulted in a Finding of No Significant Impact for the alternative including holding pens in both areas (U.S. Fish and Wildlife Service 2010a; 2011c).

A final rule establishing a nonessential experimental population was published in the Federal Register on May 5, 2011 (U.S. Fish and Wildlife Service 2011a). On Kofa NWR, a new captive breeding pen was established in 2011, as described above, and five permanent pronghorn water catchments were built for released animals. In 2013, nine pronghorn were released into the wild at Kofa NWR for the first time; an additional 15 were released from Cabeza Prieta NWR pen and nine from the Kofa pen in January 2014. In January 2015, an additional 21 were released from the Cabeza Prieta NWR pen. In January and February of 2016, 19 were released from the Kofa pen. Reproduction in the wild has been documented for this released population. In December 2015 releases began at the Sauceda area within the nonessential experimental population boundary, with 26 animals released at BMGR East, east of Highway 85 (Figure 16).

Figure 16. Pre-release pen at Sauceda, Arizona, U.S. Mountain in the background is Hat Mountain. Photo by Jim Atkinson, FWS.

Other Conservation Efforts

Periodic (about twice a month) telemetry flights are conducted to locate collared Sonoran pronghorn in Arizona. These flights are designed to yield detailed information relative to movements of marked pronghorn, habitat selection, causes of mortality and survival. In addition, fawn survival and ultimately fawn recruitment for each year is estimated annually using data collected during these flights. Habitat condition is assessed, along with any new alterations to habitat that may be ongoing (new roads, trails, wild fires, construction activities, etc.) but unkown to managers. These flights also yield important information (water levels, condition of collection points, etc.) relative to pronghorn waters in remote locations.

A relatively small number of pronghorn inhabit a very large area, consequently it is a challenge for a small work force to monitor and investigate the complex relationships associated with Sonoran pronghorn in a highly varied and complex habitat. Periodic telemetry fligths are extremely valuable to field biologist attempting to detect, describe, and observe patterns of Sonoran pronghorn behavior.

Since 1997, the BMGR has required monitoring of Sonoran pronghorn before conducting munitions delivery missions and ground operations to prevent mortalities. As of March 2016 there have been no known pronghorn injuries or mortalities attributed to military training since this program began. Protocols for standardized biological monitoring are described in Luke Air Force Base's Operating Instruction OI 13-01, Sonoran Pronghorn Monitoring (see Appendix 1 of U.S. Fish and Wildlife Service 2010c).

In 2004-2005, BLM closed 55,000 acres (Cameron Allotment) to livestock grazing to improve habitat conditions for pronghorn. From 2004-2008, Organ Pipe Cactus NM's southern boundary (barbed-wire) fence with Mexico was replaced with a vehicle barricade fence. The vehicle barricade was configured to be pronghorn-passable, and included two wire strands to discourage cattle crossing. No pronghorn crossing of that fence has been documented in Organ Pipe Cactus NM, but radio-collared pronghorn have crossed through vehicle barricade fencing farther west, on Cabeza Prieta NWR.

Additionally, some recent research has been conducted on Sonoran pronghorn, including an ongoing (as of 2016) study led by the University of Arizona to investigate the effects of human activities on Sonoran pronghorn, and a genetic assessment of Sonoran pronghorn by the University of Arizona/U.S. Geological Survey (see the section on Lack Of Genetic Diversity for more information on this study).

Conservation Efforts in Mexico

<u>Primary Agencies Responsible For Pronghorn and Habitat in Mexico</u>

Federal Ministry of the Environment and Natural Resources (Secretaría de Medio Ambiente y Recursos Naturales [SEMARNAT])
SEMARNAT is responsible for promoting the protection, restoration, and conservation of ecosystems, natural resources, and environmental goods and services in Mexico. To fulfill this mandate, SEMARNAT and its undersecretaries and decentralized agencies work in four priority areas, including the conservation and sustainable use of ecosystems and their biodiversity. Among other duties, SEMARNAT's various agencies conduct wildlife law enforcement, management, and natural area protection. SEMARNAT was created from the federal Ministry of the Environment, Natural Resources, and Fish (Secretaría de Medio Ambiente, Recursos Naturales y Pesca [SEMARNAP]) in 2001.

Federal Office of Wildlife (Dirección General de Vida Silvestre [DGVS])
DGVS, the Federal Office of Wildlife, an agency under SEMARNAT, is responsible for, among other things, approving hunting permits submitted by Unidades para la Conservación, Manejo y Aprovechamiento Sustentable de la Vida Silvestre (UMAs; Wildlife Conservation, Management, and Sustainable Utilization Units); determining extraction quotas; and regulating harvest of wildlife throughout the country. Wildlife regulation and administration was decentralized in the northern Mexican States, including Sonora and Baja California, meaning that the states now have authority for certain wildlife regulation such as approving some hunting permits submitted by UMAs. DGVS also has responsibility for issuing documents, agreements, permissions, or authorizations for conducting research on wildlife species when it involves managing or manipulating individuals. It also authorizes repopulation, relocation, and reintroduction of wildlife species, as well as permits for endangered species (NOM-059-SEMARNAT-2010).

Federal Agency of Environmental Protection (Procuraduría Federal de Proteccion del Ambiente [PROFEPA])
Wildlife and environmental law enforcement is under the jurisdiction of PROFEPA which is within SEMARNAT (Valdez et al. 2006). The principal function of PROFEPA, since its creation over 20 years ago, is to oversee the execution of all the legal dispositions, among them the General Wildlife Law, protecting the interest of the Nation in regards to the environment, and issuing sanctions to those who violate said legal precepts.

National Commission of Natural Protected Areas (Comisión Nacional de Areas Naturales Protegidas [CONANP])
CONANP is within SEMARNAT and is responsible for the protection, restoration, and sustainable use of natural resources, principally fauna and flora, within Protected Natural Areas (Valdez et al. 2006).

Branches of CONANP include, among others:

- Especies Prioritarias Para La Conservacion (Priority Species) manages the Programa de Conservacion de Especies en Riesgo (PROCER; Program for the Conservation of Species At Risk). Under PROCER, recovery programs for 60 at-risk species are developed and implemented. Currently, 40 of these recovery programs, called Programa de Acción para la Conservación de Especies (PACE; Species Conservation Action Program) have been developed. Pronghorn (including all subspecies) is a priority species in this program and the PACE for pronghorn is included in this recovery plan (Appendix C).
- Areas Naturales Protegidas (ANP; Protected Natural Areas) manages protected areas, including the El Pinacate Biosphere Reserve. CONANP runs hundreds of conservation areas (177 federal protected areas) totaling more than 25,628,239 ha (63,328,757 ac), or 12 % of the country's land.

According to Article 70 of the Reglamento Interior de Semarnat, CONANP has authority to implement activities to conserve priority species, such as the pronghorn, and their habitat both within a protected area and its zone of influence. For example, the Quitovac area is in the zone of influence for El Pinacate Biosphere Reserve. Therefore CONANP plays a role in the recovery of pronghorn in both the Pinacate and Quitovac populations. Since 2003 collaboration agreements have been established among CEDES, CONANP/El Pinacate Biosphere Reserve, and La Herradura Mine, which specifically include actions for Sonoran pronghorn conservation and recovery.

Federal Ministry of Livestock, Agriculture, Rural Development, Fisheries, and Foods (Secretaría de Agricultura, Ganaderia, Desarrollo Rural, Pesca, y Alimentación [SAGARPA])
SAGARPA is responsible for agricultural, livestock, and fish management throughout the country. Also SAGARPA is in charge of the zoo-sanitary and fito-sanitary law enforcement and regulation for international movements of wildlife (animal and plants). In the case of the pronghorn's conservation, their direct participation is minimal.

The National Commission for Knowledge and Use of Biodiversity (*Comisión Nacional para el Conocimiento y Uso de la Biodiversidad* [CONABIO])
CONABIO is a permanent interdepartmental commission of Mexico, created in 1992. The mission of CONABIO is to promote, coordinate, support and carry out activities aimed at increasing awareness of biodiversity and its conservation and sustainable use for the benefit of society. CONABIO was conceived as an applied research organization, sponsoring basic research that generates and compiles information regarding biodiversity, developing capacity in the area of biodiversity informatics, and to act as a publicly accessible source of information and knowledge.

Commission of Ecology and Development of the State of Sonora (Comisión de Ecologies y Desarrollo Sustentable del Estado de Sonora [CEDES])
CEDES is the state wildlife agency in Sonora. The Mission of CEDES is to establish environmental public policies that favor sustainable development, land ecological planning, and promote protection and care of the environment and natural resources. CEDES is responsible for the implementation and evaluation of environmental policy of the State of Sonora. CEDES promotes public participation and accountability in the formulation and implementation of environmental policy, collecting and monitoring environmental information, and other ecological actions taken by the State. CEDES is also responsible for conducting and promoting scientific studies and research of the natural environment, as well as promoting cultural and ecological values.

Ministry of Agriculture, Water Resources, Fisheries and Aquaculture (Secretaría de Agricultura, Ganadería, Recursos Hidráulicos, Pesca y Acuacultura [SAGARHPA])
SAGARHPA is an agricultural agency of the State of Sonora. Although it does not manage pronghorn or natural areas, its policies can affect pronghorn and their habitat. For example, because SAGARHPA is the permitting authority for hunting in Sonora, it can obligate UMAs to eliminate or modify barbed-wire fences that can negatively affect pronghorn movement. CEDES is the technical branch of SAGARPHA and both agencies work closely together.

Environment Protection Minsitry of Baja California (Secretaría de Protección al Ambiente de Baja California [SPA]).
SPA is the state wildlife agency in the State of Baja California.

Past Pronghorn Conservation Efforts In Mexico

The first pronghorn conservation efforts in Mexico started in 1922, when President Álvaro Obregón banned the hunting of the pronghorn (Comisión Nacional de Areas Naturales Protegidas 2009). Later in 1952, the government created the *Federal Hunting Law*, which supports the banning of pronghorn hunting in Mexico (Comisión Nacional de Areas Naturales Protegidas 2009). The *Norma Oficial Mexicana* (NOM-059-ECOL-1994) and its updates in 2001 and 2010, which classify the pronghorn populations in Mexico as an endangered species, reiterated the legal protection of the species (Comisión Nacional de Areas Naturales Protegidas 2009). In 1999, the Technical Consulting Subcommittee for the Conservation, Management and Sustainable Use of the Pronghorn (Subcomité Técnico Consultivo para la Conservación, Manejo y Aprovechamiento Sustentable del Berrendo, órgano técnico consultivo) was formed, with the mission of proposing a national strategy for the conservation and management of the pronghorn.

Recent Conservation Programs And Management Efforts for Sonoran Pronghorn In Mexico

Mexico's most ambitious wildlife conservation and management initiative is incorporated in the Wildlife Conservation and Production Diversification in the Rural Sector Program (*Programa de Conservacion de la Vida Silvestre y Diversificacion Productiva en el Sector Rural*) (Valdez et al. 2006). The major objective of this program is to integrate environmental, economic, social, and legal strategies to address wildlife needs while promoting broader societal participation and creating realistic economic incentives. This program includes: 1) the conservation and recovery of priority species, including pronghorn; and 2) the creation of a system of wildlife management units (Valdez et al. 2006). Wildlife Conservation, Management, and Sustainable Utilization Units (*Unidades para la Conservación, Manejo y Aprovechamiento Sustentable de la Vida Silvestre* [UMAs]) create economic incentives for the judicious management of wildlife resources by facilitating the integration of wildlife management programs in livestock, forestry, and agricultural schemes (Valdez et al. 2006). Wildlife uses (including plants) within UMAs include research, recreation, game parks, environmental education, game farms, and commercialization of wildlife byproducts (Valdez et al. 2006).

In 2007, the Program for the Conservation of At-Risk Species (Programa de Conservacion de Especies en Riesgo [PROCER]) was formed. Managed by CONANP, the PROCER's main objective is to contribute to recovery of 60 species with the highest level of risk by implementing a recovery program developed for each species. Under the PROCER, Species Conservation Action Programs (Programa de Acción Para la Conservación de La Especie [PACE]) are developed, which are planning documents detailing the critical needs for the conservation of priority species, including all steps needed to be implemented in the short, mid, and long term to conserve a species. These PACEs are similar to recovery plans in the U.S. In 2009, CONANP produced a PACE for the pronghorn (Appendix C).

The Reserva de la Biosfera El Pinacate y Gran Desierto de Altar (El Pinacate Biosphere Reserve) is 714,556 ha (1764.3 ac). It was declared a reserve by the Mexican government in 1993, in part to protect Sonoran pronghorn. In parts of the El Pinacate Biosphere Reserve, CONANP is removing all old and unused fences. They are also educating ranchers how to create fences that exclude cattle, but allow the passage of pronghorn. Where fences are needed to delineate boundaries, CONANP is removing wires and leaving the posts for marking purposes. They are trying to reduce the effects of highways by installing information signs in the pronghorn corridor to reduce highway collisions.). Fourteen wildlife underpasses were constructed in 2013 on Mexico Highway 2; two of these underpasses, each 45 ft long and 15 ft high, were constructed in the area occupied by Sonoran pronghorn (Horacio Alfonso Ortega Morales, CONANP, personal communication 2016). Fence adjustments are needed to make the underpasses more usable by Sonoran pronghorn, and the underpasses will be monitored with cameras if funding is received. They are seeking to reduce competition for forage and water by removing feral burros. In addition, CONANP is revising the management plan to restrict cattle to one zone. They installed nine water tanks for Sonoran pronghorn in 2015 (two in Quitovac and seven in Pinacate), although pronghorn use of these waters has not been documented likely due to cattle exclusion fences around the tanks. CONANP plans to continue experiment with the waters until pronghorn can successfully use them. CONANP is also working with the local communities to educate people about pronghorn.

In addition, CONANP is seeking to acquire more land in the El Pinacate Biosphere Reserve. Currently, around 250,000 ha (617,763 ac) in the reserve are federal land (mostly in the core zone of the reserve) and 450,000 ha (1,111,974 ac) are communal land (ejidos) (mostly in the buffer zone of the reserve). CONANP is also currently revising the El Pinacate Biosphere Reserve management plan to try to limit changes in land use by not allowing developments or mining, and closing a well in the Sonoyta area.

CONANP staff from the El Pinacate Biosphere Reserve and staff from Espacios Naturales A.C., a nonprofit organization in Mexico, have been conducting Sonoran pronghorn studies and other conservation actions since 2014 under the PROCER. Their studies focus on behavior and habitat use in the Biosphere reserve and its area of influence, including the zone of the Herradura and Nochebuena mines, El Bajio, Juan Álvarez and El Indio ejidos, private land, and the comunity of Quitovac. In July 2015, they built towers to make behavioral observations of Sonoran pronghorn.

In the Quitovac population area, CEDES is conducting Sonoran pronghorn surveys and working with the La Herradura mine and other landowners to reduce their impacts on pronghorn and their habitat.

Biological Constraints and Needs

Sonoran pronghorn needs are primarily habitat based, and are discussed in the *Habitat characteristics/ecosystem* section above. In addition to sufficient quantity and quality of habitat, Sonoran pronghorn require vast areas of unencumbered open range to meet their annual needs for survival and reproduction. This includes the ability to freely travel long distances between localized, seasonally sporadic rainfall in search of sustenance (U.S. Fish and Wildlife Service 2002).

PART II. RECOVERY

Recovery Strategy

The recovery goal, as detailed below, is to ultimately delist the species. To achieve that goal, the recovery strategy is to secure a sufficient number of Sonoran pronghorn populations that are viable under appropriate management scenarios within select areas throughout their historical range. Both the number of individual Sonoran pronghorn in each population and the number of existing populations will need to be increased by: introducing Sonoran pronghorn to additional sites within their historical range; protecting, restoring, and enhancing habitat; maintaining and improving habitat connectivity; providing supplemental forage and water; minimizing or mitigating the effects of human caused disturbance; monitoring; conducting research to better understand habitat requirements and conservation needs; securing adequate funding to implement recovery actions; enforcing existing laws; and maintaining and developing partnerships in the U.S. and Mexico.

The Recovery Team's objective is to conserve Sonoran pronghorn in as natural a state as possible, meaning providing the least amount of human intervention required to recover the pronghorn. However, given the influences of anthropogenic factors (e.g., climate change, human population growth, land use changes), many of which are beyond the control of the Recovery Team, it is anticipated that Sonoran pronghorn populations will need to be managed with a variety of techniques. Some populations will need to be more intensively managed than others to ensure their viability, particularly during drought conditions and other catastrophic events.

The Sonoran Pronghorn Recovery Plan has four overriding objectives.

1) Incorporate the important biodiversity principles of representation, resiliency and redundancy (Shaffer and Stein 2000) including:
    a. <u>representation</u>: secure Sonoran pronghorn populations throughout their range to conserve genetic variation of the species to maintain its adaptive potential;
    b. <u>resiliency</u>: ensure that each population is sufficiently large to withstand stochastic (unpredictable, random) events; and
    c. <u>redundancy</u>: secure multiple Sonoran pronghorn populations throughout their range so that this subspecies can withstand catastrophic events;
2) Summarize what is known about the status of the Sonoran pronghorn throughout its range and identify primary information gaps;
3) Identify threats to the species; and
4) Describe in significant detail the actions necessary to restore and conserve Sonoran pronghorn populations in select portions of their range, including conservation units identified below.

While the recovery plan and strategy considers the Sonoran pronghorn throughout its range, the FWS has little authority to implement actions needed to recover species outside the U.S. The management and recovery of listed species, including the Sonoran pronghorn, outside of U.S. borders are primarily the responsibility of the countries in which the species occur, with the provision, as appropriate, of available technical and monetary assistance from the U.S. However, the FWS and its partners can cooperate with partners in Mexico to focus efforts within respective jurisdictions to conserve and recover the Sonoran pronghorn. In recognition of the binational distribution of the species, and the unique challenges and opportunities this presents, two conservation units for the species have been designated: one in the U.S. and one in Mexico. These <u>conservation units</u>, as well as their subset <u>management units</u>, discussed herein, are defined and described below.

Conservation units[1] are subunits of the listed species that are 1) geographically identifiable by international boundaries, and as such, managed under the authorities of different countries; and 2) important to the recovery of Sonoran pronghorn (e.g., constitute a substantial portion of the Sonoran pronghorn's current and historical range). Conservation units are individually important to conserve genetic and demographic robustness, which are key factors for ensuring long-term sustainability of the subspecies. Each designated conservation unit plays a significant role in recovering the Sonoran pronghorn throughout its range.

Management units, for the purposes of this recovery plan, are subunits of the conservation units that may require different management, are managed by different entities, and/or encompass different populations. For Sonoran pronghorn, each management unit is important to the recovery of the species and provides a function that benefits the overall conservation unit.

The U.S. Conservation Unit

This conservation unit is located in Arizona and California and includes the historical range of Sonoran pronghorn in the U.S. In Arizona, it generally extends from the international border in the south to the Gila Bend and Kofa Mountains in the north. It is a logical conservation unit because the populations in the U.S. are 1) geographically identifiable from the populations in Mexico and managed under the authorities of the ESA, and 2) highly important to the recovery of the species because they are demographically and genetically robust and primarily occur within protected areas. Sonoran pronghorn in the U.S. are effectively geographically separated from Sonoran pronghorn populations in Mexico due to the physical barriers of Mexico Highway 2 and associated fencing.

Cabeza Prieta Management Unit

The Cabeza Prieta Management Unit (Figure 17) is defined to include the current range of the Sonoran pronghorn population in Arizona listed as endangered under the ESA. The current range of the Cabeza Prieta population was determined by radio-collared pronghorn locations and other observations. However, pronghorn from this population may occasionally occur outside of this boundary. Any pronghorn occurring outside the nonessential experimental population boundary are considered endangered. The Cabeza Prieta Management Unit generally extends

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[1] In the Recovery Planning Guidance (National Marine Fisheries Service 2010), recovery and management units are defined; however, conservation units are not defined. For the purpose of recovery planning for Sonoran pronghorn, the Sonoran Pronghorn Recovery Team determined a need to separate pronghorn into two primary units (i.e., conservation units) separated by the international border, to reflect the significant differences in pronghorn management between countries. The Team, however, also determined that the definition of recovery and management unit did not accurately reflect the intent and functions of the units and therefore developed a new term "conservation unit."

from BMGR West to Organ Pipe Cactus NM and is 8,161 km^2 (3161 mi^2) in area. It could expand if Sonoran pronghorn within the management unit expand their range to the west or slightly to the northeast. It is a logical management unit because it is managed under different regulations than the Arizona Reintroduction Management Unit (below). See *Population Trends and Distribution* for the current status of Sonoran pronghorn in the Cabeza Prieta Management Unit (referred to in the Background section as the Cabeza Prieta population).

<u>Arizona Reintroduction Management Unit</u>

The Arizona Reintroduction Management Unit (Figure 17) includes the boundaries of the nonessential experimental population under section 10(j) of the ESA in Arizona and incorporates 19,179 km^2 (7,405 mi^2) of potential habitat for Sonoran pronghorn mapped from a CART model (U.S. Fish and Wildlife Service 2010). The nonessential experimental population is located in southwestern Arizona in an area north of Interstate 8 and south of Interstate 10, bounded by the Colorado River on the west and Interstate 10 on the east; and an area south of Interstate 8, bounded by Highway 85 on the west, Interstates 10 and 19 on the east, and the United States-Mexico border on the south (Figure 17). It is a logical management unit because it is managed under different regulations than the Cabeza Prieta Management Unit.

This management unit is further separated into two subunits: Kofa and Sauceda, which correspond to Areas A and D, respectively (Figure 17), in the final rule to establish a nonessential experimental population (U.S. Fish and Wildlife Service 2011a). Kofa ranked first and Sauceda ranked second among seven proposed reintroduction areas based on seven scoring criteria evaluated by an interdisciplinary team including members of the Recovery Team, the Tohono O’odham Nation, and representatives from land management agencies located in southwestern Arizona. The Kofa subunit is located in the King Valley on Kofa NWR, and adjacent portions of primarily Yuma Proving Ground (YPG) and BLM lands. The Sauceda subunit is located east of Highway 85 on the BMGR East, BLM lands, and a portion of the Tohono O’odham Nation. Within the Arizona Reintroduction Management Unit, additional subunits, as identified in the Sonoran Pronghorn Reestablishment Environmental Assessment (U.S. Fish and Wildlife Service 2010b) and Figure 17, may be considered for future reintroductions. However, there are no current plans to release animals outside of Kofa and Sauceda subunits.

<u>California Reintroduction Management Unit</u>

The California Reintroduction Management Unit is a potential unit for which feasibility planning is currently being conducted (Figure 17). There is an interest among the Recovery Team and partners to establish a nonessential experimental population under section 10(j) of the ESA in suitable remaining portions of the Sonoran Desert ecosystem of southeastern California. The primary area of interest for Sonoran pronghorn reintroduction in California includes the Chuckwalla Bench (Clark et al. 2013). It is 5,166 km^2 (1994 mi^2). It is a logical management unit because, although it would be a 10(j) population, it will be established under a different rule than the Arizona Reintroduction Management Unit and may require different management because it would be located in California and be managed by different agencies than the Arizona Reintroduction Management Unit. It is also geographically separated from the Arizona population by the Colorado River.

Mexico Conservation Unit

The Mexico Conservation Unit includes the historical range of Sonoran pronghorn primarily in the Mexican state of Sonora. The current range is estimated at about 4,057 km^2 (1566 mi^2). The extent of the historical distribution of the Sonoran pronghorn subspecies, however, is currently under investigation, and will be determined by genetic analysis of museum specimens collected from the states of California and the extreme northeastern part of the state of Baja California. The current distribution of Sonoran pronghorn in Mexico includes the two current populations in Quitovac and Pinacate, Sonora (Figure 17). The Mexico Conservation Unit includes the ranges of the two current populations and potential reintroduction sites within the historical range. The area of potential reintroduction sites has not been calculated and is not included in the acreages above. As stated above, the historical range is still under investigation; however, the Mexico Conservation Unit generally extends from Mexico Highway 2 roughly to Caborca, Sonora. In Mexico, pronghorn of all subspecies are listed as endangered under Mexican law (NOM-059-SEMARNAT 2010), while only the Sonoran subspecies of pronghorn is listed as endangered under U.S. law (ESA). The Mexico Conservation Unit is a logical conservation unit because the populations in Mexico are: 1) geographically distinct from the populations in the U.S.; 2) managed under different laws, including the Ley General de Vida Silvestre y su Reglamento (Secretaría de Medio Ambiente y Recursos Naturales 2000) and other Mexican State laws; and 3) highly important to the recovery of the species because they are demographically and genetically robust and partially occur within protected areas.

Pinacate Management Unit

The Pinacate Management Unit includes the current range of the Sonoran pronghorn population north of Mexico Highway 8 (Figure 17). The current range of the Pinacate population was determined by radio-collared pronghorn locations and other observations and is 1,959 km^2 (756 mi^2) in area (Jill Bright, AGFD, personal communication 2015). It could expand if Sonoran pronghorn within the management unit expand their range. It is a logical management unit because it occurs within the Reserva de la Biosfera El Pinacate y Gran Desierto de Altar (El Pinacate Bioreserve), a federal protected area (Area Natural Protegida) managed by the Comision Nacional de Areas Naturales Protegidas (CONANP). The El Pinacate Bioreserve contains a mixture of federally owned and protected lands, as well as ejido and private lands.

Sonoran pronghorn in this management unit are geographically separated from pronghorn in the U.S. Conservation Unit and Quitovac Management Unit by Mexican Highways 2 and 8, respectively. As explained in the Background Section, pronghorn rarely cross these highways. See *Population Trends and Distribution* for the current status of Sonoran pronghorn in the Pinacate Management Unit (referred to in the Background section as the Pinacate population). This is a small management unit that receives little rainfall.

Quitovac Management Unit

The Quitovac Management Unit includes the current range of the Sonoran pronghorn population south of Mexico Highway 8. It extends from Mexico Highway 8 to Caborca (Figure 17). The current range of the Quitovac population was determined by radio-collared pronghorn locations and other observations and is 2,098km^2 (810 mi^2) in area (Jill Bright, AGFD, personal communication, 2015). It could expand if Sonoran pronghorn within the management unit expand their range. It is a logical management unit because it entirely occurs within unprotected lands and therefore is managed differently than the Pinacate Management Unit. Sonoran pronghorn in this management unit are geographically separated from pronghorn in the Pinacate Management Unit by Highway 8, which is fenced along both sides. As explained in the Background section, pronghorn rarely cross this highway. The area contains a mixture of ejido and private lands. There are a number of UMAs within the Quitovac Management Unit. The UMAs in the Quitovac Management Unit are primarily for the management of bighorn sheep and mule deer.

As of October 2015, this area supports 88% of the Sonoran pronghorn population in Mexico. See the *Population Trends and Distribution* for the current status of Sonoran pronghorn in the Quitovac Management Unit (referred to in the Background section as the Quitovac population).

Sonora Reintroduction Management Unit

This is a potential management unit. There is an interest among the Recovery Team and partners to establish additional populations in the unoccupied historical range in Sonora, Mexico. Because this process is in the early phases, no boundaries have been developed.

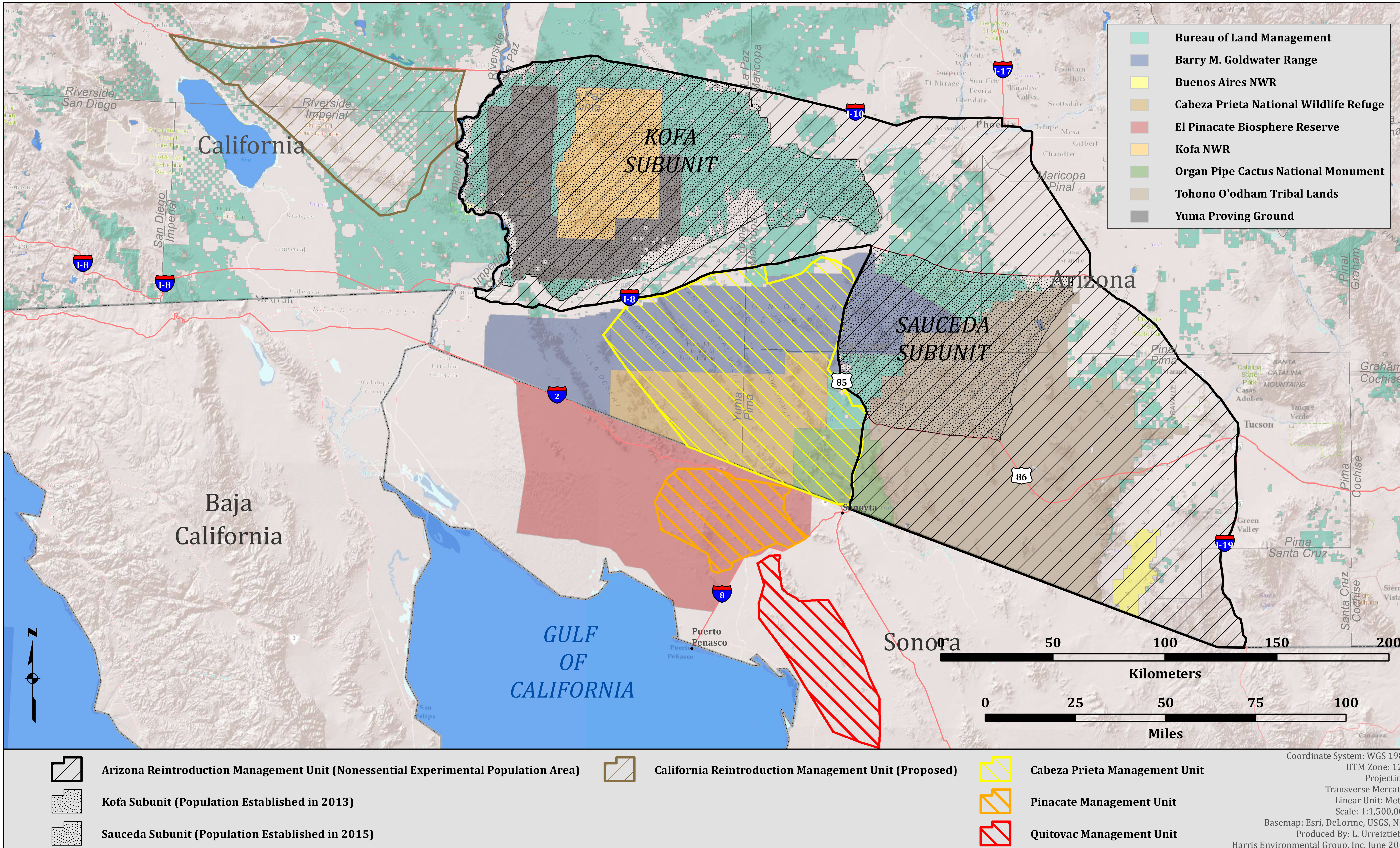

Figure 17. Sonoran pronghorn management units and subunits in the U.S. and Mexico. Because the Cabeza Prieta, Pinacate, and Quitovac Management Units are based on Sonoran pronghorn locations, the management unit boundaries could expand if Sonoran pronghorn expand their range in these areas. Because Sonoran pronghorn have not been documented outside of Cabeza Prieta Management Unit and south of I-8 and west of Hwy 85, there is an apparent gap in the map. Sonoran pronghorn could occasionally move outside of management units; any Sonoran pronghorn occurring outside the Nonessential Experimental Population area is considered endangered.

Recovery Goal, Objectives, and Criteria

Recovery Goal

The recovery goal is to conserve and protect the Sonoran pronghorn and its habitat so that its long-term survival is secured, populations within the conservation units are capable of enduring threats, and it can be removed from the list of threatened and endangered species (delisted). As a species that is listed throughout its range in two countries, the Sonoran pronghorn presents some unique challenges and opportunities for recovery planning. The 1998 Sonoran Pronghorn Recovery Plan and the 2002 update to that plan focused primarily on the recovery of the U.S. population. Although our knowledge of the species in Mexico is currently more limited than in the U.S., this current plan revision addresses recovery of the Sonoran pronghorn range-wide.

Recovery Objectives

Recovery objectives collectively describe the specific conditions under which the goal for recovery of the Sonoran pronghorn will be met throughout its range. The recovery objectives for Sonoran pronghorn are:

1) Ensure multiple viable populations of Sonoran pronghorn exist range-wide.
2) Ensure that there is adequate quantity, quality, and connectivity of Sonoran pronghorn habitat to support populations.
3) Minimize and mitigate the effects of human disturbance on Sonoran pronghorn.
4) Identify and address priority monitoring needs.
5) Identify and conduct priority research.
6) Maintain existing partnerships and develop new partnerships to support Sonoran pronghorn recovery.
7) Secure adequate funding to implement recovery actions for Sonoran pronghorn.
8) Practice adaptive management in which recovery is monitored and recovery tasks are revised by the FWS in coordination with the Recovery Team as new information becomes available.

Recovery Criteria

Recovery criteria are the values by which it is determined that an objective has been reached (National Marine Fisheries Service 2010). Recovery criteria must be objective and measurable. They provide a basis for determining whether a species can be considered for downlisting to threatened status, or removed from the list of threatened and endangered species. Because the same five statutory factors must be considered in delisting as in listing (16 U.S.C. § 1533 (a), (b), (c)), the objective, measurable criteria in this recovery plan address each of the five statutory delisting factors and provide a way to measure whether threats to the Sonoran pronghorn have been ameliorated (see Fund for Animals v. Babbitt, 903 F. Supp. 96 [D.D.C. 1995]).

The recovery criteria in this plan are not binding, and it is important to note that meeting the recovery criteria provided below does not automatically result in downlisting or delisting the species. Downlisting and delisting decisions are under the authority of the FWS Director and must undergo the rulemaking process and analyses. Both anthropogenic and non-anthropogenic threats to the Sonoran pronghorn must be acceptable in a five-factor analysis and adequate regulatory mechanisms must be in place to ensure that the species will persist into the foreseeable future. The management recommendations in this plan are believed to be necessary and advisable to achieve this goal, but the best scientific information derived from research, management experiments, and monitoring conducted at the appropriate scale and intensity should be used to test this assumption. Even if these criteria are achieved, continued management of the Sonoran pronghorn may be necessary to control the threats that otherwise might create a need to relist.

When considering downlisting or delisting the Sonoran pronghorn, the FWS will collaborate with Mexican partners, including CONANP and CEDES, and consider the requirements and scoring in Mexico's "Método de evaluación del riesgo de extinción de las especies silvestres en México" (MER; Extinction Risk Evaluation Method in Mexico) (Sanchez et al. 2007).

The Recovery Team anticipates that management actions (e.g., providing water and forage, captive breeding) will be necessary to meet the recovery criteria both in the U.S. and Mexico. In particular, management actions will likely be required to achieve population stability indicated in the recovery criteria. Management scenarios should be appropriate for each population, taking into consideration the unique criteria, opportunities, and constraints for each population. Adaptive management should be practiced to stabilize and recover all Sonoran pronghorn populations. Recovery criteria may need to be adjusted if population stability is not achieved after implementing relevant management actions.

<u>Downlisting Criteria</u>

Reclassification of Sonoran pronghorn from endangered to threatened may be considered when all six of the following criteria are met:

1. At least three free-ranging populations are viable. Two of these must be the Cabeza Prieta population and either the Quitovac or Pinacate population. The Recovery Team defines a viable population as one that has less than a 10% probability of extinction over 50 years and a growth rate that is stable or increasing. Furthermore, at least one new population must have been released, in addition to the Kofa subunit (e.g., Sauceda subunit).

> A population viability analysis (PVA) estimated abundance targets to meet the Recovery Team definition of viability, which is different for each management unit due to different environmental conditions. To be considered viable, a population estimate must meet or exceed the abundance targets and demonstrate a population growth rate that is stable or increasing ($r \geq 0$) for at least five of seven years[1]. Abundance targets for each management unit are estimated from the PVA to be: a) 225 in the Cabeza Prieta Management Unit; b) 150 in the Kofa subunit or a new subunit (Sauceda or other future established subunit); c) 150 in the Pinacate Management Unit; and d) 450 in the Quitovac Management Unit. These population sizes must be estimated by monitoring (i.e., aerial surveys).

Justification: This criterion is intended to ensure the Sonoran pronghorn subspecies has the representation, redundancy, and resiliency across its range to be successfully conserved. Representation of the subspecies in two conservation units would conserve the full range of genetic variability and different environments in which the subspecies now occurs. Conserving three redundant viable populations would decrease the chance that a single stochastic event would cause the entire subspecies to go extinct. Resiliency to stochastic events in each population is possible when populations are large and viable. The Recovery Team decided that other possible measures of viability, such as skewed male/female ratios, would be reflected in long-term growth rates. Due to differences in environmental conditions at each site, the PVA was conducted on a site-by-site basis. The Recovery Team placed more importance on having redundant, viable populations than the total number of individuals in the subspecies.

To develop population criteria, the Recovery Team used a PVA, which simulated extinction risk and population growth rates as a function of demographic, life history, and environmental variables (Appendix D). Input variables included 19 demographic and environmental variables derived from field studies and expert opinion (Table 1 in Appendix D). Some of the PVA input variables still need to be tested in the field. Models will need to be adjusted as new data become available. Initial population size and carrying capacity estimates are two of the input variables that varied the most among populations (Table 5) (see Appendix D for information on how carrying capacities were estimated). Annual mortality by age class, percent of females breeding annually, drought frequency, and drought severity also varied among populations (Table 1 in Appendix D).

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[1] As of 2016, aerial surveys to estimate Sonoran pronghorn population size alternate between the Cabeza Prieta population and the Mexico populations (Pinacate and Quitovac), so that each of these populations is surveyed every other year. Therefore, population estimates will be determined from surveys (in survey years) or the average between the previous and following year's survey estimate (in non-survey years). For information on how population estimates and confidence intervals are calculated, please see the *Recent Population Trends – Arizona* section of this plan.

Sensitivity analysis was conducted as an initial step in the PVA; results indicated that population growth rate and, by extension, extinction risk, are most sensitive to changes in adult female mortality (Appendix D). Therefore, we chose to examine PVA models that used a range of adult female mortality rates (Appendix D). Other parameters input into the models are based on best available data (Appendix D).

Table 5. Inputs and results of Sonoran pronghorn PVA.

Population	Inputs to Baseline Model		PVA model outputs	
	2012 Population Size[1]	Carrying Capacity	Raw Abundance Target	Adjusted Abundance Target [2]
Cabeza Prieta Wild	159	400	150	225
Cabeza Prieta Pen	57	57	No targets calculated	No targets calculated
Kofa Wild	9	700	100[3]	150
Kofa Pen	22	25	No targets calculated	No targets calculated
Pinacate Wild	52	150	150	150
Quitovac Wild	189	700	300	450

[1]Sonoran pronghorn population estimates from aerial surveys in 2012 (U.S.) and 2011 (Mexico).
[2]Adjusted abundance target is the raw abundance target plus a 50% buffer, and is the number used in the criteria.
[3]Outputs apply to either of the Arizona Reintroduction Populations.

As a starting point in developing population criteria, the Recovery Team used raw population abundance targets that, when achieved, could confer an acceptable level of long-term demographic stability according to the simulation models. In other words, populations that reach these raw abundance targets have the potential for a long-term positive growth rate and have a low probability of extinction (less than 10%) for 50 years after the target has been reached. The raw abundance targets (called “initial population sizes” in the PVA model scenarios because they are the population size used as a starting point in the model simulations) are the minimum number of Sonoran pronghorn individuals necessary for demographic stability and do not represent a maximum or long-term population goal. The Recovery Team assessed results for those model scenarios featuring 15% annual adult female mortality because this seems to be a threshold, all else being equal, above which long-term population growth becomes negative, leading to population decline.

The Recovery Team evaluated model outputs for those models featuring a 15% drought frequency (one drought year out of every seven years) because drought is a major mortality factor for Sonoran pronghorn and has occurred at least this frequently over the past twenty years (Cabeza Prieta NWR unpublished data). The Recovery Team picked the lowest raw population abundance target that would confer less than a 10% probability of extinction. The Recovery Team also picked the lowest raw population abundance target that would confer a positive population growth rate. For any one population, if model results for growth rate suggested a different raw population abundance target than model results for extinction probability, the Recovery Team used the larger of the two raw abundance targets. These raw abundance targets are different for each population due to differences in environmental conditions at each site. Please see Appendix D for the detailed PVA process, assumptions, and results.

For the Quitovac population, the probability of extinction is 9.2% when the raw abundance target is 250 individuals. The probability of extinction modeled for other populations was much lower: Pinacate (6.1%), Kofa (1.4%), and Cabeza Prieta (0.6%). A 9.2% extinction risk is close to the threshold of 10%, so the Recovery Team decided to take additional precaution against uncertainty and use 300 individuals as a raw abundance target for the Quitovac population, which results in a much lower extinction risk of 5.9%. The larger target value for Quitovac reflects that population's comparatively higher levels of instability, based on the judgment of species experts participating in this analysis. In summary, because of the following: 1) considerable fluctuations in population abundance; 2) relatively higher levels of demographic instability in its current habitat; and 3) higher levels of uncertainty regarding how the population will respond to threats such as climate change, the original 250 raw target abundance estimate for the Quitovac population was conservatively increased to 300.

The Recovery Team next added a 50% buffer to the raw abundance targets derived from PVA model results as a safeguard to offset possible underestimation of the raw abundance targets due to uncertainties in parameter estimation (e.g., demographic parameters) and the unknown effects of climate change. The adjusted abundance targets are shown in Table 5, and are as follows:

- For the Cabeza Prieta Management Unit, the raw abundance target is 150 individuals. Adding the 50% buffer results in an adjusted abundance target of 225 individuals.

- For the Arizona Reintroduction Management Unit, the raw abundance target is 100 individuals. Adding the 50% buffer results in an adjusted abundance target of 150 individuals. This criterion applies to either Kofa or a new Arizona subunit.

- For the Pinacate Management Unit, the raw abundance target is 150 individuals. Adding a 50% buffer is not possible because it would raise the adjusted target above the estimated carrying capacity of 150 individuals. On the other hand, the abundance target cannot be reduced because it would exceed our chosen extinction probability threshold (i.e., 10%). Therefore the adjusted abundance target remains at 150 individuals.

- For the Quitovac Management Unit, the raw abundance target is 300 individuals. Adding the 50% buffer results in an adjusted population target of 450 individuals.

In addition to meeting adjusted abundance targets, it will be important that lower confidence intervals of population estimates meet or exceed the raw abundance targets (see Table 5 for raw abundance targets). This will help ensure that actual population numbers (estimated through surveys) are not below minimum viability levels. For information on how population estimates and confidence intervals are calculated, please see the *Recent Population Trends – Arizona* section of this plan.

The Recovery Team chose to evaluate population sizes over a seven year period because that timeframe approximates the average interval of drought. In the last 20 years, severe drought (less than 50% of average rainfall) has occurred in the Sonoran pronghorn range approximately every seven years (in 1995-1996, 2002, and 2009; Cabeza Prieta NWR unpublished data). If these population numbers can be maintained through at least one severe drought, we would know that the populations are less vulnerable to severe drought as a result of management actions taken to reduce other threats and the effects of drought. The Recovery Team decided population abundance targets need to be met for five out of seven years because populations naturally fluctuate and it is likely a drought may occur within the seven-year period and cause populations to temporarily decline due to lack of water or food resources. It may take two years to recover from such a drought.

These population targets do not include individuals in pens. Population augmentation has been implemented at Cabeza Prieta and Kofa Management Units and will likely be continued to achieve their respective population targets. This will likely be less necessary over time as the populations grow and become more stable. Population augmentation may be discontinued if populations continue to grow for at least three years. Population augmentation may be warranted in the Pinacate and Quitovac Management Units if it is feasible and appropriate. If population numbers cannot be maintained, additional management actions would likely be necessary, and the population recovery criteria may need to be re-examined by the Recovery Team.

Using the seven year drought cycle, the PVA models explored impacts to the four populations and population growth rates. Although the Pinacate and Quitovac populations did not achieve population growth under the scenario of one drought every seven years, this is likely due to the high estimated mortality rates for these populations during severe drought. These populations in Mexico have endured through drought cycles in the past, but information about the habitat, availability of water, and other factors affecting survival is lacking. It is not known how they have managed to survive historical droughts. To more accurately understand the dynamics of Sonoran pronghorn population fluctuations in Sonora in response to drought, the mortality estimates used in the PVA should be tested. Population growth rates should be monitored closely if drought continues to occur on average once every seven years. If growth rates are negative, recovery actions to increase survival would be implemented.

The Recovery Team anticipates that management actions (e.g., providing water and forage, captive breeding) will be necessary to meet the recovery criteria both in the U.S. and Mexico. In particular, management actions will likely be required to achieve population stability indicated in the recovery criteria. As referenced in this strategy, management scenarios should be appropriate for each population, taking into consideration the unique criteria, opportunities, and constraints for each population. Adaptive management should be practiced to stabilize and recover all Sonoran pronghorn populations. Recovery criteria may need to be adjusted if population stability is not achieved after implementing relevant management actions.

In addition to ensuring current populations remain or become viable, this downlisting criteria calls for the release of one additional population (besides the Kofa subunit). This release will show progress toward establishing an additional population, which will provide additional redundancy to protect the Sonoran pronghorn subspecies if catastrophic loss should occur in one or more management units.

2. Within the Cabeza Prieta Management Unit, Pinacate Management Unit, Quitovac Management Unit and the Kofa and Sauceda subunits of the Arizona Reintroduction Management Unit, a minimum of 90% of current Sonoran pronghorn habitat within each unit is retained and contiguous. This Sonoran pronghorn habitat is protected through agency policies, land use regulations and plans, landowner agreements, incentives, and/or other programs and agreements. The 90% of retained and contiguous Sonoran pronghorn habitat includes key habitat features such as water sources.

Justification: As indicated in the Reasons for Listing/Threats Assessment above, habitat loss and fragmentation (historical, present, and future) are two of the most significant stressors to Sonoran pronghorn. Sonoran pronghorn occupy 12% of their former range and occur in disjunct populations. The Quitovac population, in particular, is threatened by current and future habitat loss and fragmentation. In all management units, the areas with the best forage and water availability change seasonally and are dependent on recent precipitation patterns. Sonoran pronghorn rely on nomadic movements to use the areas that currently have the best forage and water available. Sonoran pronghorn require large areas of contiguous habitat to make these seasonal movements and to survive and reproduce successfully. A reduction in the amount of usable pronghorn habitat or any loss in habitat connectivity would reduce the resiliency of each population and increase the risk of extinction, especially during severe drought. In addition, large areas of contiguous habitat are efficient to maintain because they require less active management to meet recovery objectives. Therefore, recovery actions would attempt to conserve as much contiguous habitat as possible. Contiguous habitat contains no barriers to Sonoran pronghorn movement, and is accessible to and inhabitable by Sonoran pronghorn throughout. Retaining contiguous habitat includes preventing and removing barriers to allow movement of Sonoran pronghorn. The baseline year for evaluation is 2016.

The population criteria and carrying capacity for the Pinacate population was based on the amount of habitat that currently exists in the Pinacate Management Unit, so losing up to 10% of the habitat could reduce carrying capacity. However, implementation of actions such as developing pronghorn waters and removing fences could increase carrying capacity. Carrying capacities for other populations are well above the population criteria, so those populations may still be able to meet the targeted population criteria if some habitat is lost.

3. Threats to Sonoran pronghorn habitat quality in three units are stabilized or decreasing as measured by indicators described in Appendix E. Threats must be stabilized or decreased in the three management units that correspond to the three populations that meet the population viability criteria in Recovery Criteria number 1. In particular, the threats of overgrazing; unauthorized routes, roads and trails; invasive plant and animal species threatening Sonoran pronghorn habitat; and spread of shrubby vegetation are minimized through agency policies, land use regulations and plans, landowner agreements, incentives, and/or other programs and agreements.

Justification: Threats to habitat quality may occur at low levels without significant impact to Sonoran pronghorn, but at some unknown threshold, these threats may reduce the ability of habitat to provide sufficient resources for survival and reproduction. When severe, these threats to habitat quality may render the habitat unsuitable for use by Sonoran pronghorn, although thresholds are unknown. Sonoran pronghorn populations would remain vulnerable to extinction as long as threats to their habitat remain in place. Overgrazing, unauthorized or excessive off-highway routes and trails, invasive plant and animal species, and spread of shrubby vegetation are the most likely threats to Sonoran pronghorn habitat quality.

4. Within the Cabeza Prieta Management Unit, Pinacate Management Unit, Quitovac Management Unit, and the Kofa and Sauceda subunits of the Arizona Reintroduction Management Unit, human disturbance is alleviated such that a minimum of 90% of Sonoran pronghorn habitat can be occupied by Sonoran pronghorn.

Justification: Pronghorn are relatively shy animals (please see Factor E for background information) that are very sensitive to human disturbance and the presence of humans or human activity in otherwise suitable pronghorn habitat can render it unusable for pronghorn. As described in the threats assessment, human disturbance can prevent Sonoran pronghorn from occupying an area. The 90% of habitat that can be occupied by Sonoran pronghorn must include key habitat features such as water sources. Sonoran pronghorn occur in areas with human disturbance (e.g., tactical ranges); however, at certain levels, disturbance can lead to habitat exclusion or range abandonment. The Recovery Team wants to ensure that the level of disturbance is below the threshold that prevents Sonoran pronghorn from using habitat. Although this threshold is difficult to determine, the current study on the effects of human activity on Sonoran pronghorn should help us better understand human disturbance thresholds. The Recovery Team does not believe that current levels of authorized public use exclude pronghorn from habitat.

5. Genetic diversity for three populations, as measured by heterozygosity and allelic richness for nuclear DNA markers, has been retained from levels indicated in Culver and Vaughn (2015). These three populations must meet the threshold of viability as described in Downlisting Criterion 1. The minimum level of heterozygosity of any of the three populations must be 49% (i.e., within 20% of the average heterozygosity of population segments (10) estimated by Culver and Vaughn (2015)). The minimum level of allelic richness of any of the three populations must be 1.96 (i.e., within 20% of the average allelic richness of population segments (10) estimated by Culver and Vaughn (2015)).

<u>Justification:</u> Heterozygosity is a measure of the proportion of individuals in a population having two different alleles of the same gene. As estimated by Culver and Vaughn (2015), average heterozygosity (across 16 microsatellite loci developed specifically for Sonoran pronghorn) of 10 population segments is 62% (range 54 to 68%); this level of heterozygosity is not considered an immediate threat to the subspecies. Allelic richness is a measure of the average number of alleles that takes into account rarity and commonness of alleles and provides an additional measure of genetic diversity that complements heterozygosity. Average allelic richness of 10 population segments is 2.45 (range 1.84 to 3.77; Culver and Vaughn 2015). The 10 population segments used for calculations of average heterozygosity and average allelic richness are shown in Table 7 of Culver and Vaughn (2015); however, Kofa NWR neonate and Kofa NWR pen were combined. Ideally, each population would regain the level of genetic diversity they possessed before bottlenecks occurred as a result of anthropogenic stressors and drought. An indication of pre-bottleneck diversity may be available by obtaining DNA from museum specimens. However, pre-bottleneck genetic diversity may not be achievable. Therefore, the goal is to retain as much diversity as possible, and if loss occurs, to have populations increase their genetic diversity to the level of the population that is the most diverse. The population segment with the highest overall genetic diversity is the Kofa Pen; observed heterozygosity (68%) and allelic richness (3.10) (Culver and Vaughn 2015). At a minimum for each population, however, heterozygosity must be maintained at 49% or above and allelic richness must be 1.96 or above.
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This genetic criterion must be met in addition to achieving the population size criteria because captive breeding and other management efforts could result in an increase in population numbers without obtaining acceptable levels of genetic diversity. Translocations (immigration of individuals) may be necessary to increase genetic diversity in some populations. If a single, or small number of, population(s) is observed to show a marked reduction in genetic diversity (5% or greater decline in heterozygosity and allelic richness over a 2-year period), then mixing populations (movement of individuals among populations within Arizona) to recover prior genetic diversity levels should be initiated. If all populations show a simultaneous decline in genetic diversity of 5% or greater over a 2-year period, then these declines should be investigated, minimized, and possibly mitigated.

6. Effective federal, state, tribal, and/or local laws are in place in the recovery conservation units that ensure that killing of Sonoran pronghorn is prohibited or regulated such that viable populations of Sonoran pronghorn can be maintained and are highly unlikely to need the protection of the ESA again.

Justification: The extent of the threat of poaching has not been examined and its extent is unknown. Ensuring laws are in place would enable enforcement response if poaching is determined to be negatively impacting pronghorn recovery.

Delisting Criteria

Removal from the list of threatened and endangered species may be considered when all six of the following delisting criteria are met:

1. At least three free-ranging populations are viable. Two of these must be the Cabeza Prieta population and either the Quitovac or Pinacate population. The Recovery Team defines a viable population as one that has less than a 10% probability of extinction over 50 years and a growth rate that is stable or increasing. Furthermore, at least one new population must have been established, in addition to the Kofa subunit (e.g., Sauceda subunit). Established means that the population is stable and is no longer in need of augmentation from a captive breeding program.

   A population viability analysis (PVA) estimated abundance targets to meet the Recovery Team definition of viability, which is different for each management unit due to different environmental conditions. To be considered viable, a population estimate must meet or exceed the abundance targets and demonstrate a population growth rate that is stable or increasing ($r \geq 0$) for at least 10 of 14 years[1]. Abundance targets for each management unit

[1] As of 2016, aerial surveys to estimate Sonoran pronghorn population size alternate between the Cabeza Prieta population and the Mexico populations (Pinacate and Quitovac), so that each of these populations is surveyed every other year. Therefore, population estimates will be determined from surveys (in survey years) or the average between the previous and following year's survey estimate (in non-survey years). For information on how

are estimated from the PVA to be: a) 225 in the Cabeza Prieta Management Unit; b) 150 in the Kofa subunit or a new subunit (Sauceda or other future established subunit); c) 150 in the Pinacate Management Unit; and d) 450 in the Quitovac Management Unit. These population sizes must be estimated by monitoring (i.e., aerial surveys).

Justification: Population numbers within each management unit are the same as those in the downlisting criteria, but must remain viable for a longer period of time for delisting to be considered. Removal from the list of threatened and endangered species requires greater confidence in the long-term persistence of the subspecies than downlisting requires. Demonstrating population abundance at target levels for a longer time provides greater confidence that adequate population numbers and positive growth rates are not temporary increases, but will remain sustainable over the long term.

All other delisting recovery criteria are the same as for downlisting:

2. Within the Cabeza Prieta Management Unit, Pinacate Management Unit, Quitovac Management Unit and the Kofa and Sauceda subunits of the Arizona Reintroduction Management Unit, a minimum of 90% of current Sonoran pronghorn habitat within each unit is retained and contiguous. This Sonoran pronghorn habitat is protected through agency policies, land use regulations and plans, landowner agreements, incentives, and/or other programs and agreements. The 90% of retained and contiguous Sonoran pronghorn habitat includes key habitat features such as water sources.
3. Threats to Sonoran pronghorn habitat quality in three management units are stabilized or decreasing as measured by indicators described in Appendix E. Threats must be stabilized or decreased in the three management units that correspond to the three populations that meet the population viability criteria in Recovery Criteria number 1. In particular, the threats of overgrazing; unauthorized routes, roads and trails; invasive plant and animal species threatening Sonoran pronghorn habitat; and spread of shrubby vegetation are minimized through agency policies, land use regulations and plans, landowner agreements, incentives, and/or other programs and agreements.
4. Within the Cabeza Prieta Management Unit, Pinacate Management Unit, Quitovac Management Unit, and the Kofa and Sauceda subunits of the Arizona Reintroduction Management Unit, human disturbance is alleviated such that a minimum of 90% of Sonoran pronghorn habitat can be occupied by Sonoran pronghorn.
5. Genetic diversity for three populations, as measured by heterozygosity and allelic richness for nuclear DNA markers, has been retained from levels indicated in Culver and Vaughn (2015). These three populations must meet the threshold of viability as described in

population estimates and confidence intervals are calculated, please see the Recent Population Trends – Arizona section of this plan.

Downlisting Criterion 1. The minimum level of heterozygosity of any of the three populations must be 49% (i.e., within 20% of the average heterozygosity of population segments (10) estimated by Culver and Vaughn (2015)). The minimum level of allelic richness of any of the three populations must be 1.96 (i.e., within 20% of the average allelic richness of population segments (10) estimated by Culver and Vaughn (2015)).

6. Effective federal, state, tribal, and/or local laws are in place in the recovery conservation units that ensure that killing of Sonoran pronghorn is prohibited or regulated such that viable populations of Sonoran pronghorn can be maintained and are highly unlikely to need the protection of the ESA again.

Recovery Action Outline and Narrative

The Recovery Team used the conceptual models of threats (Appendix A) to visually assess if each stressor was addressed with at least one recovery action and to assess if the factors contributing to each direct threat were considered. Recovery actions were developed to reduce the impact of each stressor, by addressing the stressor itself, minimizing the effect of the source, or by minimizing the indirect threats. Recovery actions are listed by stressor and source in the threats tracking table (Appendix F).

The following is a list of the actions needed to recover the Sonoran pronghorn. The list is organized by objective, followed by threat type and broad recovery actions. Recovery actions are often broken down into sub-actions and underlined recovery actions represent the most stepped-down levels for the recovery program narrative. The narrative describes the actions in further detail and some of the reasons the action may be important for recovery. However, it is not intended to provide the detail necessary to implement each action; detailed plans will be developed prior to implementation as needed. Priorities, estimated costs, and responsible parties are listed for each underlined action in the Implementation Schedule, which follows this Outline. In some cases, as more information becomes available, the Recovery Team may determine an action is not necessary or not feasible.

In 2009, Mexico developed the PACE for pronghorn and is currently is implementing it. The FWS and Recovery Team acknowledge the significant contribution of the PACE to pronghorn conservation. The FWS and Recovery Team will work with Mexico to ensure coordination in implementing actions from this plan and the PACE; these plans share many of the same recovery actions. See Appendix C for a translated version of the PACE.

Objective 1: Ensure multiple viable populations of Sonoran pronghorn exist range-wide.

1.1. Stabilize, increase, or maintain the number of individuals within existing populations, range-wide, where there is adequate habitat.

1.1.1. Maintain genetic diversity of Sonoran pronghorn.

1.1.1.1. <u>Transfer animals among Sonoran pronghorn populations to maintain diversity within each population as needed based on ongoing genetic evaluation (see research section).</u> If genetic monitoring (see recovery action 5.5 for details) demonstrates that the Arizona Sonoran pronghorn populations as a whole drop below 0.49 observed heterozygosity (see Recovery Criteria #5 and Culver and Vaughn 2015 for more information on observed heterozygosity in Sonoran pronghorn), this will trigger management actions such as considering translocations to Arizona from Mexico. If any single population in Arizona drops below 0.49 observed heterozygosity, this will trigger actions to move individuals among Arizona populations. If translocations are required, the number of individuals needed would be between 1-10 individuals; 1 individual will prevent differentiation between two populations and 10 individuals will make two populations panmictic. Translocations should occur every 5-10 years, based on need. If heterozygosity of Sonoran pronghorn in Sonora drops below acceptable levels, this will trigger management actions such as considering translocations from Arizona to Mexico, or among populations in Sonora. Specific thresholds and ideal translocation frequencies for Sonoran pronghorn in Sonora are not available; therefore, additional studies should focus on providing this information. Prior to transfers, conduct a cost/benefits analysis to determine if the benefit of increasing genetic diversity outweighs the risk of capture/moving animals, particularly with the significant delays at the international border associated with moving animals. The Recovery Team needs to ensure that animals moved will reproduce; therefore it may be most effective to move females, which are more likely to reproduce than males. On the other hand, the risk to the donor population of losing a female is greater.

1.1.2. Reduce mortality caused by diseases.

1.1.2.1. <u>Vaccinate against Epizootic Hemorrhagic Disease and Blue Tongue.</u> Currently, vaccinations are limited to animals captured within the pens during annual capture and release operations. All captured pronghorn, whether designated for wild release or returned to the pen, are vaccinated via hand-held syringe. Only pen-raised animals are vaccinated and only when they are being handled for other purposes. In the future there may be ways to vaccinate without handling. If that is the case, the Recovery Team would expand vaccination program to free-ranging pronghorn.

- 1.1.2.2. Vaccinate against other diseases that threaten Sonoran pronghorn if vaccination is available. Pronghorn could be vaccinated against other diseases during handling for other purposes if vaccines become available. In the future there may be ways to vaccinate without handling; if that is the case, the Recovery Team would expand vaccination program to free-ranging pronghorn.

1.1.3. Decrease poaching (the level of effort needed for 1.1.3.2 to 1.1.3.6. will depend on the results of 1.1.3.1).

- 1.1.3.1. Determine the extent of poaching. Poaching is not currently a threat in the U.S. populations. The amount of poaching that occurs in the populations in Mexico is unknown. The extent of poaching and its potential impact on Sonoran pronghorn needs investigation to determine if there is a need for anti-poaching programs.
- 1.1.3.2. Increase and maintain community vigilance programs in Mexico (an existing federal program in Mexico). Community vigilance programs to detect and report illegal pronghorn hunting are ongoing in Sonora, Mexico. These programs should be maintained and increased where feasible.
- 1.1.3.3. Promote the detection and denunciation of illegal hunting of pronghorn, including designing actions to reduce each kind of illegal hunting.
- 1.1.3.4. Promote and reinforce inspection and surveillance rounds in the areas where pronghorn are distributed during the seasons when hunting is allowed for other species that share habitat with pronghorn, with coordination of state and municipal governments. This action would target the source of poaching presumed to most likely, which is hunters for other species misidentifying or intentionally taking pronghorn.
- 1.1.3.5. Increase enforcement of existing wildlife protection laws. Laws to protect Sonoran pronghorn are in place in both countries. However, based on information from Recovery Team members from Mexico, enforcement is not adequate in Mexico and needs to be improved.
- 1.1.3.6. Monitor reductions in poaching. It is inherently difficult to monitor an illegal activity. However, as an estimate, community vigilance groups could provide the Recovery Team with records of poaching observations. These observations would be an incomplete count of the number of individual Sonoran pronghorn poached, but could be used as a rough index to assess if poaching is increasing or decreasing over time. Another rough index may be the number of poached animals or body parts confiscated by law enforcement officials.

1.1.4. Reduce predation by native, feral, and domestic predators

- 1.1.4.1. Identify under what conditions, when, and where predator control is needed. Predator control may be needed to achieve and maintain higher population levels of Sonoran pronghorn under certain conditions. Examples of such conditions include: a) when Sonoran pronghorn populations decline and high predation rates on fawns are documented, or b) when unacceptably high predation rates are occurring in special circumstances such as in the vicinity of the pens, or c) when predation rates, as documented by telemetry, are occurring on newly released animals that are determined to be unacceptably high by the Recovery Team. The amount, location, and type of predation would need to be assessed to determine when and where predator control would be implemented.

1.1.4.2. Implement predator control programs as needed. This action would occur when and where deemed necessary by the investigations and assessments described above.

1.1.5. Reduce mortality caused by canals.

1.1.5.1. Work with irrigation districts (i.e., those entities that manage canals) to develop possible solutions to prevent drowning in canals. Develop cooperative agreements and best management practices with irrigation districts.

1.1.5.2. Fence or modify canals to prevent Sonoran pronghorn from entering and drowning in canals. Possible modifications that may prevent drowning include escape structures or fencing.

1.1.5.3. Set criteria and conditions for response if pronghorn are approaching canals. A coordinated interagency response plan would outline which agencies, groups, or individuals would respond if pronghorn are detected in the vicinity of canals. This plan would describe procedures for actions such as intercepting pronghorn before they reach canals and removing pronghorn trapped in canals. The plan would include a contact list and determine which parties are responsible based on where and when pronghorn are detected in the vicinity of canals.

1.1.5.4. Monitor annual canal-related incidents (e.g., drowning, injury). Develop a reporting system and database of incidents. This database would be used to track the success of the above actions (1.1.5.1 – 1.1.5.3) in reducing canal-related mortalities.

1.1.5.5. Monitor mi/km/m of canals rendered safe by fences or escape ramps. Develop a reporting system and database of fences, escape ramps, and other canal modifications. This database would be used to track these improvements as an indicator of our success at reducing canal-related threats.

1.2. Continue captive breeding program.

- 1.2.1. <u>Maintain current captive breeding program, including care of Sonoran pronghorn and captive breeding infrastructure.</u>
- 1.2.2. <u>Evaluate and modify as needed methods of captive breeding, handling, transport, and transplant.</u> Continuously update methods as new information becomes available. In particular: a) evaluate transplant holding requirements and protocol, b) evaluate and modify as needed the annual trapping and release plan, and c) continue to update handling/anesthesia protocols as needed with the help of veterinarians and other experts.
- 1.2.3. <u>Define desired captive and released population structure.</u> Sex ratios, age, etc. should be considered when defining the desired population structure.

1.3. Establish additional populations within the historical range of Sonoran pronghorn.

- 1.3.1. <u>Evaluate suitability and prioritize reintroduction sites.</u> Determine if predator abundance, particularly of coyotes, is too high to support pronghorn. This analysis needs to be done near the time of reintroduction because drought cycles can affect predator densities. Determine if fences can be removed, or conversely, if hazards need to be fenced to protect pronghorn. Conduct vegetation sampling at reintroduction sites to determine forage composition and abundance. Determine if Sonoran pronghorn would be able to subsist on available forage. Evaluate number, accessibility, availability (permanent, ephemeral, seasonal etc.), and quality of water sources. Determine whether sources of water are present. If natural, determine if perennial or seasonal. If man-made, determine if they are maintained as reliable water sources all year or seasonally. Count water sources and measure dispersion of water. Field check water sources to determine if still functioning.
  - 1.3.1.1. <u>Evaluate legal aspects of reintroduction at each site.</u> Determine whether reintroduction will be legal and supported. This may include considering establishment of a nonessential experimental population, conducting a NEPA analysis, and other steps.
- 1.3.2. <u>Evaluate reintroduction techniques, taking into consideration site specific needs.</u> Investigate transfer and release techniques, particularly whether soft or hard releases are most effective. Evaluate and modify the trapping and release plan annually.
- 1.3.3. Establish new populations.
  - 1.3.3.1. <u>Release Sonoran pronghorn into Kofa and Sauceda subunits of the Arizona Reintroduction Management Unit.</u> An Environmental Assessment for Sonoran pronghorn reestablishment was completed that analyzed potential reintroduction areas (U.S. Fish and Wildlife Service 2010). Seven potential areas were ranked using seven criteria (size, forage, water, fragmentation, disturbance, logistics, and other). The Kofa site (Area A) received the

highest total score and the Sauceda site (Area D) received the second highest total score (U.S. Fish and Wildlife Service 2010b). Release of Sonoran pronghorn in Areas A and D were each approved in a Finding of No Significant Impact (FONSI) for the Environmental Assessment (U.S. Fish and Wildlife Service 2011b).

1.3.3.2. Establish additional populations in other sites already evaluated in the Arizona Reintroduction Management Unit. Establish additional populations at other sites evaluated in the Environmental Assessment for Sonoran pronghorn reestablishment (U.S. Fish and Wildlife Service 2010b).

1.3.3.3. Establish additional Sonoran pronghorn populations within unoccupied areas of its historical range in Sonora if the sites are determined to be appropriate for reintroduction.

1.3.3.4. Determine by genetic analysis if pronghorn in the historical range of Baja California were *A.a. sonoriensis*. It would be inappropriate to consider introductions in Baja if a different subspecies (e.g., *A. a. peninsularis*) occurred there historically.

1.3.3.5. If genetically appropriate as determined above, establish Sonoran pronghorn populations in Baja California where appropriate and feasible. Work with CONANP, SPA, and other Mexican Federal and State agencies to determine if reintroduction is compatible with their goals and budgets, and if so, proceed to determine feasibility as in 1.3.1 above. Clark and Brown (2013) have investigated the physical feasibility of some potential release sites.

1.3.3.6. Determine by genetic analysis if pronghorn in the historical range of California were *A.a. sonoriensis*. An analysis of museum specimens from within the historical range of pronghorn in California is being conducted by the University of Arizona.

1.3.3.7. If genetically appropriate as determined above, establish Sonoran pronghorn populations in California where appropriate and feasible. Work with California Department of Fish and Wildlife, Palm Springs U.S. Fish and Wildlife Service Office, BLM, the Marines, and the peninsular pronghorn team to determine if reintroduction is compatible with their goals and budgets, and if so, proceed to determine feasibility as in 1.3.1 above. Clark and Brown (2013) have investigated the physical feasibility of some potential release sites. If a California Reintroduction Management Unit is established and a decision is made to reintroduce pronghorn, conduct a PVA or similar analysis to determine a viable population abundance target.

Objective 2: Ensure that there is adequate quantity, quality, and connectivity of Sonoran pronghorn habitat to support populations.

2.1. Assess the quantity and quality of Sonoran pronghorn habitat.

2.1.1. Monitor and assess the quantity of habitat through aerial surveys annually. An initial assessment of the quantity of habitat available is necessary to determine the baseline for evaluating habitat loss and for determining if the habitat criterion has been met.

2.1.2. Conduct surveys through terrestrial and other methods (satellite images), as needed, to refine our understanding of vegetation changes. Understanding the spatial extent and magnitude of vegetation change (e.g., increases in shrubby plants, changes in distribution of plant communities) is necessary to determine how much habitat has become unsuitable for pronghorn.

2.1.3. Monitor and assess habitat quality (particularly greenness) through aerial surveys at least three times a year, and other methods as needed. Greenness is one of the best indicators of the nutritional quality of forage. Seasonal variation is extreme in the range of Sonoran pronghorn, therefore it is essential to measure several times per year to determine the range of variation. Development of quantitative indicator(s) of greenness and defensible, cost-effective methods is the first step in this recovery action.

2.1.4. Create maps seasonally (coinciding with data collected above) showing results of quality and quantities of habitat. Create Geographic Information System (GIS) layers that show the quality and quantity of habitat across the range of Sonoran pronghorn. A spatial database would be valuable for planning where to implement restoration actions and for analyzing effects of proposed projects that may negatively affect Sonoran pronghorn habitat.

2.1.5. Create a vegetation map for Sonoran pronghorn habitat throughout its range.

2.1.5.1. In Mexico. Create a vegetation map using the Brown et al. (1994) classification system for Mexico. The map should be at the sixth (Association) level of detail in Brown et al. (1994).The map will enable managers to determine which vegetation types are available and which ones are threatened by future land use changes.

2.1.5.2. In the U.S. Vegetation mapping has been completed for Organ Pipe Cactus NM, most of BMGR, and portions Cabeza Prieta NWR. Create vegetation maps for areas where none have yet been completed.

2.1.6. Assess impacts of unauthorized land use in Sonoran pronghorn habitat. Determine where, what type, and to what extent unauthorized or exempted land uses are occurring and whether those activities result in habitat impacts.

2.1.7. Install weather stations within Sonoran pronghorn habitat (to measure temperature, precipitation, dew point, relative humidity, etc.). Installing weather stations will enable the recovery team to assess the impacts of extreme temperatures. It would also help determine where water is most limiting and where water developments are most needed. In Mexico, work with Comision Nacional de Agua (National Water Commission; a federal agency), Comision estatal de agua (State Water Commission a state agency), and the University of Sonora, as appropriate. In the U.S., work with Recovery Team partner agencies to determine number and placement of stations that would provide the most representative sample. Although there are a number of weather stations existing already, there is a need to link and standardize information so it is more of a network. Currently, the Arizona Meteorological Network has 5, BMGR East has 30, BMGR West has 5, National Oceanic and Atmospheric Administration's Cooperative Observer Network has 14, Cabeza Prieta NWR has 10, Kofa NWR has 22, the Flood Control District of Maricopa County has 30, Organ Pipe Cactus NM has 25, Pinacate has 3, private landowners have 2, and YPG has 21 weather stations. The details will be developed as needed for implementing the recovery action.

2.1.8. <u>Update the information on land ownership of Sonoran Pronghorn habitat in Mexico.</u> Obtain information on land ownership, preferably on a spatial database.

2.1.9. <u>Monitor (document and track) the protection status of pronghorn habitat in each Sonora Management Unit.</u>

2.1.9.1. <u>In Pinacate (every two years).</u> "Protection" means lands that are not at risk for conversion to development, mining, intensive agriculture, or other land uses that would permanently destroy Sonoran pronghorn habitat. Track by reporting all new acres protected by category (e.g., UMAs, Areas Naturales Protegidas [ANPs], change in El Pinacate Biosphere Reserve core area, etc).

2.1.9.2. <u>In Quitovac (annually).</u> "Protection" means lands that are not at risk for conversion to development, mining, intensive agriculture, or other land uses that would permanently destroy Sonoran pronghorn habitat. Track by reporting by category all new acres protected (UMA, Areas Naturales Protegidas [ANP], etc).

2.2. Protect and/or increase the amount of existing habitat range-wide.

2.2.1. <u>Continue to acquire and protect more land for Sonoran pronghorn conservation in Mexico.</u>

2.2.1.1. <u>Expand the size of the core areas within the boundary of the El Pinacate Biosphere Reserve.</u> Core areas have the most protection and management for Sonoran pronghorn. Expanding the core areas is a management action that is not a purchase and would not necessarily change land ownership.

2.2.1.2. <u>Create protected reserve(s) for Sonoran pronghorn within the Quitovac Management Unit (e.g., UMA, State, private reserve).</u> CEDES and CONANP could work with ejidos, private entities, and/or state or federal governments to create one or more reserves that include the protection of Sonoran pronghorn habitat.

2.2.1.3. Identify and designate priority conservation areas (Área Prioritaria para la Conservación – CONANP/ CONABIO) or other State designation for the conservation of the Sonoran pronghorn. CEDES and CONANP could work with ejidos, private entities, and/or state or federal governments to create one or more reserves that include the protection of Sonoran pronghorn habitat.

2.2.2. Acquire more land for Sonoran pronghorn conservation in the U.S. Although most Sonoran pronghorn habitat is already in federal ownership, some private lands could be acquired by federal or State agencies and put into status that is protected from conversion to other land uses.

2.2.3. Protect, through appropriate laws, regulations, and policies, Sonoran pronghorn habitat in the U.S. Although most land currently occupied by Sonoran pronghorn in the U.S. is currently managed by the federal government, lands within reintroduction units are not all federally-owned or in protected status. These lands could go into a status that would protect Sonoran pronghorn habitat from conversion to other land uses or degradation from current uses. This could include conservation easements or change in land use designation.

2.2.4. Restore highly degraded Sonoran pronghorn habitat.

2.2.4.1. Identify and prioritize areas where restoration is needed. Some areas are so highly degraded they no longer provide habitat for Sonoran pronghorn, but could be restored by planting native vegetation and other methods. Identify those areas through aerial imagery, telemetry flights, ground surveys, and other field work.

2.2.4.2. Restore and protect potential Sonoran pronghorn habitat that is highly degraded. Restore habitat by planting native vegetation, restoring soils, removing hazards, and other methods. Restoration methods will be site-specific.

2.2.4.3. Work with La Herradura and Noche Buena Mines to restore Sonoran pronghorn habitat.

2.2.4.3.1. Work with the Fresnillo mining company to encourage them to implement voluntary conservation measures. Fresnillo mining company owns the Noche Buena Mine. Fresnillo also co-owns La Herradura mine with Newmont Mining Company and operates La Herradura (Fresnillo PLC 2016, Wikipedia 2016). Provide technical assistance for implementing the restoration, including providing information about Sonoran pronghorn habitat needs and habitat restoration techniques.

2.2.4.3.2. Work with the Newmont Mining Company (based in Colorado) to become a corporate sponsor of Sonoran pronghorn recovery and implement voluntary conservation measures. Newmont Mining Company owns 44% of La Herradura (Wikipedia 2016). This action provides an opportunity for agencies in the U.S. to facilitate conservation of habitat for the Sonoran pronghorn population in Quitovac.

2.2.5. Promote the conservation and protection of ANPs, Predios Certificados para la Conservación (Certified Properties for Conservation), communal and/or private reserves, and UMAs. Promote the establishment and conservation of these areas by working with responsible agencies, communities, and landowners.

2.2.6. Ask the existing UMAs to incorporate Sonoran pronghorn in their list of protected and managed animals (free ranging pronghorn already occur within the UMAs).

2.3. Prevent or minimize the loss of Sonoran pronghorn habitat to land use impacts.

2.3.1. Cooperate with La Herradura Mine on their mining plan to prevent and minimize loss of Sonoran pronghorn habitat. Work with the mine on ways to minimize the footprint of the mine in Sonoran pronghorn habitat.

2.3.2. Work with agencies and authorities (federal, state, municipal) to monitor, prevent, minimize, and/or mitigate habitat loss or future detrimental land use changes.

2.3.2.1. In Mexico SEMARNAT and SAGARHPA are responsible for monitoring, preventing, and/or mitigating these land use changes through implementing state and federal laws.

2.3.2.2. In the U.S. In the U.S. this coordination would occur primarily through ESA section 7 consultation on projects with a federal nexus.

2.3.3. Monitor by land use type the area of Sonoran pronghorn habitat lost and extent of Sonoran pronghorn habitat fragmentation caused by all land uses. Land use activities include mines (e.g., La Herradura), agriculture, development, renewable energy, off-road races near Rocky Point, etc. Track the number of acres reported in consultation documents in the U.S. and by aerial imagery in Sonora. This includes tracking the spread of the La Herradura mine footprint and other mines in Sonora annually. Maintain information in a GIS database. Suitable habitat models for the Quitovac management unit could be created by incorporating data and suggested refinements from Pate (2014). Suitable habitat models/maps could be used to monitor area of suitable habitat available and determine if desert lost to agriculture, mines, etc. was within suitable habitat. Otherwise land use conversions would be tracked for the entire management unit.

2.4. Implement environmental services, employment programs, and rural development programs in priority Sonoran pronghorn conservation areas in Sonora, and limit and/or regulate activities and infrastructure that can threaten those areas.

2.4.1. Work cooperatively with land owners within the ANPs and UMAs to adapt land management to benefit pronghorn. Work with these landowners and communities to provide information and to help them apply for federal programs to benefit ecosystem conservation.

2.4.2. Promote productive alternative low impact activities that benefit wildlife on ranches (wildlife management, ecotourism, etc.) These activities include, "Productive diversification," a concept in the Mexican General Wildlife Law that refers to alternative low-impact activities that benefit wildlife on ranches. Examples include wildlife management and harvesting, ecotourism, and use of local plants in natural habitats.

2.4.3. Establish programs to organize and coordinate agricultural and livestock activities in or around important pronghorn habitat. Work with landowners and communities to improve cattle management so that it is compatible with Sonoran pronghorn conservation. Coordinate with SAGARPHA and La Union Ganadera Regional del Estado de Sonora (Cattle Union of Sonora) on this action.

2.4.4. Promote coordinated actions regarding land use programs at the municipal and state levels, focused on avoiding changes in land uses in priority conservation areas for pronghorn.

2.5. Maintain and improve the quality of existing habitat (including an appropriate mix of vegetation types) range-wide.

2.5.1. Limit livestock grazing where it impacts Sonoran pronghorn habitat.

2.5.1.1. Reduce the amount of livestock grazing where it impacts Sonoran pronghorn habitat.

2.5.1.1.1. Coordinate with appropriate agencies to examine the need to reduce livestock numbers. In the U.S., BLM has specific procedures for reducing livestock numbers that would need to be followed. In Sonora, coordination would be with SAGARHPA and UMAs.

2.5.1.1.2. Reduce livestock numbers as determined by 2.5.1.1.1.

2.5.1.1.3. Provide financial incentives/ and other income opportunities to ranchers to reduce livestock grazing.

2.5.1.1.3.1. In Mexico. Incentives could come through programs such as Servicios Ambientales (environmental services) – CONAFOR (Comisión Nacional Forestal); PROCODES (Programa de Conservacion para Desarollo Sustantable) – CONANP; or PROCER (Programa para la Conservacion de Especies en Riesgo) - CONANP.

2.5.1.1.3.2. In the U.S. Non-governmental organizations, such as TNC may be able to establish forage banks. This action may also include buying out allotment grazing privileges or land from willing sellers.

2.5.1.1.4. Develop and implement other strategies to reduce livestock grazing.

2.5.1.2. Track changes in the number of cattle.

2.5.1.2.1. In Mexico. Develop an index with SAGARHPA or others.

2.5.1.2.2. In the U.S. This is already a requirement for allotments on BLM land in the U.S.

2.5.2. Reduce the impacts of livestock grazing where it will continue.

2.5.2.1. Coordinate with appropriate agencies to incorporate conservation measures to maintain or improve pronghorn habitat and forage availability. Coordinate with both U.S. agencies and Mexican agencies responsible for managing lands with livestock (e.g., BLM and SAGARPHA). Coordination will be to reduce the effects of livestock grazing on habitat quality, including, but not limited to, threats from reduced forage quality, increases in invasive and/or shrubby plants, and erosion. See Yoakum (2004, pages 521-532) for general recommendations for design of grazing systems in areas with pronghorn, which could be adapted for the unique habitat requirements of Sonoran pronghorn.

2.5.2.2. Involve SAGARPA, SAGARHPA, and other agencies in improving management of areas for the Sonoran pronghorn in Sonora. These agencies are responsible for agricultural activities, including grazing, in Sonora.

2.5.2.3. Decrease livestock numbers or remove livestock from habitat during times of emergency (drought, fire, etc). Livestock grazing may increase the impact on availability and quality of forage during times that forage species are stressed, such as during drought. Emergency removal of livestock during times of emergency can be implemented by BLM with little lead time. Work with SAGARPA and SAGARHPA to develop similar protocols.

2.5.2.4. Establish a utilization monitoring protocol and utilization thresholds, which if exceeded, would trigger the reduction or removal of livestock to maintain adequate forage and habitat for pronghorn.

2.5.2.4.1. In Mexico. SAGARPA provides recommendations on utilization thresholds to landowners in Sonora; however, they do not regulate the threshold. CEDES and CONANP could work directly with landowners to reduce livestock grazing through incentive programs as discussed above in 2.5.1.1.2.1.

2.5.2.4.2. In the U.S. Continue to monitor utilization within BLM-managed allotments, and adapt BLM protocols to include additional or revised measures that are more specific to Sonoran pronghorn habitat. Most other lands within Sonoran pronghorn habitat in the U.S. (e.g., Cabeza Prieta NWR, BMGR, Organ Pipe Cactus NM) are not grazed.

2.5.3. Manage invasive species in Sonoran pronghorn habitat.

2.5.3.1. Remove feral burros, goats, cattle, and horses in Sonoran pronghorn habitat. Feral (unmanaged wild) livestock can damage Sonoran pronghorn habitat by spreading invasive plants, overgrazing forage, causing erosion, and compacting soil. Removal of feral livestock on Organ Pipe Cactus NM and Cabeza Prieta NWR has resulted in improved forage conditions and water. Feral burros can deny ungulates access to water sources and their urine and feces can rapidly degrade water sources, making them unsuitable for pronghorn (John Hervert, AGFD, personal communication, 2013). The Cabeza Prieta NWR staff observed a lone jack (male) burro successively drive three mature mule deer bucks away from one of the wildlife waters on the refuge, denying them access until they eventually departed the area. Pronghorn, being a smaller ungulate than a mule deer, would be likely similarly affected at a water source that was frequented by burros.

2.5.3.2. Manage invasive, non-native plant species.

2.5.3.2.1. Identify distribution of invasive, non-native plant species that occur within Sonoran pronghorn habitat and assess the need to control them. Although some invasive, non-native plant species are known to occur within the range of Sonoran pronghorn, the extent of their distribution has not been fully investigated. Efforts have been made to map some species, such as bufflegrass, but maps showing overlap of their distribution with Sonoran pronghorn habitat have not been produced. The geographic scope of this stress, and resulting need for management, will remain unknown until the distribution has been identified. Monitor area of spread by species.

2.5.3.2.2. Control invasive, non-native plants if they are determined to be detrimental to Sonoran pronghorn habitat and if the benefit of controlling the species outweighs the potential risks to pronghorn. As the recovery team gains more knowledge about the distribution and impact of non-native plants, the priorities for which species and locations to conduct control will evolve. Those species that do cause significant alteration of structure or composition of Sonoran pronghorn habitat should be controlled using mechanical, manual, chemical, or biological methods. However, in some cases the impact of the control on Sonoran pronghorn (e.g., forage loss, toxicity, or human disturbance) may exceed the impact of the non-native plant.

2.5.3.2.3. Ensure herbicide use within Sonoran pronghorn habitat does not negatively affect Sonoran pronghorn or habitat. Herbicide may be applied to benefit agriculture or native species or ecological communities other than Sonoran pronghorn. Ensuring such herbicide use does not impact Sonoran pronghorn or their habitat would involve coordination with land management agencies, agricultural agencies, or other groups. It may also involve landowner agreements or agreements with ejidos, agricultural groups, or other interested groups.

2.5.4. Avoid and minimize impacts (contamination, fugitive dust, noise, lights, off-road vehicle use, changes in runoff patterns etc.) on Sonoran pronghorn habitat quality from adjacent projects and activities. Work with developers, mining companies, farms, energy facilities, and others to ensure their projects do not spread dust, cause erosion, or otherwise impact Sonoran pronghorn habitat outside the footprint of the development. These edge effects could effectively reduce the size of habitat patches available to pronghorn.

2.5.5. Minimize and mitigate impacts of border-related activity on Sonoran pronghorn habitat.

2.5.5.1. Work with Customs and Border Protection (CBP) and USBP to minimize and mitigate, to the greatest extent possible, operation of off-road vehicles in Sonoran pronghorn habitat. Off-road vehicle use contributes to erosion and altered hydrology which can affect forage and availability of water.

2.5.5.2. Work with USBP to minimize road dragging that is currently occurring in Sonoran pronghorn habitat. These roads affect hydrology, erosion, and vegetation of Sonoran pronghorn habitat. Work with USBP to find ways to minimize their creation and use or minimize their impacts on habitat.

2.5.5.3. Work with USBP to identify and implement alternative methods of cross-border violator detection that are less destructive than road dragging to Sonoran pronghorn habitat. Identify methods that minimize soil and water erosion and do not change vegetation structure or composition. One example would be integrated fixed towers.

2.5.5.4. Work with USBP to minimize, to the greatest extent possible, impacts of other border operations on Sonoran pronghorn habitat quality. In particular, work with USBP to limit the use of existing roads to the ones that are most critical to Border Patrol and explore alternatives to reduce the creation of new roads. Restore unnecessary roads.

2.5.5.5. Document number/miles of new drag roads, and undesignated vehicle routes and trails created. Documenting the amount of roads and trails will enable monitoring of the effectiveness of strategies listed above.

2.5.5.6. Monitor extent of erosion and changes in hydrologic patterns resulting from new roads and routes.

2.5.6. Reduce the impacts of mines (e.g., La Herradura) on Sonoran pronghorn habitat quality.

2.5.6.1. Assess the effects of La Herradura mine on Sonoran pronghorn habitat quality (contamination, fugitive dust, noise, lights, off-road vehicle use, etc.). The effects of mining can extend beyond the footprint of the mine. It is important to know if the La Herradura mine is having a negative impact on Sonoran pronghorn habitat surrounding it.

2.5.6.2. Work with La Herradura mine and provide technical assistance to minimize and mitigate the effects of the mine on Sonoran pronghorn habitat. Technical assistance would be aimed at ensuring all areas outside the footprint of the mine are minimally impacted. Assistance could be provided to minimize dust, runoff, lights, and contamination that penetrate into Sonoran pronghorn habitat as well as reducing off-road vehicle use in Sonoran pronghorn habitat surrounding the mine.

2.5.6.3. Identify and work with other mines that impact Sonoran pronghorn habitat. Technical assistance would be similar to that described for La Herradura mine above.

2.5.7. Reduce the negative impacts of agriculture on Sonoran pronghorn habitat quality.

2.5.7.1. Identify where agriculture impacts Sonoran pronghorn habitat quality.

2.5.7.2. Work with agricultural representatives to minimize and mitigate the effects of agriculture on Sonoran pronghorn habitat.

2.5.8. Establish Best Management Practices (BMPs) for U.S. projects on BLM land, to minimize the impacts of projects on Sonoran pronghorn habitat quality. BLM will work with the Recovery Team to create recommendations for BMPs and potential mitigation for all actions that may impact Sonoran pronghorn and their habitat.

2.5.9. Minimize impacts of off-road racing in Sonora on Sonoran pronghorn habitat. This would include evaluating impacts and if detrimental impacts are occurring, assemble a team to develop and implement strategies to minimize and mitigate the impacts.

2.6. Protect and/or improve the connectivity of existing Sonoran pronghorn habitat range-wide.

2.6.1. Improve Sonoran pronghorn habitat connectivity where it is impeded by barriers (e.g., highways, fences, canals).

2.6.1.1. Monitor the number of barriers in miles. Existing and planned barriers are likely documented by Arizona Department of Transportation and La Secretaria de Infraestructura y Desarrollo Urbano (the Sonora, Mexico road agency), railroad companies, and canal companies. Data (including geospatial data) on existing and planned fences could be obtained from land management agencies, ejidos, and SAGARPHA.

2.6.1.2. <u>Identify potential travel ways across existing barriers and other impediments to Sonoran pronghorn movement.</u> Using telemetry data and field observations, identify areas where pronghorn would be most likely to attempt to cross highways, canals, fences, and railroads.

2.6.1.3. <u>Remove or modify existing barriers and impediments to allow for Sonoran pronghorn passage (e.g., remove/modify fences, railroad tracks, roads, install overpasses).</u> Prioritize areas based on data gathered in 2.6.1.1 for fence removal and modification projects. Also install overpasses for highways, canals, and railroad tracks. Modify the fences along Mexico Highway 2 to funnel pronghorn to safe crossings. Current information suggests overpasses would be more successful than underpasses.

2.6.1.4. <u>Monitor (document) number or miles of barriers eliminated or modified to allow safe passage by pronghorn.</u> Track the progress by maintaining a database of number of miles of barriers eliminated or modified.

2.6.1.5. <u>Protect existing Sonoran pronghorn habitat corridors used frequently for movement between seasonal habitat use areas.</u> Some areas are used frequently for travel between seasonal use areas. These travel areas should be protected from habitat loss, modification, or creation of barriers.

2.6.2. Prevent creation and/or minimize impacts of new barriers/impediments (e.g., roads, fences, transmission lines) to Sonoran pronghorn movement.

2.6.2.1. <u>Work with appropriate authorities and stakeholders to prevent creation of new barriers/impediments to Sonoran pronghorn movement.</u> Work cooperatively with stakeholders to find ways to achieve their goals without creating barriers to Sonoran pronghorn movement.

2.6.2.2. <u>Where new barriers will be constructed, work with appropriate authorities and stakeholders to minimize the impacts of those barriers on Sonoran pronghorn movement.</u> Effects of barriers can be minimized by altering fence design; altering placement of barriers; or providing alternative passage routes for pronghorn.

2.6.3. Minimize current and avoid future Sonoran pronghorn habitat fragmentation (see section 2.6.2 for actions pertaining to barriers).

2.6.3.1. <u>Work with mine companies within the Sonoran pronghorn range to avoid and minimize habitat fragmentation.</u>

2.6.3.1.1. <u>Work with mine companies operating in Mexico.</u> The La Herradura mine could threaten to fragment the area occupied by the Quitovac population into two smaller and isolated areas that are not likely to provide for the long-range movements and habitat diversity necessary for Sonoran pronghorn to persist. It is extremely important to ensure any expansion of the mine does not split Sonoran pronghorn habitat into two isolated blocks or otherwise restrict movement of the population between different areas of its current range. It would also be important to ensure any future mines do not create similar fragmentation.

2.6.3.1.2. Work with mine companies operating in the U.S.

2.6.3.2. Work with authorities to enforce environmental laws pertaining to mining to prevent habitat fragmentation.

2.6.3.3. Work with authorities to enforce environmental laws pertaining to other sources of habitat fragmentation (e.g., new paved roads).

2.6.3.4. Establish BMPs for U.S. projects on BLM land, to minimize habitat fragmentation.

2.7. Enhance forage quality and availability to support viable populations of Sonoran pronghorn range-wide.

2.7.1. Continue forage enhancement plot program in the U.S.

2.7.1.1. Evaluate the effectiveness of existing forage enhancement plots. Develop and implement studies to determine if forage enhancement plots are effective at: 1) increasing adult survival; or 2) increasing reproductive success, primarily fawn survival.

2.7.1.2. Maintain existing forage enhancement plots, including periodic irrigation. Maintain plots unless determined ineffective in 2.7.1.1. , above.

2.7.1.3. Evaluate the need for additional forage enhancement plots.

2.7.1.4. Develop additional plots, if they are determined to be necessary and are demonstrated to be successful.

2.7.2. Continue the supplemental feeding program in the U.S.

2.7.2.1. Evaluate the effectiveness of supplemental feeding of Sonoran pronghorn. Develop and implement studies to determine if supplemental feed is effective at: 1) increasing adult survival; or 2) increasing reproductive success, primarily fawn survival.

2.7.2.2. Provide supplemental feed to Sonoran pronghorn. Continue to provide supplemental feed as needed during the spring and summer months to enhance the survival of fawns as the pronghorn populations increase to target levels. Reevaluate if not determined to be effective.

2.7.3. Evaluate feasibility of and initiate a food plot program in the U.S.

2.7.3.1. Convert current agriculture to alfalfa for Sonoran pronghorn forage. This may include purchasing agricultural lands and using them as additional forage enhancement plots or converting to Sonoran pronghorn habitat. Arizona State Heritage funds may be available to buy private lands that Sonoran pronghorn may use in the future; however, they could only be used to purchase land once Sonoran pronghorn use of the area is confirmed (Kofa region).

2.8. Maintain and improve availability of and access to water (both natural and human-made) range-wide.

2.8.1. Assess availability, amount, and accessibility to current and potential future Sonoran pronghorn waters. Monitor availability, amount, and accessibility of water seasonally

2.8.2. Map and monitor existing water sites available to Sonoran pronghorn or that could be available with some modification. Reduced availability and access to water are two of the most significant stressors to Sonoran pronghorn. Mapping water sources would provide information on how far apart usable water sources are on the landscape and if the distribution of water is adequate considering distance between waters and barriers such as paved roads and fences.

2.8.3. Maintain water sources for Sonoran pronghorn. Reduced availability of water is one of the most significant stressors to Sonoran pronghorn and is expected to worsen with climate change. Maintaining water sources is an action to counter this effect of climate change.

2.8.4. Modify existing water sources to make them available to Sonoran pronghorn as needed. This may include actions such as removing fences, fixing damaged water sources, and taking over abandoned wells to use the water for pronghorn.

2.8.5. Create new water sources for Sonoran pronghorn. Construct new water sources for Sonoran pronghorn that the Recovery Team recommends at sites determined through consultation between the site specific land management agency and the Recovery Team. Construction may include self-filling systems (catchments) or drilling wells. Ensure water sources will have certainty of being maintained before constructing. Some areas may require pronghorn-safe fencing, grids on top of the water, or other devices to exclude livestock. Water catchments may be needed within wilderness because approximately half (50.3%) of the current Cabeza Prieta population range is designated wilderness. Within Cabeza Prieta NWR, approximately 93% of the refuge is designated wilderness, and within the Organ Pipe Cactus NM, approximately 95% is designated wilderness. There are few remaining opportunities within the southern half of the current Cabeza Prieta range to implement meaningful recovery actions for Sonoran pronghorn outside of wilderness.

2.8.5.1. In the U.S. New waters sources for Sonoran pronghorn will be considered for construction based upon the recommendation of any land management representative on or associated with the Recovery Team. Any decision to proceed with construction will follow consultation and coordination between the site-specific land management agencies involved, AGFD, FWS, and Recovery Team. Coordinatation with other entities and acquisition of necessary permits may also be required.

2.8.5.2. In Mexico. New waters were constructed at El Pinacate Biosphere Reserve and in the Quitova area in 2015. Investigate reasons these waters are not being used and make any adjustments needed to encourage use. Construct new waters where feasible and beneficial to Sonoran pronghorn.

Objective 3. Minimize and mitigate the effects of human disturbance on Sonoran pronghorn.

3.1. Minimize and mitigate the impact of border-related activities on Sonoran pronghorn.

3.1.1. Complete study of effects of human disturbance on Sonoran pronghorn. As of 2016, a study is ongoing that is examining the effects of human activity on Sonoran pronghorn.

3.1.2. Monitor an index of border-related human disturbance. The index may be recommended by the human disturbance study. It may be most meaningful to monitor disturbance at important habitat features such as water sources and forage plots. It may also be effective to monitor an index of human disturbance based on the number of border crossers and CBP/USBP activities (obtain documentation from CBP).

3.1.3. Continue to work with CBP/USBP to minimize and mitigate the impacts of their operations on Sonoran pronghorn. Work with CBP/USBP to find solutions to enable effective operations while protecting Sonoran pronghorn from human disturbance, including disturbance from vehicles and low-level helicopter operations as well as foot patrols. Continue educating agents about the status of the subspecies and the sensitivity of Sonoran pronghorn to human disturbance. Measures to avoid and minimize human disturbance impacts resulting from CBP operations have been included in biological opinions. The FWS, Recovery Team, and CBP need to continue to collaborate to ensure the effectiveness of these measures, and develop new measures as needed.

3.2. Minimize and mitigate the impact of recreational activities on Sonoran pronghorn.

3.2.1. Work with off-highway vehicle (OHV) groups to inform them about Sonoran pronghorn and ways to minimize disturbance to the species. This could include presentations to OHV groups or meeting with group leaders.

3.2.2. Evaluate impacts of off-road races near Puerto Peñasco (Rocky Point), Sonora and the need to develop measures to minimize their impact on Sonoran pronghorn. Measures, if needed, may include regulating or developing BMPs with racing groups to minimize disturbance to pronghorn.

3.2.3. Work with other recreational users to inform them about Sonoran pronghorn and ways to minimize disturbance to the species. This could include presentations to hiking, biking, hunting, or other recreational groups or meeting with group leaders. The Cabeza Prieta NWR staff members currently conduct outreach presentations. This action should continue to encourage the groups to care about Sonoran pronghorn conservation, recognize if their actions may disturb pronghorn, and utilize practices that minimize disturbance.

3.2.4. Consider closing some areas of El Pinacate Biosphere Reserve to recreational activity.

3.2.5. Consider closing select roads and trails to public use during times of the year when Sonoran pronghorn are under stress. This would be determined by the Recovery Team on an annual basis, including identifying which roads and the timing of the closure. These could be emergency closures or ongoing annual closures as needed for times of extreme population decline or other extreme circumstances.

3.3. Minimize and mitigate the impact of military activities on Sonoran pronghorn.

3.3.1. Continue to work with the military partners in the U.S. (BMGR [MCAS Yuma and Luke Air Force Base], Army National Guard, Yuma Proving Ground) to minimize the impact of military activities on Sonoran pronghorn. On BMGR East, this would be a continuance of the near-daily monitoring for presence of pronghorn in vicinity of targets. When pronghorn are detected, targets within specified distances are closed for the day.

3.3.2. Update the Memorandum of Understanding between the Department of Defense and Department of Interior Relating to the Cabeza Prieta NWR. It was signed in 1994 and at some point, will need to be updated.

3.4. Minimize and mitigate the impact of public land management agency activities on Sonoran pronghorn.

3.4.1. Continue to work with land management agencies in the U.S. to minimize the impact of their activities on Sonoran pronghorn. Work with land management agencies to ensure they have policies in place to inform employees, volunteers, and contractors of ways to avoid disturbing pronghorn when conducting field activities.

3.5. Minimize and mitigate the impact of mining activities on Sonoran pronghorn.

3.5.1. Identify sources of disturbance to Sonoran pronghorn from mining activities. Sources of disturbance could include vehicles, personnel, and other human activities in the vicinity of mines. The Recovery Team needs further information to determine which activities associated with mining are disturbing to Sonoran pronghorn and how far from the mines these disturbances affect pronghorn.

3.5.2. Work with mining authorities to minimize and mitigate human disturbance. Work with mining companies to ensure they have policies in place to inform employees and contractors of ways to avoid disturbing pronghorn and minimize human activities in areas surrounding the mines.

3.6. Minimize and mitigate the impact of other activities on Sonoran pronghorn.

3.6.1. Identify sources of disturbance to Sonoran pronghorn from other activities. These activities may include agriculture and ranching, and other sources that have not yet been identified.

3.6.2. Work with authorities regulating these other activities to minimize and mitigate human disturbance when and where feasible. Work with companies to ensure they have policies in place to inform employees and contractors of ways to avoid disturbing pronghorn and minimize human activities.

Objective 4. Identify and address priority Sonoran pronghorn population monitoring needs.

4.1. Aerially survey Sonoran pronghorn populations annually to determine abundance.

4.2. Monitor Sonoran pronghorn populations to determine, among other things, population structure (e.g., sex ratios, recruitment, and age), mortality, and distribution.

4.2.1. Continue to monitor using periodic telemetry flights.

4.2.2. Monitor using other methods. Use methods such as hilltop surveys and cameras in addition to telemetry flights where they may add additional information. Investigate use of fecal DNA to improve population estimates. Fecal DNA can be used to estimate population size and survival (Woodruff, et al, *in press*), as well as to monitor movement of individuals.

4.2.3. Identify sources of Sonoran pronghorn mortality when possible.

4.3. Continue to mark (e.g., ear tags, collars) captive-raised Sonoran pronghorn released from pens. Marking captive-raised pronghorn when they are released from a pen is relatively safe and inexpensive when compared to capturing and marking wild animals and provides an effective means to use mark-recapture monitoring methods.

4.4. Evaluate the need to capture and mark (e.g., ear tags, collars) wild Sonoran pronghorn and implement as needed. Evaluate if additional wild Sonoran pronghorn need to be tagged or collared for population monitoring enhancement to be accurate.

4.5. Monitor effectiveness of predator control if and when implemented. If predator control is implemented, conduct monitoring to determine its effectiveness; if and when the objectives have been achieved; and if the effort is worthwhile or needs to be modified, changed, or discontinued.

4.6. Ensure adequate training, personnel, and infrastructure are available to monitor Sonoran pronghorn.

4.6.1. Ensure adequate training, personnel, and infrastructure are available for monitoring Sonoran pronghorn in Mexico.

4.6.1.1. <u>Train personnel in Mexico for monitoring Sonoran pronghorn.</u>

4.6.1.2. <u>Provide equipment (e.g., radio collars) to personnel in Mexico.</u>

4.6.1.3. <u>Establish a biological station in or near the Quitovac Management Unit.</u>

4.6.1.4. <u>Ensure adequate numbers of personnel are available to monitor Sonoran pronghorn in Mexico.</u>

4.6.2. Ensure adequate training, personnel, and infrastructure are available for monitoring Sonoran pronghorn in the U.S.

4.6.2.1. <u>Train personnel for monitoring Sonoran pronghorn.</u>

4.6.2.2. <u>Provide equipment (e.g., radio collars).</u>

4.6.2.3. <u>Ensure adequate numbers of personnel are available to monitor Sonoran pronghorn.</u>

4.6.3. Report regularly on Sonoran pronghorn status.

4.6.3.1. <u>Provide periodic (monthly or as needed) Sonoran pronghorn status updates.</u>

4.6.3.2. <u>Notify appropriate agencies and personnel of Sonoran pronghorn fatalities.</u>

4.6.4. <u>Identify additional Sonoran pronghorn monitoring needs.</u>

Objective 5. Identify and address priority research needs.

5.1. <u>Research the extent of disease within Sonoran pronghorn populations.</u> The Recovery Team can develop a good herd health profile by sampling both wild and captive animals when handled. Random, captive and wild fecal samples can provide additional health information. The diseases of most concern to date are Blue tongue and Epizootic Hemorrhagic Disease in both groups and coccidia in the captive pens. If Sonoran pronghorn are exposed to livestock in the future, other communicable diseases will be of concern depending upon which livestock are present and their geographical location.

5.2. <u>Continue to research the impact of human disturbance on Sonoran pronghorn populations.</u> Continue to support the study “Effects of human activities on Sonoran Pronghorn” and determine if additional research is necessary.

5.3. <u>Investigate ways to optimize Sonoran pronghorn survey techniques.</u> Consider using data from concurrent pronghorn monitoring efforts (e.g., cameras placed at waters, data collected by the BMGR range monitors, and use of fecal DNA) to corroborate data collected from aerial surveys.

5.4. Research and evaluate genetic diversity, gene flow, and potential founder effects of Sonoran pronghorn wild populations. Utilize feces, blood, hair, or other types of samples such as opportunistic tissue samples. Collect samples yearly, if feasible and budgets allow.

5.5. Continue conducting periodic evaluation of genetic diversity of captive Sonoran pronghorn populations. Monitor genetic diversity (heterozygosity, allelic richness, and number of unique haplotypes) from fecal pellets and blood samples, including collections from a variety of locations (some at waters and some free range) until 50 samples are obtained per population. Monitor every four years.

5.6. Determine if Baja and California reintroduction sites should have Sonoran pronghorn or peninsular pronghorn through genetic analysis of museum specimens. CONANP is working on genetic analysis of peninsular and Chihuahuan pronghorn. Plan a meeting among researchers to share information on genetic analysis results.

5.7. Investigate Sonoran pronghorn subspecies differentiation relative to other pronghorn subspecies. This could include genetic, epigenetic, and/or morphometric investigations.

5.8. Research the impact of predation on Sonoran pronghorn fawns. Determine if predation on fawns is occurring at high enough levels to have an effect on populations.

5.9. Investigate effects of cattle grazing on Sonoran pronghorn habitat. Determine extent of competition for forage between cattle and Sonoran pronghorn. Determine if cattle grazing is affecting Sonoran pronghorn forage species composition or abundance. Determine whether cattle grazing is impacting vegetation structure in ways that are detrimental to pronghorn (e.g., reducing thermal cover or fawning cover).

5.9.1. In Mexico.

5.9.2. In the U.S.

5.10. Investigate interactions and competition between deer and Sonoran pronghorn. The primary focus should be on mule deer. This investigation would be especially appropriate in the eastern portions of BMGR and Organ Pipe Cactus NM where pronghorn observations have declined since 1940 and mule deer observations have increased. The relationship could be due to habitat changes, water provision, or competition.

5.11. Investigate the effects of fire on Sonoran pronghorn.

5.11.1. Research Sonoran pronghorn fawn recruitment as it relates to the relationship between burned areas and predation. Although burned areas provide improved forage, they provide less cover and seem to have greater fawn predation. Research is needed to determine if greater predation in burned areas is a consistent pattern.

5.11.2. Evaluate effects of fire on forage availability and vegetation structure.

5.11.3. Monitor the area of Sonoran pronghorn habitat with fire frequencies outside the natural range of variation. Work with plant ecologists to determine the natural range of variation in fire frequencies.

5.12. Research the effects of supplemental water sources on Sonoran pronghorn adult survival and fawn recruitment. Supplemental water is instrumental in increasing adult survival and fawn recruitment. Validating this assumption is crucial for determining if the priority placed on supplying water is justified. This research should also include the influence of other variables on survival and recruitment.

5.13. Investigate Sonoran habitat use and preferences, including identifying critical use areas.

5.14. Investigate the effects of helicopters on Sonoran pronghorn. The study should focus on the intensity and frequency of helicopter use by USBP in their interdiction effort. USBP helicopter flight patterns are different than military flight patterns. USBP helicopter use involves slow back and forth and hovering movements that are hypothesized to impact Sonoran pronghorn more than military flights, which fly higher and in more direct paths.

5.15. Describe demography and reproductive biology of Sonoran pronghorn in Sonora. Little information is available currently on demography and reproductive biology in Sonora. Differences between Sonoran populations and U.S. populations need to be understood before recovery actions that are based on field data collected in the U.S. can be assumed appropriate for pronghorn populations in Sonora.

5.16. Determine extent of Sonoran pronghorn distribution in Mexico.

5.17. Revise PVA in ten years, or earlier if determined necessary due to new information.

5.18. Coordinate among individuals conducting field work within Sonoran pronghorn management units. Ensure coordination among researchers, biologists, managers, and citizen scientists to optimize research efforts, staffing, and funding.

5.19. Centrally manage Sonoran pronghorn data. Ensure historical and current data collected on Sonoran pronghorn ecology, recovery, and management (of biotic and abiotic elements) by researchers, biologists, managers, and citizen scientists is shared with appropriate groups and organized and managed in a database. The purpose of this database is to facilitate data management, archiving, and inquiries.

Objective 6. Maintain existing partnerships and develop new partnerships to support Sonoran pronghorn recovery.

6.1. Continue the work of the Recovery Team. The Recovery Team is vital for sharing information among partners and developing cooperative projects.

6.2. Continue and promote coordination between Mexico and the U.S. to recover Sonoran pronghorn.

6.2.1. Establish a binational agreement or letter of intent (Mexico-U.S.) to implement binational recovery actions in the Sonoran Pronghorn Recovery Plan and PACE. A letter of intent between CONANP and the FWS would help Mexico and the U.S. coordinate on implementing joint recovery actions.

6.2.2. Establish a binational steering committee for the Sonoran pronghorn that could facilitate and support the tasks of the Recovery Team, exchange between ministries in the Mexican Government, and the commitment of resources (both human and economic) towards the Plan. Information exchange should occur annually and meetings should be held as necessary, or at least every 5 years. Information to be exchanged should include progress in implementing state and federal Sonoran pronghorn recovery and conservation plans in the U.S. and Mexico, including updates on implementation of actions from both the PACE and the U.S. recovery plan as well as their effectiveness in recovering Sonoran pronghorn. Agencies in Mexico could include: CONANP, DGVS, PROFEPA, state wildlife agencies, and other agencies as necessary. Agencies in the U.S. could include: FWS, AGFD, and other agencies as necessary.

6.2.3. Coordinate to secure funding to recover Sonoran pronghorn.

6.3. Develop a Sonora State PACE for Sonoran pronghorn to, among other things, faciliate recovery actions between Sonora and Arizona.

6.4. Expand partnerships with interested groups to implement Sonoran Pronghorn recovery. Expand partnerships to include groups that may support Sonoran pronghorn recovery. Also partner with groups that may be opposed to recovery actions to develop mutually-agreeable actions.

6.5. Increase public support for the Sonoran pronghorn recovery program. Public support can be increased through public presentations and media.

6.6. Promote active social participation in the protection of Sonoran pronghorn and habitat in Mexico.

6.7. Increase and maintain community vigilance programs in Mexico (Programa de Vigilancia is the existing federal program in Mexico). Increase support of the program and expand the program outside of Pinacate.

6.8. Engage universities and other interested parties (e.g., zoos) in priority research of Sonoran pronghorn. Communicate Sonoran pronghorn research needs to universities through symposia (e.g., Sonoran desert symposium), and communication with individual professors, research teams, and students.

6.9. Conduct education and outreach to promote Sonoran pronghorn recovery. Include information on the loss of natural water sources and importance of supplemental water to counter effects of climate change. Specific education and outreach programs and materials (e.g., videos, pamphlets, posters) for those who live in the range of Sonoran pronghorn should be developed in Spanish and English and disseminated.

6.10. Work with governments (federal, state, and municipal) to recover Sonoran pronghorn.

6.11. Work to improve and maintain partnerships with ranchers in Mexico to conserve Sonoran pronghorn. Develop specific information (videos, pamphlets, posters) for those that live in the pronghorn areas and/or support the recovery plan.

6.12. Develop, maintain, and disseminate a directory of specialists and working groups that conduct studies or implement actions for the management, recovery, conservation, and protection of the Sonoran pronghorn at the regional, national, and international level. Develop and maintain the directory as part of Recovery Team duties.

6.13. Ensure sufficient personnel are trained and resources (e.g., vehicles) are available to adequately monitor, manage, and protect Sonoran pronghorn in Mexico. An evaluation of the current and needed levels of personnel should be conducted.

Objective 7. Secure adequate funding to implement recovery actions for Sonoran pronghorn.

7.1. Explore U.S.-based funding source options; secure and manage funds acquired from those sources.

7.2. Explore Mexico-based funding source options; secure and manage funds acquired from those sources.

7.3. Secure and manage mitigation and compensation funding in the U.S.

7.4. Secure and manage mitigation and compensation funding in Mexico.

7.5. Manage the environmental impact mitigation fund in Mexico to ensure that funds are applied specifically to Sonoran pronghorn conservation. Regardless of the species being impacted by a project, mitigation funds for that project go into a general conservation fund and are not necessarily used to mitigate impacts to the species affected by the project. Language should be added to that fund for the conservation of pronghorn, when pronghorn are impacted by projects.

7.6. Secure and manage funding from other funding sources (e.g., nongovernmental organizations, international funds, corporate sponsors).

Objective 8. Practice adaptive management, in which recovery is monitored and recovery tasks are revised by the FWS in coordination with the Recovery Team as new information becomes available.

8.1. Use adaptive management principles in the context of structured decision making (e.g., *The Open Standards for the Practice of Conservation* by the Conservation Measures Working Group [http://cmp-openstandards.org/] and the Department of Interior's Technical Guide to Adaptive Management) to evaluate this recovery effort on an ongoing basis.

8.1.1. Conduct monitoring of Sonoran pronghorn populations, habitat, and threats. Monitoring that is needed is listed in sections above. Monitoring populations will provide information on success towards reaching population criteria. Monitoring habitat and threats is also important because large populations would still be vulnerable if threats persist. Habitat and threats monitoring indicators will need to be refined and methods and monitoring plans developed. It may be important to respond to a rapidly-growing threat before its effects are shown in Sonoran pronghorn population sizes or demographics because by the time effects are shown in populations the threat may have already reached an irreversible threshold.

8.1.2. Analyze and share results of monitoring.

8.1.2.1. Compile (FWS) and discuss Sonoran pronghorn recovery accomplishments and updates (via email, conference call, or meeting) with the Sonoran

Pronghorn Recovery Team at least two times per year. Discuss formal monitoring results and informal observations as well as successes and failures with recovery implementation.

8.1.2.2. Exchange information annually and hold meetings as necessary, or at least every two years, between agencies and universities in Mexico and the U.S. to discuss progress in implementing Sonoran pronghorn recovery in the U.S. and Mexico. Agencies in Mexico include: CONANP, CEDES, DGVS, PROFEPA, and other agencies as necessary. Agencies in the U.S. include: FWS, AGFD, Organ Pipe Cactus NM, and other agencies as necessary.

8.1.2.3. Report regularly on Sonoran pronghorn status. See 4.6.3 above for population status. Also report regularly on status of habitat and threats.

8.1.3. Revise recovery actions and tasks using monitoring results (Adaptive Management Plan). If actions are not effective, revise or eliminate. Increase efforts if actions are effective but not broad enough in scope.

8.1.4. Revise recovery criteria, if warranted, following new PVA or if other new information becomes available that suggests the recovery criteria in the document are not sufficient for recovering Sonoran pronghorn (in 10 years or earlier if determined necessary).

PART III. IMPLEMENTATION SCHEDULE

The implementation schedule that follows outlines the recovery actions and estimated costs for the recovery program for Sonoran pronghorn, as set forth in this recovery plan. It is a guide for meeting the recovery goals outlined in this plan. This schedule includes recovery action numbers, action descriptions, action priorities, duration of actions, the parties responsible for actions (either funding or carrying out), and estimated costs. The actions that will incur costs (the most stepped-down recovery actions) are indicated by underlining of the action name in the implementation schedule. Priorities, responsible parties, and costs are shown for each of these actions. For clarity, they are organized by objective and grouped by similar actions as in the recovery action outline and narrative. Objectives are indicated in bold. Objective and other category headings are not underlined, do not incur costs, and were not prioritized by the team.

Priorities are based in part on the immediacy and severity of specific threats, as determined by the threats assessments presented above and in Appendix A, and how each recovery action would ameliorate those threats. Action priorities in the implementation schedule are assigned as follows:

Priority 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.
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.

Action duration is the estimated length of time to complete the recovery action. If the action will be continuous throughout the recovery of the species and is currently underway, it is described as "ongoing." The Recovery Team expects recovery to take **20 years**. Some actions may be continuous throughout the recovery period but not currently underway, and are described as "continuous." Other actions are of a definite duration, such as research projects, and in these cases the estimated number of years to complete the action is provided.

Costs for each recovery action are estimates, and actual budgets will have to be determined when each recovery action is undertaken. Cost estimates were rounded from original workbook and may not add up due to rounding differences. Cost estimates do not commit funding by any agency. Section 4(f) of the ESA requires the time and cost to be estimated to reach the plan's goal (usually delisting). For any actions listed as "Ongoing" in duration, costs were calculated for 20 years, the time period the Recovery Team estimated to recover the species. To determine if an action's costs should be included, the Recovery Team evaluated if the costs are incurred because the species is listed and the action is necessary for recovery (i.e., if they wouldn't be incurred "but for" the recovery action for the listed species). If the costs are due to the species being listed, the Recovery Team included them in the implementation schedule. If, on the other hand, the action truly would take place regardless of the involvement of the listed species, the Recovery Team did not include the costs. The total estimated cost of recovery, by priority, calculated from the information in this implementation schedule is provided in the executive summary. In addition to total cost of recovery, annual costs for the first five years are also shown in the executive summary.

Responsible parties are the parties with authority, responsibility, or expressed interest to implement a specific recovery action. The listing of a party in the Implementation Schedule does not require the identified party to implement the action(s) or to secure funding for implementing the action(s).

Responsible Party Acronyms Used in the Implementation Schedule:

- ADOT: Arizona Dept. of Transportation
- AESO: AZ Ecological Services Office (FWS)
- All AZMUs: All applicable land and wildlife management agencies in the US Conservation Unit, including: DOI (BLM-LSFO, BLM-YFO, CPNWR, OPCNM, KOFA), DOD (BMGR-EAST, BMGR-WEST, YPG), AGFD
- All CAMU: All applicable land and wildlife management agencies in the California Management Unit including: CDFW. BLM, DOD/CMGR
- All Sonora MUs: All applicable land and wildlife agencies in the Sonora Management Units: CEDES, CONANP (Pinacate), SAGARHPA
- APHIS: Animal & Plant Health Inspection Service
- AGFD: Arizona Game and Fish Department
- AZMU: all management units in Arizona
- BLM: Bureau of Land Management
- BMGR-EAST: Barry M Goldwater Range-East (Luke Air Force Base)
- BMGR-WEST: Barry M Goldwater Range-West (Marine Corps Air Station Yuma)
- CAMU: California Management Unit
- CBP: US Customs and Border Protection
- CDFW: California Department of Fish and Wildlife
- CDPCG: CA Desert Pronghorn Coordination Group

- CEDES: Commission of Ecology and Development of the State of Sonora (Comisión de Ecologies y Desarrollo Sustentable del Estado de Sonora)
- CMGR: Chocolate Mountain Gunnery Range (U.S. Marine Corps)
- CONANP (Pinacate): National Commission of Natural Protected Areas (Comisión Nacional de Areas Naturales Protegidas), El Pinacate Biosphere Reserve
- CONANP (Priority Species): National Commission of Natural Protected Areas (Comisión Nacional de Areas Naturales Protegidas), Priority Species (Especies Prioritarias Para La Conservacion)
- CPNWR: Cabeza Prieta National Wildlife Refuge (USFWS)
- DGVS: Mexican Federal Office of Wildlife (Dirección General de Vida Silvestre)
- DOD: Department of Defense
- FWS: Fish & Wildlife Service
- ID: Irrigation Districts
- Luke AFB: Luke Air Force Base
- MCAS: Marine Corps Air Station
- OPCNM: Organ Pipe Cactus National Monument
- PROFEPA: Mexican Federal Agency of Environmental Protection (Procuraduría Federal de Proteccion del Ambiente)
- SAGARHPA: State of Sonora Ministry of Agriculture, Water Resources, Fisheries and Aquaculture (Secretaría de Agricultura, Ganadería, Recursos Hidráulicos, Pesca y Acuacultura)
- SAGARPA: Mexican Federal Ministry of Livestock, Agriculture, Rural Development, Fisheries, and Foods (Secretaría de Agricultura, Ganaderia, Desarrollo Rural, Pesca, y Alimentación)
- SCT: Mexico Highway Department (Secretaría de Comunicaciones y Transportes)
- Sonora CU: Sonora Conservation Unit
- SPA: Environment Protection Minsitry of Baja California (Secretaría de Protección al Ambiente de Baja California)

- SPRT: Sonoran Pronghorn Recovery Team
- U of A: University of Arizona
- UMAs:
- USCU: U.S. Conservation Unit
- USGS: U.S. Geological Survey
- YPG: Yuma Proving Ground

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
Na	1	Ensure multiple viable populations of Sonoran pronghorn range wide.	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	1.1	Stabilize, increase, or maintain the number of individuals within existing populations, range wide, where there is adequate habitat	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	1.1.1	Maintain genetic diversity of Sonoran pronghorn	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	1.1.1.1.	Transfer animals among Sonoran pronghorn populations to maintain genetic diversity within each population as needed based on ongoing genetic evaluation (see research section 5).	1	4	SPRT	No	100.00	0.00	0.00	0.00	0.00	25.00	Costs include vet costs, helicopters or ground transfer; collars. This action may only be needed every 5 years starting in 2019.
NA	1.1.2	Reduce mortality caused by diseases	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	1.1.2.1	Vaccinate against Epizootic Hemorrhagic Disease and Blue Tongue.	1	Ongoing	AZGFD, CDFW	No	28.00	1.40	1.40	1.40	1.40	1.40	Note, for all ongoing actions, costs are calculated for 20 years, the estimated time to recovery. Estimated costs based on current vaccination program.
3	1.1.2.2	Vaccinate against other diseases that threaten Sonoran pronghorn if vaccination is available.	1	Ongoing	AZGFD, CDFW	No	32.20	1.61	1.61	1.61	1.61	1.61	

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
	1.1.3	Decrease poaching (the level of effort needed for 1.1.3.2 to 1.1.3.6 will depend on the results of 1.1.3.1)	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	1.1.3.1	<u>Determine the extent of poaching</u>	1	Ongoing	PROFEPA, CEDES, SAGARPHA	No	87.00	4.36	4.36	4.36	4.36	4.36	Cost estimates based on an average wage of $1000 per month or $45.45 per day (salary and benefits) for Mexican Patrol Officers. Minimum of two officers needed to patrol the two populations during the fall and winter months (6 months) at least eight days per month.
3	1.1.3.2	<u>Increase and maintain community vigilance programs in Mexico (an existing Federal program in Mexico).</u>	1	Ongoing	CONANP, CEDES	No	19.00	0.93	0.93	0.93	0.93	0.93	Cost estimates based on an average wage of $1700 per month or $77.27 per day (salary and benefits) for Mexican Biologists. Minimum of one biologist needed to increase community vigilance at least one day per month.
3	1.1.3.3	<u>Promote detection and denunciation of illegal hunting of pronghorn, including designing actions to reduce each kind of illegal hunting.</u>	1	Ongoing	PROFEPA, CONANP, CEDES, SAGARPHA	No	37.00	1.85	1.85	1.85	1.85	1.85	Cost estimates based on an average wage of $1700 per month (salary and benefits) for Mexican Biologists. Minimum of one biologist needed to increase community vigilance at least two days per month.

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
3	1.1.3.4	Promote and reinforce inspection and surveillance rounds in the areas where pronghorn are distributed, during the seasons when hunting is allowed for other species that share the habitat with the pronghorn, with coordination of state and municipal governments.	1	Continuous	PROFEPA, CONANP, CEDES, SAGARPHA	No	131.00	6.54	6.54	6.54	6.54	6.54	Cost estimates based on an average wage of $1000 per month (salary and benefits) for Mexican Patrol Officers. Minimum of two officers needed to patrol the two populations during the fall and winter months (6 months) at least 12 days per month. Costs calculated for 20 years.
3	1.1.3.5	Increase enforcement of existing wildlife protection laws	1	Continuous	PROFEPA	No	22.00	1.09	1.09	1.09	1.09	1.09	Cost estimates based on an average wage of $1000 per month (salary and benefits) for Mexican Patrol Officers. Minimum of two officers needed to increase enforcement of existing wildlife protection laws during the fall and winter months (6 months) at least 2 days per month. Costs calculated for 20 years.
3	1.1.3.6	Monitor reductions in poaching	1	Continuous	PROFEPA	No	5.00	0.27	0.27	0.27	0.27	0.27	Cost estimates based on an average wage of $1000 per month (salary and benefits) for Mexican Patrol Officers. Minimum of one officer needed to monitor reduction in poaching during the fall and winter months (6 months) at least 1 day per month. Costs calculated for 20 years.

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
	1.1.4	Reduce predation by native, feral, and domestic predators	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	1.1.4.1	<u>Identify under what conditions and when and where predator control is needed</u>	1	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below.
2		<u>In AZMUs</u>	1	Continuous	All AZMUs	No	4.00	0.20	0.20	0.20	0.20	0.20	A shared function between the AZGFD and land managers. Unknown frequency of need depending on circumstances and predator populations. On the average, 1 day per year and a minimum of two staff devoted to this. Costs calculated for 20 years.
2		<u>In Sonora MUs</u>	1	Continuous	Pinacate, CEDES	No	3.0	0.15	0.15	0.15	0.15	0.15	A shared function between the CEDES and CONANP staff. Unknown frequency of need depending on circumstances and predator populations. On the average, 1 day per year and a minimum of two staff devoted to this. Costs calculated for 20 years.
	1.1.4.2	<u>Implement predator control programs as needed</u>	1	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below.
2		<u>In AZMUs</u>	1	2	APHIS, AZGFD	No	30.00	0.00	0.00	0.00	0.00	15.00	Small scale around or within pen; unknown frequency needed but estimate once per 5-10 years. Aphis contract.

					Responsibility					Cost Estimate by FY (by $1,000s)			
Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	Comments
2		In Sonora MUs	1	2	CEDES, UMAs	No	50.00	0.00	0.00	0.00	0.00	10.00	This would be controlling wild populations of coyotes if needed within Mexico. The estimate frequency would be once every 10 years for an average cost of $10,000 per operation.
	1.1.5	Reduce mortality caused by canals	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	1.1.5.1	Work with irrigation districts (i.e., those entities that manage canals) to develop possible solutions to prevent drowning in canals	1	Ongoing	FWS, AZGFD, BLM, BMGR	Yes	3.60	0.18	0.18	0.18	0.18	0.18	At least one staff biologist may work occasionally on this action every year.
3	1.1.5.2	Fence or modify canals (provide escape structures, or provide food and water next to canals) to prevent Sonoran pronghorn from entering and drowning in canals	1	5	AZGFD	No	50.00	0.00	0.00	10.00	0.00	10.00	Includes staff time to write grants to get projects funded. Estimating 5 total projects needed @ an average of $10,000 per project. Fencing projects occur once, but food and water would be provided as needed.
3	1.1.5.3	Set criteria and conditions for response if pronghorn are approaching canals	1	Continuous	FWS, AZGFD, BLM, BMGR	Yes	5.60	0.28	0.28	0.28	0.28	0.28	Handled on a case by case basis. May occur at least three times per year involving at least two staff biologists. Costs calculated for 20 years.

					Responsibility					Cost Estimate by FY (by $1,000s)			
Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	Comments
3	1.1.5.4	Monitor annual canal-related incidents (e.g. drowning, injury)	1	Ongoing	FWS, AZGFD, BLM, BMGR	Yes	5.60	0.28	0.28	0.28	0.28	0.28	Handled on a case by case basis. May occur at least three times per year involving at least two staff biologists.
3	1.1.5.5	Monitor miles/km/m of canals rendered safe by fences or escape ramps	1	Continuous	FWS, AZGFD, BLM, BMGR	Yes	0.00	0.00	0.00	0.00	0.00	0.00	Handled on a case by case basis. May occur at least three times per year involving at least two staff biologists. Costs included in 1.1.5.4 above.
	1.2.	Continue captive breeding program	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	1.2.1	Maintain current captive breeding program, including care of Sonoran pronghorn and captive breeding infrastructure	1	10	AZGFD, FWS	No	3900.00	390.00	390.00	390.00	390.00	390.00	Costs include Cabeza Prieta and Kofa pens, and are based on current cost of operating pens.
3	1.2.2	Evaluate and modify as needed methods of captive breeding, handling, transport, and transplant	1	10	SPRT	Yes	0.00	0.00	0.00	0.00	0.00	0.00	Ongoing; costs covered in 1.2.1
3	1.2.3	Formulate captive and released population structure	1	10	SPRT	Yes	0.00	0.00	0.00	0.00	0.00	0.00	Ongoing; costs covered in 1.2.1
	1.3.	Establish additional populations within the historical range of Sonoran pronghorn	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	1.3.1.	Evaluate suitability and prioritize reintroduction sites	1	6	SPRT	Yes	0	0	0	0	0	0	Costs included in action 1.3.1.1. below

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
	1.3.1.1.	Evaluate legal aspects of reintroduction at each site.	1	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below.
3		In U.S.	1	6	All AZMUs, All CAMU	No	2.40	0.40	0.40	0.40	0.40	0.40	Mostly completed within the U.S. Prioritization and planning requires at least three days per year and at least four staff. These activities should be completed by 2021 within the U.S.
3		In Mexico	1	1	All Sonora MUs, SPA	No	13.00	0.00	0.00	13.00	0.00	0.00	Estimate for evaluating and prioritizing site suitability within Mexico would involve a minimum of 12 staff biologists/managers at least 14 days out of a year. Should only need doing once.
3	1.3.2.	Evaluate reintroduction techniques, taking into consideration site specific needs.	1	Ongoing	SPRT	Yes	0.00	0.00	0.00	0.00	0.00	0.00	Ongoing; part of existing positions
	1.3.3.	Establish new populations	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
3	1.3.3.1.	Release Sonoran pronghorn into Kofa and Sauceda subunits of the Arizona Reintroduction MU	1	6	SPRT	Yes	138.00	23.00	23.00	23.00	23.00	23.00	Cost includes holding pen construction and transoprt of pronghorn. Pen materials in stock. Pen crew is already employed in other capacities. In-kind support is estimated at about 40 staff people per year, ranging from volunteers to people with $100K salaries. Estimate 4 days per year.
3	1.3.3.2	Establish additional populations in other sites already evaluated in the Arizona Reintroduction MU	1	6	SPRT	Yes	0.00	0.00	0.00	0.00	0.00	0.00	Costs included in the estimates above for 1.3.3.1. The effort in any one location would take place for at least three years.
3	1.3.3.3	Establish additional Sonoran pronghorn populations within unoccupied areas of its historical range in Sonora if the sites are determined to be appropriate for reintroduction	1	3	CONANP (Priority Species), CEDES, DGVS	No	0.00	0.00	0.00	0.00	0.00	0.00	Costs not estimated due to high level of uncertainity in timing, location, and effort needed to accomplish this action.
3	1.3.3.4	Determine by genetic analysis if pronghorn in the historical range of Baja California were *A.a. sonoriensis.*	1	2	SPRT, CDPCG	No	0.00	0.00	0.00	0.00	0.00	0.00	Already funded nearly completed.

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	2016	2017	Cost Estimate by FY (by $1,000s): 2018	2019	2020	Comments
3	1.3.3.5	If genetically appropriate as determined above, establish Sonoran pronghorn populations in Baja California where appropriate and feasible.	1	3	CONANP (Priority Species), CEDES, DGVS, SPA	No	0.00	0.00	0.00	0.00	0.00	0.00	Costs not estimated due to high level of uncertainity in timing, location, and effort needed to accomplish this action.
3	1.3.3.6	Determine by genetic analysis if pronghorn in the historical range of California were *A.a. sonoriensis*.	1	2	SPRT, CDPCG	No	0.00	0.00	0.00	0.00	0.00	0.00	Already funded and nearly completed.
3	1.3.3.7	If genetically appropriate as determined above, establish Sonoran pronghorn populations in California where appropriate and feasible.	1	3	SPRT, CDPCG	Yes	0.00	0.00	0.00	0.00	0.00	0.00	Cost not estimated due to high level of uncertainity in timing, location, and effort needed to accomplish this.
	2.	Ensure that there is adequate quantity, quality, and connectivity of Sonoran pronghorn habitat to support populations	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2.1.	Assess the quantity and quality of Sonoran pronghorn habitat.	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	2.1.1.	Monitor and assess the quantity of habitat through aerial surveys annually	2	Continuous	AZGFD	No	28.50	0.00	1.50	1.50	1.50	1.50	Costs include costs of one monitoring flight per year ($1000 for the plane and $500 for the staff time associated annually); however, other techniques such as use remote sensing may be preferred in the future.

Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
3	2.1.2.	Conduct surveys through terrestrial and other methods (satellite images), as needed, to refine our understanding of vegetation changes	2	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
3		In U.S.	2	4	AZGFD	No	200.00	0.00	0.00	0.00	0.00	50.00	Based on $18,000 for veg analysis contract for just the Cabeza Prieta NWR alone. Should be repeated once every five years rangewide.
3		In Mexico	2	4	All Sonora MUs	No	120.00	0.00	0.00	0.00	30.00	0.00	Based on $18,000 for veg analysis contract for just the Cabeza Prieta NWR alone. Should be repeated once every five years rangewide.
2	2.1.3.	Monitor and assess habitat quality (particularly greenness) through aerial surveys at least three times a year, and other methods as needed	2	Ongoing	AZGFD	No	90.00	4.50	4.50	4.50	4.50	4.50	Same unit cost as for 2.1.1 above multiplied by three surveys.
3	2.1.4.	Create maps seasonally (coinciding with data collected above) showing results of quality and quantities of habitat.	2	Continuous	AZGFD	No	30.00	0.00	3.00	1.50	1.50	1.50	AZGFD staff time to create map, estimated @ $500.00. Costs for 2017 doubled to account for greater amount of time needed to create initial map.

					Responsibility					Cost Estimate by FY (by $1,000s)			
Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	Comments
	2.1.5.	Complete a vegetation map for Sonoran pronghorn habitat in throughout its range.	2	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
3	2.1.5.1	In Mexico	2	10	CEDES	No	200.00	20.00	20.00	20.00	20.00	20.00	Estimate extrapolated from known costs in the U.S. applied to pronghorn range within Sonora.
3	2.1.5.2	In the U.S.	2	5	OPCNM, CPNWR, BMGR, AZGFD	No	110.00	22.00	22.00	22.00	22.00	22.00	Estimate provided for portions of the CPNWR that remain to be mapped. Adjacent areas within pronghorn range have already been completed.
3	2.1.6.	Assess impacts of unauthorized land use in Sonoran pronghorn habitat	2	4	OPCNM, CPNWR, BMGR, CONANP	Yes	300.00	0.00	75.00	75.00	75.00	75.00	Each land area would likely be assessed separately. $75K estimated for each
3	2.1.7.	Install weather stations within Sonoran pronghorn habitat (to measure temp, precipitation, dew point, RH, etc.)	2	4	All AZMU, All Sonora MUs	No	10.00	0.00	2.50	2.50	2.50	2.50	Aprroximately $2,500.00 per station.
3	2.1.8.	Update the information on land ownership of Sonoran Pronghorn habitat in Mexico	2	2	All Sonora MUs, CONANP (Priority Species)	No	10.00	5.00	5.00	0.00	0.00	0.00	5 coastal municipalities
	2.1.9	Monitor (document and track) the protection status of pronghorn habitat in each Sonora MU	2	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below

Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
2	2.1.9.1.	In Pinacate every two years	2	10	CONANP (Pinacate)	No	15.50	0.00	1.55	0.00	1.55	0.00	Costs include costs for 2 Mexican biologists, 10 days per year, every other year.
1	2.1.9.2.	In Quitovac annually	2	20	CEDES	No	31.00	0.00	1.55	0.00	1.55	0.00	Costs include costs for 2 Mexican biologists, 10 days per year annually.
	2.2.	Protect and/or increase the amount of existing habitat range wide	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2.2.1.	Continue to acquire and protect more land for Sonoran pronghorn conservation in Mexico	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	2.2.1.1.	Expand the size of the core areas within the boundary of the Pinacate Biosphere Reserve	2	5	CONANP (Pinacate)	No	30.00	6.00	6.00	6.00	6.00	6.00	
2	2.2.1.2.	Create a protected reserve for the Sonoran pronghorn within the Quitovac Management Unit (e.g. UMA, State ANP, private reserve)	2	5	CEDES, SAGARHPA	No	30.00	6.00	6.00	6.00	6.00	6.00	
2	2.2.1.3	Identify and designate priority conservation areas (Área Prioritaria para la Conservación – CONANP/CONABIO) or other State designation for the conservation of the Sonoran pronghorn	2	4	CONANP (Priority Species)	No	8.00	0.00	2.00	0.00	0.00	0.00	Update every five years

					Responsibility					Cost Estimate by FY (by $1,000s)			
Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	Comments
3	2.2.2.	Acquire more land for Sonoran pronghorn conservation in the U.S.	2	5	All AZMUs, All CAMU	No	250.00	0.00	0.00	50.00	0.00	50.00	Costs will vary by locality and size of parcel. Estimate provided based on the known asking price for 0.5 section of land within current range in Arizona.Will likely occur at intermittent intervals, costs calculated for 5 purchaes over 20 years.
1	2.2.3.	Protect, through appropriate laws and regulations, Sonoran pronghorn habitat in the U.S. by changing or maintaining land use designations	2	2	All AZMUs, All CAMU	Yes	200.00	0.00	0.00	0.00	0.00	0.00	Costs of maintaining designations part of existing agency budgets; costs of changing land use designations would include NEPA and other analyses. Not anticipated more frequently than once every 10 years.
	2.2.4.	Restore highly degraded Sonoran pronghorn habitat	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	2.2.4.1.	Identify areas where restoration is needed	3	4	SPRT	No	0.00	0.00	0.00	0.00	0.00	0.00	Costs covered in 2.1.6 above
3	2.2.4.2.	Restore and protect potential Sonoran pronghorn habitat that is highly degraded	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
3		In U.S.	3	1	All AZMUs, All CAMU	No	1750.00	1750.00	0.00	0.00	0.00	0.00	Cost estimates based on restoration work within OCPNM and CPNWR in 2015.
3		In Mexico	3	1	All Sonora MUs	No	580.00	0.00	0.00	0.00	0.00	580.00	Cost estimates based on restoration work within OCPNM and CPNWR in 2015.

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
2	2.2.4.3.	Work with La Herradura and Noche Buena Mines to restore Sonoran pronghorn habitat.	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	2.2.4.3.1	Work with the Fresnillo Mining Company to encourage them to implement voluntary conservation measures.	3	Ongoing	CEDES	No	140.00	7.00	7.00	7.00	7.00	7.00	The action will require annual engagement with the mine company.
2	2.2.4.3.2	Work with the Newmont Mining Company (based in Colorado) to become a corporate sponsor of Sonoran pronghorn recovery and implement voluntary conservation measures.	3	Continuous	CEDES, FWS	No	140.00	7.00	7.00	7.00	7.00	7.00	This action provides an opportunity for agencies in the U.S. to facilitate conservation of habitat for the Sonoran pronghorn population in Quitovac and the action will require annual engagement with the mine company.
2	2.2.5.	Promote the conservation and protection of ANPs, Predios Certificados para la Conservación (Certified Properties for Conservation), communal and/or private reserves, and UMAs.	2, 3	Ongoing	CONANP (Priority Species and Pinacate), CEDES	No	37.00	1.85	1.85	1.85	1.85	1.85	Cost estimates based on an average wage of $1700 per month (salary and benefits) for Mexican Biologists. Minimum of one biologist needed to promote conservation and protection at least two days per month.

					Responsibility					Cost Estimate by FY (by $1,000s)			
Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	Comments
3	2.2.6	<u>Ask existing UMAs to incorporate pronghorn in their list of protected and managed animals.</u>	2,3	5	SAGARHPA ,CEDES	No	3..90	0.00	0.00	0.77	0.00	0.00	Cost estimates based on an average wage of $1700 per month (salary and benefits) for Mexican Biologists. A minimum of one biologist may work on this about 10 days every four years.
	2.3.	Prevent or minimize the loss of Sonoran pronghorn habitat to land use impacts	2, 3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	2.3.1.	<u>Cooperate with La Herradura Mine on their mining plan to prevent and minimize loss of Sonoran pronghorn habitat.</u>	2, 3	Ongoing	CEDES	No	200.00	10.00	10.00	10.00	10.00	10.00	
2	2.3.2.	<u>Work with agencies and authorities (federal, state, municipal) to monitor, prevent, minimize, and/or mitigate future detrimental land use changes</u>	2, 3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
2	2.3.2.1	<u>In Mexico</u>	2, 3	Ongoing	All Sonora MUs	No	200.00	10.00	10.00	10.00	10.00	10.00	Cost estimate provided by CEDES.

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2	2.3.2.2	In US	2, 3	Ongoing	All AZMUs, All CAMU	Yes	2400.00	120.00	120.00	120.00	120.00	120.00	Incremental costs for section 7 consultation specifically on pronghorn are totaled here for both USFWS and technical experts helping USFWS (150 days) and action agencies.
1	2.3.3	Monitor area of Sonoran pronghorn habitat lost	2, 3	Ongoing	All AZMUs, All CAMU, All Mexico CU	No	0.00	0.00	0.00	0.00	0.00	0.00	Costs covered in 2.1.6 above
	2.4.	Implement environmental services, employment programs and rural development programs in priority Sonoran pronghorn conservation areas in Sonora, and limit and/or regulate activities and infrastructure that can threaten those areas.	2, 3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	2.4.1.	Work cooperatively with the landowners of the Natural Protected Areas (Areas Naturales Protegidas) and UMAs to adapt land management to benefit pronghorn.	3	Ongoing	CONANP (Priority Species and Pinacate), CEDES, SAGARHPA	No	37.00	1.85	1.85	1.85	1.85	1.85	Cost estimates based on an average wage of $1700 per month (salary and benefits) for Mexican Biologists. Minimum of one biologist needed to work with landowners at least two days per month.

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
3	2.4.2.	Promote productive alternative low impact activities that benefit wildlife on ranches (wildlife management, ecotourism, etc.)	3	Ongoing	CONANP (Priority Species and Pinacate), CEDES, SAGARHPA	No	0.00	0.00	0.00	0.00	0.00	0.00	Costs covered in 2.4.1 above
3	2.4.3.	Establish programs to organize and coordinate agricultural and livestock activities in or around important pronghorn habitat.	3	3	CONANP (Priority Species and Pinacate), CEDES, SAGARHPA	No	5.60	0.00	0.00	1.85	1.85	1.85	Cost estimates based on an average wage of $1700 per month (salary and benefits) for Mexican Biologists. Minimum of one biologist needed two days per month for at least three years to establish programs beneficial to pronghorn.
2	2.4.4.	Promote coordinated action among municipal and state agencies to decree the state land use program which is focused on avoiding changes in land uses in priority areas.	3	3	CONANP (Priority Species and Pinacate), CEDES, SAGARHPA	No	5.60	0.00	0.00	1.85	1.85	1.85	Cost estimates based on an average wage of $1700 per month (salary and benefits) for Mexican Biologists. Minimum of one biologist needed two days per month for at least three years for this action.
	2.5.	Maintain and improve the quality of existing habitat (including an appropriate mix of vegetation types) range wide	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2.5.1.	Limit livestock grazing where it impacts Sonoran pronghorn	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
		habitat											
	2.5.1.1.	Reduce the number of livestock grazing in Sonoran pronghorn habitat in the Mexico CU, Cabeza Prieta MU and the A10jMU	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	2.5.1.1.1.	<u>Coordinate with appropriate agencies to examine the need to reduce livestock numbers</u>	3	1	SAGARHPA, BLM	No	1.90	0.00	0.00	1.86	0.00	0.00	Cost estimates based on an average wage of $1700 per month (salary and benefits) for Mexican Biologists. Minimum of one biologist needed two days per month for at least one year for this action.
	2.5.1.1.2.	<u>Reduce numbers when necessary.</u>	3	Continuous	SAGARHPA, BLM	No	4.00	0.20	0.20	0.20	0.20	0.20	Estimate based on at least five days per year to implement this action. Costs calculated for 20 years.
2	2.5.1.1.3	<u>Provide financial incentives/ and other income opportunities to ranchers to reduce livestock grazing</u>	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	See below
2	2.5.1.1.3.1	<u>In U.S.</u>	3	Continuous	BLM	No	62.80	3.14	3.14	3.14	3.14	3.14	Cost estimates based on an average wage of $314 per day (salary and benefits) for a GS-11 Position. Minimum of one biologist needed at least ten days per year to coordinate this action. Costs calculated for 20 years.

Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
2	2.5.1.1.3.2	In Mexico	3	Continuous	SAGARHPA	No	15.50	0.77	0.77	0.77	0.77	0.77	Cost estimates based on an average wage of $1700 per month (salary and benefits) for Mexican Biologists. Minimum of one biologist needed at least ten days per year to coordinate this action. Costs calculated for 20 years.
	2.5.1.1.4	Develop and implement other strategies to reduce livestock grazing.	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	See below
2		In U.S.	3	3	All AZMUs, All CAMU	No	9.42	0.00	3.14	3.14	3.14	0.00	Cost estimates based on an average wage of $314 per day (salary and benefits) for a GS-11 Biologist. Minimum of one biologist needed at least ten days per year for at least three years to coordinate this action.
2		In Mexico	3	5	All Mexico CU	No	3.90	0.77	0.77	0.77	0.77	0.77	Cost estimates based on an average wage of $1700 per month (salary and benefits) for Mexican Biologists. Minimum of one biologist needed at least ten days per year for at least five years to coordinate this action.
3	2.5.1.2	Track changes in the number of cattle	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	See below

Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
3		In U.S.	3	10	BLM	No	9.40	0.94	0.94	0.94	0.94	0.94	Cost estimates based on an average wage of $314 per day (salary and benefits) for a GS-11 Position. Minimum of one biologist needed at least three days per year for at least 10 years to compile livestock numbers from allotments in pronghorn range.
3		In Mexico	3	Continuous	SAGARPHA	No	15.50	0.77	0.77	0.77	0.77	0.77	Cost estimates based on an average wage of $1700 per month (salary and benefits) for Mexican Biologists. Minimum of one biologist needed at least ten days per year to compile livestock numbers on ejidos. Costs calculated for 20 years.
	2.5.2.	Reduce the impacts of livestock grazing where it will continue	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	2.5.2.1.	Coordinate with appropriate agencies to incorporate conservation measures to maintain or improve pronghorn habitat and forage availability	3	Ongoing	FWS,BLM, SAGARPHA, CONANP (Priority Species), CEDES	No	0.00	0.00	0.00	0.00	0.00	0.00	Costs included in action 2.3.2.2 above

					Responsibility					Cost Estimate by FY (by $1,000s)			
Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	Comments
3	2.5.2.2.	Involve SAGARPA, SAGARHPA, and other agencies in improving management of areas for the Sonoran pronghorn	3	Ongoing	All Mexico CU	No	3.10	0.15	0.15	0.15	0.15	0.15	Minimum of two, one day meetings per year to coordinate this action. Assumes an average wage of $1700 per month (salary and benefits) for Mexican Biologists.
2	2.5.2.3.	Decrease livestock numbers or remove livestock from habitat during times of emergency (drought, fire, etc).	3	4	BLM	No	3.76	0.00	0.94	0.00	0.00	0.00	Minimum of three days per year once every five years to coordinate this action. Assumes an average wage of $314 per day (salary and benefits) for a GS-11 position.
	2.5.2.4.	Establish utilization monitoring protocol, including utilization thresholds, which if exceeded would trigger the need for reducing or removing livestock to maintain adequate forage and habitat for pronghorn.	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	See below
3		In Mexico	3	Continuous	SAGARPHA	No	15.70	0.00	1.70	0.78	0.78	0.78	First year of costassumes an average wage of $1700 per month (salary and benefits) for one Mexican Biologist to develop the protocol. Subsequent costs assume rate of $850 per month ($39 per day) for techs. 2 techs 10 days per year to monitor. Costs calculated for 19 years.

					Responsibility					Cost Estimate by FY (by $1,000s)			
Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	Comments
3		In the U.S.	3	Continuous	BLM	No	34.00	0.00	1.57	1.80	1.80	1.80	Costs are for adapting utilization monitoring plan and for collecting any additional data that is solely for Sonoran pronghorn habitat. Costs calculated for GS11 5 days to develop measures and two GS7 techs 5 extra days (each) annually on top of regular allotment management monitoring. GS7 calculated at $181 (salary + benefits) per day; GS11 at $314 per day. Costs calculated for 19 years.
	2.5.3.	Manage invasive species in Sonoran pronghorn habitat	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	2.5.3.1.	Remove feral burros, goats, cattle, and horses in Sonoran pronghorn habitat	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
1		In U.S.	3	Ongoing	All AZMUs, All CAMU	No	128.00	6.40	6.40	6.40	6.40	6.40	One annual meeting involving at least 15 agency participants in addition to the annual estimated cost of control.
1		In Mexico	3	Ongoing	All Mexico CU	No	40.00	2.00	2.00	2.00	2.00	2.00	At least one annual coordination meeting and the estimated cost of controlling feral livestock.
	2.5.3.2.	Manage invasive, non-native plant species	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	2.5.3.2.1.	Identify distribution of invasive, non-native plant species that occur within Sonoran pronghorn habitat and assess the need to control them	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below

Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
3		In U.S.	3	Ongoing	All AZMUs, All CAMU	No	112.00	5.60	5.60	5.60	5.60	5.60	Estimated to require at least 60 staff days per year (assumes a field crew of at least two) to complete annually in priority areas throughout pronghorn range.
3		In Mexico	3	Ongoing	All Mexico CU	No	36.40	1.82	1.82	1.82	1.82	1.82	Estimated to require at least 20 staff days (at $45.45 per day) per year (assumes a field crew of at least two) to complete annually in priority areas throughout pronghorn range.
3	2.5.3.2.2.	Control invasive, non-native plants if they are determined to be detrimental to Sonoran pronghorn habitat and if the benefit of controlling the species outweighs the potential risks to pronghorn	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
3		In U.S.	3	Ongoing	All AZMUs, All CAMU	No	200.00	10.00	10.00	10.00	10.00	10.00	Costs depend on control technique and extent of infestation; however, annual estimated costs are provided.

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
3		In Mexico	3	Continuous	All Mexico CU	No	100.00	5.00	5.00	5.00	5.00	5.00	Costs depend on control technique and extent of infestation; however, annual estimated costs are provided. Costs calculated for 20 years.
3	2.5.3.2.3.	Ensure herbicide use within Sonoran pronghorn habitat does not negatively affect Sonoran pronghorn or habitat	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
3		In U.S.	3	Ongoing	All AZMUs, All CAMU	Yes	1.80	0.09	0.09	0.09	0.09	0.09	One annual meeting per year required per proposed control project involving at least four participants.
3		In Mexico	3	Continuous	All Mexico CU	No	1.00	0.05	0.05	0.05	0.05	0.05	One annual meeting per year required per proposed control project involving at least four participants. Costs calculated for 20 years.
3	2.5.4.	Avoid and minimize noise and lights associated with projects, actions, and/or activities within Sonoran pronghorn habitat	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
3		In U.S.	3	Ongoing	All AZMUs, All CAMU	Yes	0.00	0.00	0.00	0.00	0.00	0.00	Costs included in action 2.3.2.2 above.

Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
3		In Mexico	3	Ongoing	All Mexico CU	No	6.00	0.30	0.30	0.30	0.30	0.30	Will require coordination meetings. Anticipate at least two staff at least three times per year to propose mitigation measures for proposed activities in pronghorn range.
	2.5.5.	Minimize and mitigate impacts of border related activity on Sonoran pronghorn habitat	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	2.5.5.1.	Work with CBP/USBP to minimize and mitigate, to the greatest extent possible, operation of off-highway vehicles in Sonoran pronghorn habitat	3	Ongoing	SPRT	Yes	94.20	4.71	4.71	4.71	4.71	4.71	Estimated to involve at least five resource agency staff (assuming GS-11 level) for a least three days per year to coordinate.
2	2.5.5.2.	Work with USBP to minimize road dragging that is currently occurring in Sonoran pronghorn habitat	3	Ongoing	SPRT	Yes	94.20	4.71	4.71	4.71	4.71	4.71	Estimated to involve at least five resource agency staff (assuming GS-11 level) for a least three days per year to coordinate.
3	2.5.5.3.	Work with USBP to identify and implement alternative methods of cross-border violator detection that are less destructive than road dragging to Sonoran pronghorn habitat	3	Ongoing	SPRT	Yes	0.00	0.00	0.00	0.00	0.00	0.00	Estimated costs covered in 2.5.5.2 above

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility		Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s)					Comments
					Parties	Is FWS Lead?		2016	2017	2018	2019	2020	
1	2.5.5.4.	Work with USBP to minimize, to minimize, to the greatest extent possible, impacts of other border operations on Sonoran pronghorn habitat quality.	3	Ongoing	SPRT	Yes	94.20	4.71	4.71	4.71	4.71	4.71	Estimated to involve at least five resource agency staff (assuming GS-11 level) for a least three days per year to coordinate.
2	2.5.5.5	Document number/miles of new drag roads and undesignated vehicle routes and trails created	3	1	OPCNM, BMGR, CPNWR, BLM	No	800.00	0.00	0.00	0.00	0.00	0.00	Estimate based on a recent project led by OPCNM to document the extent of UVR's. Each land area would likely be assessed separately. This activity would likely be conducted once during the recovery period.
3	2.5.5.6	Monitor extent of erosion and changes in hydrologic patterns resulting from new roads and routes.	3	2	OPCNM, CONANP (Pinacate)	No	0.00	0.00	0.00	0.00	0.00	0.00	Would likely be done regardless of pronghorn ESA status, so no costs included.
	2.5.6.	Reduce the impacts of mines (e.g. La Herradura) on Sonoran pronghorn habitat quality	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	2.5.6.1.	Assess the effects of La Herradura mine on Sonoran pronghorn habitat quality (contamination, fugitive dust, noise, lights, off-road vehicle use, etc.)	3	5	CEDES	No	10.00	2.00	2.00	2.00	2.00	2.00	

Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
2	2.5.6.2.	Work with La Herradura mine and provide technical assistance to minimize and mitigate the effects of the mine on Sonoran pronghorn habitat.	3	Ongoing	CEDES	No	120.00	6.00	6.00	6.00	6.00	6.00	
	2.5.6.3.	Identify and work with other mines that impact Sonoran pronghorn habitat	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
3		In U.S.	3	Ongoing	BLM, AZGFD	No	40.00	2.00	2.00	2.00	2.00	2.00	Costs will vary depending on the size, duration and number of proposed mines. Estimated costs includestaff time (at least four staff for at least two days per year) per mine.
3		In Mexico	3	Ongoing	All Mexico CU	No	200.00	10.00	10.00	10.00	10.00	10.00	Costs will vary depending on the size, duration and number of proposed mines. Estimated costs include staff time (at least four staff for at least 8 days per year) per mine.
	2.5.7.	Reduce the negative impacts of agriculture on Sonoran pronghorn habitat quality	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	2.5.7.1.	Identify where agriculture impacts Sonoran pronghorn habitat quality (once every 5 years)	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
3		In U.S.	3	4	All AZMUs, All CAMU	No	60.00	0.00	0.00	15.00	0.00	0.00	Will require aerial imagery to track new agricultural areas adjacent to BLM lands and BMGR.
3		In Mexico	3	4	All Mexico CU	No	60.00	0.00	0.00	15.00	0.00	0.00	Will require use aerial imagery to track new agricultural areas.

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
3	2.5.7.2.	Work with agricultural representatives to minimize and mitigate the effects of agriculture on Sonoran pronghorn habitat	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below.
3		In U.S.	3	Continuous	BLM, AZGFD, BMGR, CADFW	No	62.80	3.14	3.14	3.14	3.14	3.14	Cost estimates based on an average wage of $314 per day (salary and benefits) for a GS-11 Biologist. Minimum of two biologists needed at least five days per year annually to coordinate this action. Costs estimated for 20 years.
3		In Mexico	3	Continuous	All Mexico CU	No	37.00	1.86	1.86	1.86	1.86	1.86	Cost estimates based on an average wage of $1700 per month (salary and benefits) for Mexican Biologists. Minimum of one biologist needed two days per month to coordinate this action. Costs estimated for 20 years.
3	2.5.8	Establish Best Management Practices for U.S. projects on BLM land, to minimize habitat loss.	3	1	SPRT	No	2.80	2.80	0.00	0.00	0.00	0.00	Based on best management practices and standard operating proceedures outlined in the 2012 lower Sonoran RMP and 2010 Yuma RMP.
1	2.5.9	Minimize impacts of off-road racing in Sonora on Sonoran pronghorn habitat.	2	Continuous	CONANP, CEDES	No	34.00	1.70	1.70	1.70	1.70	1.70	Costs based on 2 biologists for 2 weeks per year to evaluate impacts. No cost estimates are provided for assembling a team because the extent of the issue is not currently known. Costs estimated for 20 years.
	2.6.	Protect and/or improve the connectivity of existing Sonoran pronghorn habitat range wide	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

					Responsibility					Cost Estimate by FY (by $1,000s)			
Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	Comments
	2.6.1.	Improve Sonoran pronghorn habitat connectivity where it is impeded by barriers (e.g., highways, fences, canals)	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	2.6.1.1	<u>Monitor number of miles of barriers</u>	2	Continuous	All AZMUs, All CAMU, All Mexico CU	No	18.80	0.94	0.94	0.94	0.94	0.94	Cost estimates based on an average wage of $314 per day (salary and benefits) for a GS-11 Position. Minimum of one biologist needed at least three days per year to monitor the number of miles of barriers in pronghorn habitat. Costs estimated for 20 years.
2	2.6.1.2	<u>Identify potential travel ways across existing barriers and other impediments to Sonoran pronghorn movement</u>	2,3	1	SPRT	No	15.00	0.00	0.00	15.00	0.00	0.00	This action would involve modeling using telemetry data and should only need to be done once.
2	2.6.1.3	<u>Remove or modify existing barriers and impediments to allow for Sonoran pronghorn passage (e.g. remove/modify fences, railroad tracks, roads, install overpasses)</u>	2, 3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
2		<u>In U.S.</u>	2,3	Ongoing	All AZMUs, All CAMU, ADOT	No	0.00	0.00	0.00	0.00	0.00	0.00	Costs not estimated because they will vary according to the scope of the proposed project. Although no projects are currently proposed, efforts to identify such projects are ongoing.
2		<u>In Mexico</u>	2,3	Ongoing	All Mexico CU, SCT	No	0.00	0.00	0.00	0.00	0.00	0.00	Costs not estimated because they will vary according to the scope of the proposed project. Although nNo projects are currently proposed, efforts to identify such projects are ongoing..

					Responsibility					Cost Estimate by FY (by $1,000s)			
Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	Comments
2	2.6.1.4	Monitor (document) number or miles of barriers eliminated or modified to allow safe passage by pronghorn	2,3	2	SPRT	No	18.60	0.00	0.00	0.00	0.00	9.30	Will likely be assessed at least once every ten years. Estimated costs include four biologists for 10 days, plus mileage.
2	2.6.1.5	Protect existing Sonoran pronghorn habitat corridors used frequently for movement between seasonal habitat use areas.	2,3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
2		In U.S.	2,3	Ongoing	All AZMUs, All CAMU, ADOT	No	0.00	0.00	0.00	0.00	0.00	0.00	Costs included in action 2.3.2.2 above
2		In Mexico	2,3	Ongoing	CEDES, CONANP (Pinacate)	No	3.0	0.15	0.15	0.15	0.15	0.15	Cost estimates based on an average wage of $1700 per month (salary and benefits) for Mexican Biologists. Minimum of one biologist needed two days per year to coordinate this action.
	2.6.2.	Prevent creation and/or minimize impacts of new barriers/impediments (e.g. roads, fences, transmission lines) to Sonoran pronghorn movement	2,3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	2.6.2.1.	Work with appropriate authorities and stakeholders to prevent creation of new barriers/impediments to Sonoran pronghorn movement	2,3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
1		In Mexico	2,3	Ongoing	CEDES, CONANP (Pinacate and Priority Species)	No	3.0	0.15	0.15	0.15	0.15	0.15	Cost estimates based on an average wage of $1700 per month (salary and benefits) for Mexican Biologists. Minimum of two biologists needed at least one day per year to coordinate this action.
1		In U.S.	2,3	Ongoing	All AZMUs, All CAMU	Yes	25.20	1.26	1.26	1.26	1.26	1.26	Cost estimates based on an average wage of $314 per day (salary and benefits) for a GS-11 Biologist. Minimum of four biologists needed at least one day per year annually to coordinate this action.
1	2.6.2.2.	Where new barriers will be constructed, work with appropriate authorities and stakeholders to minimize the impacts of those barriers on Sonoran pronghorn movement	2,3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
		In U.S.	2,3	7	SPRT	Yes	8.82	0.00	0.00	1.26	0.00	0.00	Cost estimates based on an average wage of $314 per day (salary and benefits) for a GS-11 Biologist. Minimum of four biologists needed at least one day every three years to coordinate this action.
		In Mexico	2,3	Ongoing	CEDES, CONANP (Pinacate and Priority Species)	No	6.0	0.30	0.30	0.30	0.30	0.30	Cost estimates based on an average wage of $1700 per month (salary and benefits) for Mexican Biologists. Minimum of two biologists needed at least two days per year to coordinate this action.
	2.6.3.	Minimize current and avoid future Sonoran pronghorn habitat fragmentation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

					Responsibility				Cost Estimate by FY (by $1,000s)				
Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	Comments
	2.6.3.1.	Work with mine companies within the Sonoran pronghorn range to avoid and minimize habitat fragmentation	2,3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
1	2.6.3.1.1.	In Mexico	2,3	Ongoing	All Mexico CU	No	200.00	10.00	10.00	10.00	10.00	10.00	Costs copied from similar actions estimated by CEDES
3	2.6.3.1.2.	In the U.S.	2,3	Ongoing	All AZMUs, All CAMU	No	0.00	0.00	0.00	0.00	0.00	0.00	Cost estimates included in 2.5.6.3 above
1	2.6.3.2.	Work with authorities to enforce environmental laws pertaining to mining to prevent habitat fragmentation	2	Ongoing	All AZMUs, All CAMU	No	25.20	1.26	1.26	1.26	1.26	1.26	Cost estimates based on an average wage of $314 per day (salary and benefits) for a GS-11 Biologist. Minimum of four biologists needed at least one day per year annually to coordinate this action.
1	2.6.3.3	Work with authorities to enforce environmental laws pertaining to other sources of habitat fragmentation (e.g. new roads)	2,3	Ongoing	All AZMUs, All CAMU	No	25.20	1.26	1.26	1.26	1.26	1.26	Cost estimates based on an average wage of $314 per day (salary and benefits) for a GS-11 Biologist. Minimum of four biologists needed at least one day per year annually to coordinate this action.
	2.6.3.4.	Establish Best Management Practices for U.S. projects on BLM land, to minimize habitat fragmentation.	2	1	SPRT	No	0.00	0.00	0.00	0.00	0.00	0.00	No costs included because this action would be coordinated with 2.5.8 above to reduce costs associated with additional meetings.
	2.7.	Enhance forage quality and availability to support viable populations of Sonoran pronghorn range wide	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2.7.1.	Continue forage enhancement plot program in the U.S.	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
2	2.7.1.1.	Evaluate the effectiveness of existing forage enhancement plots	3	1	AZGFD, FWS, BMGR East and West	No	346.00	346.00	0.00	0.00	0.00	0.00	The costs reflects the actual cost of a project coordinated by the AZGFD.
2	2.7.1.2.	Maintain existing forage plots, including irrigation	3	10	AZGFD,FWS,BMGR	No	180.00	18.00	18.00	18.00	18.00	18.00	The costs reflect the actual current costs of maintaining plots.
2	2.7.1.3.	Evaluate the need for additional forage enhancement plots	3	Ongoing	SPRT	Yes	25.20	1.26	1.26	1.26	1.26	1.26	Cost estimates based on an average wage of $314 per day (salary and benefits) for a GS-11 Biologist. Minimum of four biologists needed at least one day per year annually to implement this action.
2	2.7.1.4.	Develop additional plots	3	1	All AZMUs, All CAMU	Yes	220.00	0.00	0.00	0.00	0.00	220.00	The costs cover the addition of one plot.
	2.7.2.	Continue the supplemental feeding program in the U.S.	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	2.7.2.1	Evaluate the effectiveness of supplemental feeding of Sonoran pronghorn	3	3	SPRT	No	346.00	0.00	115.00	115.00	115.00	0.00	Estimate based on 2.7.1.1 which is similar in scope
1	2.7.2.2	Provide supplemental feed to Sonoran pronghorn	3	Ongoing	AZGFD, FWS	No	50.00	5.00	5.00	5.00	5.00	5.00	Approximately $2,100 for the alfalfa hay bales needed, Additional staff time to distribute hay annually, approximately $5,000
NA	2.7.3.	Evaluate feasibility of and initiate a food plot program in the U.S.	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	2.7.3.1.	Convert current agriculture to alfalfa for Sonoran pronghorn forage	3	3	All AZMUs, All CAMU	No	75.00	25.00	25.00	25.00	0.00	0.00	Likely a small scale effort of not more than 5 - 10 acre plots in six locations. Estimate based on the cost of annual irrigation at the feps

					Responsibility					Cost Estimate by FY (by $1,000s)			
Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	Comments
NA	2.8.	Maintain and improve availability of and access to water (both natural and human-made) range wide	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	2.8.1.	Assess availability, amount of, and accessibility to current and potential future Sonoran pronghorn waters	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
3		In the U.S.	3	Ongoing	AZGFD	No	160.00	8.00	8.00	8.00	8.00	8.00	AZGFD and CPNWR do this on an ongoing basis
3		In Mexico	3	Ongoing	CONANP (Pinacate and CEDES)	No	80.00	4.00	4.00	4.00	4.00	4.00	Pinacate staff are currently monitoring waters for pronghorn
3	2.8.2.	Map and monitor existing water sites available to Sonoran pronghorn or that could be available with some modification	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
3		In the U.S.	3	Ongoing	AZGFD	No	0.00	0.00	0.00	0.00	0.00	0.00	Mapping is done. Monitoring is ongoing and costs are covered in 2.8.1.1.
3		In Mexico	3	Ongoing	CEDES	No	10.00	5.00	5.00	0.00	0.00	0.00	Mapping is complete for Pinacate, incomplete for Quitovac. Cost estimate provided to complete mapping for Quitovac over 2 years. Monitoring is ongoing and costs are covered in 2.8.1.2.
1	2.8.3.	Maintain water sources for Sonoran pronghorn	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below

Priority	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
1		In the U.S.	3	Ongoing	All AZMUs, All CAMU	Yes	376.80	18.84	18.84	18.84	18.84	18.84	Cost estimates based on an average wage of $314 per day (salary and benefits) for a GS-11 Biologist. Minimum of two staff needed at least 30 days per year annually to coordinate this action.
1		In Mexico	3	Ongoing	All AZMUs, All CAMU	No	100.00	5.00	5.00	5.00	5.00	5.00	Costs based on an ongoing effort to provide water (via temporary waters) for Sonoran pronghorn at Pinacate.
1	2.8.4.	Modify existing water sources to make them available to Sonoran pronghorn as needed	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
1		In the U.S.	3	4	All AZMUs, All CAMU	No	30.00	0.00	0.00	0.00	7.50	0.00	Estimate that four existing waters will be modified for pronghorn over a 20 year period at $7,500 each.
1		In Mexico	3	2	CEDES	No	6.00	3.00	0.00	0.00	0.00	3.00	Estimate that two existing waters will be modified for pronghorn over a 20 year period at $3,000 each.
1	2.8.5.	Create new water sources for Sonoran pronghorn	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
1		In U.S.	3	10	AZGFD	No	400.00	40.00	40.00	40.00	40.00	40.00	Two large 18,000 gallon capacity catchments per year for the next 10 years at $20,000 each.
1		In Mexico	3	5	CONANP (Pinacate)	No	17.00	3.40	3.40	3.40	3.40	3.40	Two above ground 1000 gallon capacity systems per year for the next five years at $1,700 each

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
NA	3.	Minimize and mitigate the effects of human disturbance on Sonoran pronghorn	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Na	3.1.	Minimize and mitigate the impact of border-related activities on Sonoran pronghorn	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	3.1.1.	Complete study of effects of human disturbance on Sonoran pronghorn	4	1	CBP, UofA, FWS	No	482.00	482.00	0.00	0.00	0.00	0.00	Cost includes cost of actual study that will be completed by Feb, 2017.
2	3.1.2.	Monitor an index of border-related human disturbance	4	6	FWS,CBP, OPCNM	Yes	33.60	5.60	0.00	0.00	5.60	0.00	Costs included above in 3.1.1.
1	3.1.3.	Continue to work with CBP/USBP to minimize and mitigate the impacts of their operations on Sonoran pronghorn	4	Ongoing	SPRT	Yes	0.00	0.00	0.00	0.00	0.00	0.00	Costs included 2.5.5.2 - 2.5.5.5 above
NA	3.2.	Minimize and mitigate the impact of recreational activities on Sonoran pronghorn	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	3.2.1.	Work with OHV groups to inform them about Sonoran pronghorn and ways to minimize disturbance to the species	4	6	SPRT	No	1.90	0.00	0.00	0.31	0.00	0.00	Costs include 1 day of a GS-11 biologist to meet with OHV groups every 3 years over 20 years.

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	Cost Estimate by FY (by $1,000s) 2018	2019	2020	Comments
3	3.2.2.	Evaluate impacts of off-road races near Puerto Penasco (Rocky Point), Sonora and develop measures to minimize their impact on Sonoran pronghorn.	3,4	Ongoing	CEDES, CONANP (Priority Species)	No	40.00	2.00	2.00	2.00	2.00	2.00	Costs estimated from costs provided by CEDES below in 3.6.2 for a similar action.
3	3.2.3.	Work with other recreational users, as needed, to inform them about Sonoran pronghorn and ways to minimize disturbance to the species	4	Ongoing	SPRT	No	0.00	0.00	0.00	0.00	0.00	0.00	Cost estimates included in 2.3.2.2 above
3	3.2.4	Evaluate recreational activity within Pinacate Bioreserve and close areas as necessary to protect Sonoran pronghorn during fawning season or other periods of vulnerability (e.g., dry years).	4	Ongoing	CONANP (Priority Species and Pinacate), CEDES, and others in Sonora	No	3.10	0.15	0.15	0.15	0.15	0.15	Cost estimates based on an average wage of $1700 per month (salary and benefits) for Mexican Biologists. Minimum of one biologist needed two days per year to coordinate this action.
3	3.2.5.	Close select roads and trails to public use during times of the year when Sonoran pronghorn are under stress.	4	Ongoing	All AZMUs	Yes	0.00	0.00	0.00	0.00	0.00	0.00	Cost estimates included in 2.3.2.2 above
NA	3.3.	Minimize and mitigate the impact of military activities on Sonoran pronghorn	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
2	3.3.1.	Continue to work with the military partners in the U.S. (Luke AFB, MCAS, ARNG, YPG) to minimize the impact of military activities on Sonoran pronghorn	4	Ongoing	SPRT	Yes	0.00	0.00	0.00	0.00	0.00	0.00	Cost estimates included in 2.3.2.2 above
3	3.3.2.	Update MOU between military and USFWS-CPNWR, as needed	4	2	FWS, DOD	Yes	12.52	0.00	0.00	6.28	0.00	0.00	Cost estimates based on an average wage of $314 per day (salary and benefits) for a GS-11 Biologist. Minimum of two biologists needed at least 10 days per year, once every 10 years to coordinate this action.
NA	3.4.	Minimize and mitigate the impact of land management agency activities on Sonoran pronghorn	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	3.4.1.	Continue to work with land management agencies in the U.S. to minimize the impact of their activities on Sonoran pronghorn	4	Ongoing	SPRT	Yes	0.00	0.00	0.00	0.00	0.00	0.00	Cost estimates included in 2.3.2.2 above
	3.5.	Minimize and mitigate the impact of mining activities on Sonoran pronghorn	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	3.5.1.	Identify sources of disturbance to Sonoran pronghorn from mining activities	4	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility			Cost Estimate by FY (by $1,000s)					Comments
					Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	
3		In U.S.	4	6	BLM, AZGFD	No	18.80	0.00	0.00	0.00	6.28	0.00	Cost estimates based on an average wage of $314 per day (salary and benefits) for a GS-11 Biologist. Minimum of two biologists needed at least 10 days per year, once every three years to coordinate this action.
3		In Mexico	4	20	All Mexico CU	No	40.00	2.00	2.00	2.00	2.00	2.00	Cost estimate provided by CEDES
2	3.5.2.	Work with mining authorities to minimize and mitigate human disturbance	4	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
2		In U.S.	4	Ongoing	BLM,AZGFD ,FWS	No	0.00	0.00	0.00	0.00	0.00	0.00	Cost estimates included in 2.3.2.2 above
2		In Mexico	4	Ongoing	All Mexico CU,CONAN P (Priority Species)	No	80.00	4.00	4.00	4.00	4.00	4.00	Cost estimate provided by CEDES
NA	3.6.	Minimize and mitigate the impact of other activities on Sonoran pronghorn	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	3.6.1.	Identify sources of disturbance to Sonoran pronghorn from agricultural activities	4	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below

					Responsibility					Cost Estimate by FY (by $1,000s)		
Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	Comments
3		In U.S.	4	Continuous	All AZMU; mostly BMGR and BLM N of I8	No	25.20	1.26	1.26	1.26	1.26	1.26	Landscape level analysis. Cost estimates based on an average wage of $314 per day (salary and benefits) for a GS-11 Biologist. Minimum of four biologists needed at least one day per year annually to coordinate this action.
3		In Mexico	4	Continuous	All Mexico CU	No	6.20	0.31	0.31	0.31	0.31	0.31	Cost estimates based on an average wage of $1700 per month (salary and benefits) for Mexican Biologists. Minimum of two biologists needed at least two days per year to coordinate this action. Costs estimated for 20 years.
3	3.6.2.	Work with authorities regulating other activities to minimize and mitigate human disturbance	4	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
3		In U.S.	4	Ongoing	All AZMUs, All CAMU	Yes	0.00	0.00	0.00	0.00	0.00	0.00	Cost estimates included in 2.3.2.2 above
3		In Mexico	4	Ongoing	All Mexico CU	No	40.00	2.00	2.00	2.00	2.00	2.00	Cost estimate provided by CEDES
NA	4.	Identify and address priority Sonoran pronghorn population monitoring needs	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	4.1.	Aerially survey Sonoran pronghorn populations annually to determine abundance	1	Ongoing	AZGFD, FWS	No	400.00	20.00	20.00	20.00	20.00	20.00	Costs based on current actual costs of surveys.

					Responsibility				Cost Estimate by FY (by $1,000s)			
Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	Comments
NA	4.2.	Monitor Sonoran pronghorn populations to determine, among other things, population structure (e.g., sex ratios, recruitment, and age), mortality, and distribution	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	4.2.1.	Continue to monitor using periodic telemetry flights	1	Ongoing	AZGFD	No	300.00	15.00	15.00	15.00	15.00	15.00	
2	4.2.2.	Monitor using other methods such as hilltop surveys and cameras	1	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
2		In U.S.	1	Ongoing	All AZMU	No	653.20	32.66	32.66	32.66	32.66	32.66	Cost estimates based on an average wage of $314 per day (salary and benefits) for a GS-11 Biologist. Minimum of two biologists needed at least one day per week (=104 GS11 days per year) to do hilltop surveys and maintain cameras.
2		In Mexico	1	Ongoing	All Mexico CU	No	74.20	3.7	3.7	3.7	3.7	3.7	Cost estimates based on an average wage of $1700 per month (salary and benefits) for Mexican Biologists. Minimum of two biologists needed at least two days per month to monitor pronghorn from the ground via telemetry and maintain cameras.
2	4.2.3.	Identify sources of Sonoran pronghorn mortality when possible.	1	Ongoing	SPRT	No	44.00	2.20	2.20	2.20	2.20	2.20	Minimum of four biologists involved on an average of six days per year to locate and investigate pronghorn remains.

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
1	4.3.	Continue to mark (e.g., ear tags, collars) captive-raised Sonoran pronghorn released from pens	1	10	AZGFD, FWS	No	120.00	12.00	12.00	12.00	12.00	12.00	In addition to the costs associated with the annual captured summarized above in 1.3.3.1, annual radio collar and ear-tag costs are approximately $12,000.
3	4.4.	Evaluate the need to capture and mark (e.g., ear tags, collars) wild Sonoran pronghorn and implement as needed	1	Ongoing	SPRT	No	90.00	0	0	10.00	0	10.00	Evaluation is ongoing and conducted at Recovery Team meeitings (costs of which are covered in action 4.6.4.). Capturing is done about every three years in U.S. and about every 5 years in Mexico.Therefore, about 6 captures in the U.S. and 3 in Mexico would occur during the recovery period. Wild captures cost approximately $10,000 per event.
2	4.5.	Monitor effectiveness of predator control when and if implemented	1	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
2		In U.S.	1	Ongoing	USCU	No	402.00	20.10	20.10	20.10	20.10	20.10	Would require a predator monitoring program involving at least two biologists at least two days per week for at least four months per year (64 GS11 days). GS-11 rate.
2		In Mexico	1	Ongoing	Mexico CU	No	98.00	4.90	4.90	4.90	4.90	4.90	Would require a predator monitoring program involving at least two biologists at least two days per week for at least four months per year. Mexican biologist rate.
NA	4.6.	Ensure adequate training, personnel, and infrastructure are available to monitor Sonoran pronghorn	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
NA	4.6.1.	Ensure adequate training, personnel, and infrastructure is available for monitoring Sonoran pronghorn in Mexico	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	4.6.1.1.	Train personnel in Mexico for monitoring Sonoran pronghorn	1	6	AZGFD, CONANP, CEDES	No	30.00	5.00	5.00	5.00	5.00	5.00	Cost estimates provided by CEDES.
2	4.6.1.2.	Provide equipment (e.g. radio collars)	1	4	All AZMUs	No	16.00	4.00	0.00	0.00	0.00	0.00	Need approximately 10 collars every five years at $400 per VHF collar.
3	4.6.1.3.	Establish a biological station in Quitovac MU	1	3	CEDES	No	50.00	10.00	20.00	20.00	0.00	0.00	Cost estimates provided by CEDES.
3	4.6.1.4.	Ensure adequate number of personnel are available to monitor Sonoran pronghorn in Mexico	1	Ongoing	CEDES, CONANP (Pinacate)	No	100.00	5.00	5.00	5.00	5.00	5.00	
NA	4.6.2.	Ensure adequate training, personnel, and infrastructure is available for monitoring Sonoran pronghorn in the U.S.	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	4.6.2.1.	Train personnel for monitoring Sonoran pronghorn	1	6	All AZMUs, All CAMU	No	55.80	9.30	0.00	0.00	9.30	0.00	Estimated the involvement of at least 10 resource and biologist staff for at least 10 days per year, approximately every three years. Staff could vary from GS11 to interns. Actual costs will vary annually depending on training needs.

					Responsibility					Cost Estimate by FY (by $1,000s)		
Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	Comments
2	4.6.2.2.	Provide equipment (e.g. radio collars)	1	Ongoing	AZGFD, FWS	No	0.00	0.00	0.00	0.00	0.00	0.00	$400 for VHF; $2500 for GPS collars. Will mostly be using VHF collars from now on. Costs are included in 4.3 above.
3	4.6.2.3.	Ensure adequate numbers of personnel are available to monitor Sonoran pronghorn	1	Ongoing	All AZMUs	No	100.00	5.00	5.00	5.00	5.00	5.00	In the absense of positions dedicated solely to pronghorn monitoring, this action would be absorbed by existing positions with time allocations accordingly.
NA	4.6.3.	Report regularly on Sonoran pronghorn status	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	4.6.3.1.	Provide periodic (monthly or as needed) Sonoran pronghorn status updates	1	Ongoing	AZGFD	No	150.60	7.53	7.53	7.53	7.53	7.53	Approximately two days per month at the GS-11 rate to produce and distribute the Sonoran Pronghorn Update.
3	4.6.3.2.	Notify appropriate agencies and personnel of Sonoran pronghorn fatalities	1	Ongoing	SPRT	No	12.40	0.62	0.62	0.62	0.62	0.62	Approximately two days per year at the GS-11 rate to prepare and distribute notices of pronghorn mortalities.
2	4.6.4.	Identify additional Sonoran pronghorn monitoring needs	1	Ongoing	SPRT	No	628.00	31.40	31.40	31.40	31.40	31.40	Discussed quarterly at Recovery Team Meetings. Recovery Team Meetings average 25 agency staff at a GS-11 rate
NA	5.	Identify and address priority research needs	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	5.1.	Research the extent of disease within Sonoran pronghorn populations	1	3	SPRT (AZGFD)	No	360.00	0.00	0.00	120.00	120.00	120.00	Three year study estimated at $360,000

Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility		Cost Estimate by FY (by $1,000s)						Comments
					Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	
2	5.2.	Continue to research the impact of human disturbance on Sonoran pronghorn populations.	3	4	SPRT, UofA	No	500.00	0.00	0.00	0.00	125.00	125.00	Costs of a followup study would be similar to those of the current study.
3	5.3.	Investigate ways to optimize Sonoran pronghorn survey techniques	1	3	SPRT (AZGFD)	No	360.00	0.00	0.00	120.00	120.00	120.00	Estimated three year study at approximately $360,000
2	5.4.	Research and evaluate genetic diversity, gene flow, and potential founder effects of Sonoran pronghorn wild populations.	1	5	USGS/UofA	No	500.00	25.00	25.00	25.00	25.00	25.00	
2	5.5.	Continue conducting periodic evaluation of genetic diversity of captive Sonoran pronghorn populations	1	5	USGS/UofA	No	100.00	0.00	0.00	0.00	0.00	20.00	Estimated cost approximately $20,000 every four years. ($100 per sample * 50 per population* 4 populations)
3	5.6.	Determine if Baja and California reintroduction sites should have Sonoran pronghorn or peninsular pronghorn through genetic analysis of museum specimens	1	1	SPRT, CDPCG, CONANP (Priority Species), SPA	No	0.00	0	0	0	0	0	Already funded and begunnearly completed.
3	5.7.	Investigate Sonoran pronghorn subspecies differentiation relative to other pronghorn subspecies	1	4	USGS/UofA	No	100.00	25.00	25.00	25.00	25.00	0.00	Estimated cost approximately $100,000
1	5.8.	Research the impact of Sonoran pronghorn fawn predation	3	3	AZGFD, CEDES	No	360.00	0.00	120.00	120.00	120.00	0.00	Estimated three year study at approximately $360,000

Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
3	5.9.	Determine if cattle grazing is affecting Sonoran pronghorn forage species composition or abundance.	3	See below	See below	See below	See below	See below	See below	See below	See below	See below	Costs covered below
3		In Mexico	3	3	SPRT	No	150.00	0.00	0.00	0.00	0.00	50.00	Estimated three year study by full-time two biologists and expenses for transportation and materials.
3		In the U.S.	3	3	SPRT	No	360.00	0.00	0.00	0.00	0.00	120.00	Estimated three year study at approximately $360,000.
3	5.10.	Investigate interactions and competition between deer and Sonoran pronghorn	3	3	SPRT	No	360.00	0.00	0.00	0.00	0.00	0.00	Estimated three year study at approximately $360,000
NA	5.11.	Investigate the effects of fire on Sonoran pronghorn.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	5.11.1	Research Sonoran pronghorn fawn recruitment as it relates to the relationship between burned areas and predation	3	3	AZGFD	No	360.00	0.00	120.00	120.00	120.00	0.00	Estimated three year study at approximately $360,000
3	5.11.2	Evaluate effects of fire on forage availability and vegetation structure.	3	3	AZGFD	No	180.00	0.00	60.00	60.00	60.00	0.00	Additional cost tiered off of 5.11.1 above

					Responsibility					Cost Estimate by FY (by $1,000s)			
Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	Comments
3	5.11.3	Monitor the area of Sonoran pronghorn habitat with fire frequencies outside the natural range of variation.	3	3	SPRT	No	180.00	0.00	0.00	60.00	60.00	60.00	Could be tiered off of existing vegetative community monitoring conducted by agency personnel within BMGR, CPNWR and OPCNM but at additional cost as estimated at left
1	5.12.	Evaluate the effects of supplemental water sources and feed on the survival and recruitment of both wild and pen raised Sonoran pronghorn.	3	3	AZGFD, CEDES	No	360.00	0.00	120.00	120.00	120.00	0.00	Estimated three year study at approximately $360,000
1	5.13.	Investigate Sonoran habitat use and preferences, including identifying critical use areas.	3	Ongoing	AZGFD	No	0.00	0.00	0.00	0.00	0.00	0.00	Costs above in 4.2.1 and 4.2.2.
3	5.14.	Investigate the effects of helicopters on Sonoran pronghorn.	4	3	SPRT	No	360.00	0.00	0.00	120.00	120.00	120.00	Estimated three year study at approximately $360,000
3	5.15	Describe demography and reproductive biology of Sonoran pronghorn in Sonora.	1	3	CEDES, CONANP, AZGFD	No	360.00	0.00	0.00	120.00	120.00	120.00	Estimated three year study at approximately $360,000
3	5.16	Determine extent of Sonoran pronghorn distribution in Mexico.	1	3	CEDES, CONANP, AZGFD	No	360.00	0.00	0.00	120.00	120.00	120.00	Estimated three year study at approximately $360,000

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility		Cost Estimate by FY (by $1,000s)						Comments
					Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	
3	5.17	Revise PVA in ten years, or earlier if determined necessary due to new information.	1	2	SPRT	Yes	60.00	30.00	0.00	0.00	0.00	0.00	Estimated cost of the PVA and agency staff participants is approximately $30,000 per event.
3	5.18	Coordinate among individuals conducting field work within Sonoran pronghorn management units	1,2,3,4,5, 6	Ongoing	SPRT	Yes	0.00	0.00	0.00	0.00	0.00	0.00	Costs covered in other coordination actions, primarily 4.6.4.
3	5.19	Centrally manage Sonoran pronghorn data.	1,2,3,4,5, 6	Continuous	SPRT	Yes	195.00	100.00	5.00	5.00	5.00	5.00	Estimated cost of $100,000 to develop and organize data into a central database. Estimated $5,000 to manage the database annually after it is developed.
NA	6.	Maintain existing partnerships and develop new partnerships to support Sonoran pronghorn recovery	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	6.1.	Continue the work of the Sonoran Pronghorn Recovery Team	1,2,3,4	Ongoing	SPRT	Yes	0.00	0.00	0.00	0.00	0.00	0.00	Costs calculated above in 4.6.4
NA	6.2	Continue and promote coordination between Mexico and the U.S. to recover Sonoran pronghorn.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	Comments
								Cost Estimate by FY (by $1,000s)					
1	6.2.1	Establish a binational agreement or letter of intent (Mexico-U.S.) to implement binational recovery actions in the Sonoran Pronghorn Recovery Plan and PACE	1,2,3,4	1	SPRT, FWS, CONANP	No	1.57	1.57	0.00	0.00	0.00	0.00	Costs calculated using one GS11 to write agreement for 1 week. Coordination included in 6.2.2., below.
1	6.2.2	Establish a binational steering committee for the Sonoran pronghorn that could facilitate and support the tasks of several members of the recovery team, have more weight in the exchange between ministries in the Mexican Government and facilitate the flow of resources (both human and economic) towards the Plan.	1,2,3,4	Ongoing	SPRT, FWS, CONANP	No	20.00	1.00	1.00	1.00	1.00	1.00	
1	6.2.3	Coordinate to secure funding to recover Sonoran pronghorn.	1,2,3,4	Ongoing	SPRT, FWS, CONANP	No	0.00	0.00	0.00	0.00	0.00	0.00	Costs covered above in 4.6.4
1	6.3	Develop a Sonora State PACE for Sonoran pronghorn to, among other things, faciliate recovery actions between Sonora and Arizona.	1,2,3,4	1	CEDES, CONANP (Priority Species and Pinacate)	No	20.40	0.00	0.00	0.00	0.00	20.40	Two Mexican Biologists at half time for one year.
3	6.4	Expand partnerships with interested groups to implement Sonoran Pronghorn recovery	1,2,3,4	Ongoing	SPRT	Yes	12.60	0.63	0.63	0.63	0.63	0.63	Two staff attending partner meetings once per year. GS-11 standard salary.

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
3	6.5	Increase public support for the Sonoran pronghorn recovery program	1,2,3,4	Ongoing	SPRT	Yes	37.60	1.88	1.88	1.88	1.88	1.88	Recovery staff involvement in public seminars and symposia, 6 days per year estimated.
3	6.6	Promote active social participation in the protection of Sonoran pronghorn and habitat in Mexico	1,2,3,4	Ongoing	SPRT (CEDES and CONANP (Priority Species))	No	22.00	1.10	1.10	1.10	1.10	1.10	Mexico biologist staff involvement in education and outreach to the public. At least five days per year for 3 biologists.
3	6.7	Increase and maintain community vigilance programs in Mexico (existing Federal program in Mexico)	1,2,3,4	Ongoing	SPRT (CEDES and CONANP (Priority Species))	No	0.00	0.00	0.00	0.00	0.00	0.00	Costs covered above in 6.4
3	6.8	Engage universities and other interested parties (e.g. zoos) in research of Sonoran pronghorn	1,2,3,4	Ongoing	SPRT	Yes	31.40	1.57	1.57	1.57	1.57	1.57	Annually coordinate with science group.GS-11 standard salary. Minimum of five staff days per year.
3	6.9	Conduct education and outreach to promote Sonoran pronghorn recovery	1,2,3,4	Ongoing	SPRT	No	31.40	1.57	1.57	1.57	1.57	1.57	Recovery staff involvement in education and outreach to the public. At least five days per year. GS-11 salary standard.
1	6.10	Work with governments (federal, state, and municipal) to recover Sonoran pronghorn	1,2,3,4	Ongoing	SPRT	Yes	62.80	3.14	3.14	3.14	3.14	3.14	Costs partially covered above in 4.6.4. Additional five days per year of at least two GS-11 staff required annually for follow through.
2	6.11	Work to improve and maintain partnerships with ranchers in Mexico to conserve Sonoran pronghorn	1,2,3,4	Ongoing	CEDES, CONANP (Priority Species and Pinacate)	No	22.00	1.10	1.10	1.10	1.10	1.10	Cost estimates based on an average wage of $1700 per month (salary and benefits) for Mexican Biologists. Minimum of two biologists needed at least 10 days per year to coordinate this action.

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	Cost Estimate by FY (by $1,000s): 2018	2019	2020	Comments
3	6.12	Develop, maintain, and disseminate a directory of specialists and working groups that conduct studies or implement actions for the management, recovery, conservation, and protection of the Sonoran pronghorn at the regional, national, and international level	1,2,3,4	Continuous	SPRT	Yes	6.28	0.31	0.31	0.31	0.31	0.31	One GS-11 staff day per year required to update and distribute annually. Costs estimated for 20 years.
3	6.13	Ensure sufficient personnel and resources (e.g., vehicles) are trained and available to adequately monitor, manage, and protect Sonoran pronghorn in Mexico.	1,2,3,4	Ongoing	CEDES, CONANP (Priority Species and Pinacate)	No	15.40	0.77	0.77	0.77	0.77	0.77	Costs partially covered above in 4.6.1.4. Additional five days per year of at least two staff (one from CEDES and one from CONANP) required annually for follow through.
NA	7.	Secure adequate funding to implement recovery actions for Sonoran pronghorn	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Na
1	7.1.	Explore U.S.-based funding source options; secure and manage funds acquired from those sources.	1,2,3,4	Ongoing	SPRT	Yes	100.00	5.00	5.00	5.00	5.00	5.00	Requires the involvement of at least three GS-11 staff for 16 days per year.
1	7.2.	Explore Mexico-based funding source options; secure and manage funds acquired from those sources.	1,2,3,4	Ongoing	SPRT	No	100.00	5.00	5.00	5.00	5.00	5.00	Requires the involvement of at least three staff, for at least 16 days per year.

					Responsibility					Cost Estimate by FY (by $1,000s)			
Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Parties	Is FWS Lead?	Total Cost ($1,000s)	2016	2017	2018	2019	2020	Comments
2	7.3.	Secure and manage mitigation and compensation funding in the U.S.	1,2,3,4	Ongoing	SPRT	Yes	0.00	0.00	0.00	0.00	0.00	0.00	Costs included in 2.3.2.2 above.
2	7.4	Secure and manage mitigation and compensation funding in Mexico.	1,2,3,4	Ongoing	CONANP, CEDES	No	7.70	0.39	0.39	0.39	0.39	0.39	Costs partially covered above in 3.5.2 and 3.6.2 above. At least an additional five staff days per year may be required to implement this action.
3	7.5	Manage the environmental impact mitigation fund in Mexico to ensure that funds are applied specifically to Sonoran pronghorn conservation	1,2,3,4	Ongoing	SPRT (CEDES and CONANP (Priority Species))	No	50.00	2.50	2.50	2.50	2.50	2.50	Would require state and national agency staff participation to implement and manage. Estimate at least $2,500 per year in staff involvement to implement this action.
3	7.6	Secure funding from other funding sources (e.g., nongovernmental organizations, international funds)	1,2,3,4	Ongoing	SPRT	Yes	6.58	0.94	0.00	0.00	0.94	0.00	Occasional, not anticpated every year. Estimate two GS-11 staff working with an NGO to coordinate at least three days per year, at least every three years.
NA	8.	Practice adaptive management in which recovery is monitored and recovery tasks are revised by the USFWS in coordination with the Sonoran Pronghorn Recovery Team as new information becomes available	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Prior-ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility		Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s)					Comments
					Parties	Is FWS Lead?		2016	2017	2018	2019	2020	
NA	8.1.	Use adaptive management principles in the context of structured decision making (e.g. The Open Standards for the Practice of Conservation and the DOI Technical Guide to evaluate this recoery effort on an ongoing basis.	1,2,3,4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	8.1.1.	Conduct monitoring of Sonoran pronghorn populations, habitat, and threats.	1,2,3,4	Ongoing	All AZMUs, All CAMU, Mexico CU	No	0.00	0.00	0.00	0.00	0.00	0.00	Costs covered in monitoring actions above. Specifically, 2.1, 2.3, 4.2 and 4.5
	8.1.2.	Analyze and share results of monitoring	1,2,3,4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	8.1.2.1.	Compile (FWS) and discuss Sonoran pronghorn recovery accomplishments and updates (via email, conference call, or meeting) with the Sonoran Pronghorn Recovery Team at least two times per year	1,2,3,4	Ongoing	SPRT	Yes	0.00	0.00	0.00	0.00	0.00	0.00	Costs covered in recovery team meeting cost estimates above in 4.6.4
3	8.1.2.2.	Exchange information annually and hold meetings as necessary, or at least every two years, between agencies and universities in Mexico and the U.S to discuss progress in implementing Sonoran pronghorn recovery in the U.S. and Mexico	1,2,3,4	Ongoing	SPRT	Yes	0.00	0.00	0.00	0.00	0.00	0.00	This would be done at recovery team meetings (costs calculated above in 4.6.4), as well as at the Sonoran Desert symposium every two years; however this meeting would occur regardless of the Sonoran pronghorn's listed status, so no costs are included.

Prior -ity	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility: Parties	Responsibility: Is FWS Lead?	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): 2016	2017	2018	2019	2020	Comments
3	8.1.2.3.	Report regularly on Sonoran pronghorn status (see 4.6.3.1 above)	1,2,3,4	Ongoing	SPRT	No	0.00	0.00	0.00	0.00	0.00	0.00	Cost covered above in actions 4.6.3.1 and 8.1.2.2.
3	8.1.3.	Revise recovery actions and tasks using monitoring results	1,2,3,4	3	SPRT	Yes	9.20	0.00	0.00	0.00	0.00	2.30	This only includes costs of revising the recovery actions, if needed, every 5 years with the recovery team, it does not include the cost of implementing revised actions. Anticipate at least a one day meeting with at least 25 participants every five years for recovery action revision.
3	8.1.4.	Revise recovery criteria, if warranted, following new PVA or if other new information becomes available that suggests the recovery criteria in the document are not sufficient for recovering Sonoran pronghorn (revise in ten years; or earlier if determined necessary).	1,2,3,4	3	SPRT	Yes	0.00	0.00	0.00	0.00	0.00	0.00	No costs included because this action would be coordinated with 8.1.3 above to reduce costs associated with additional meetings.

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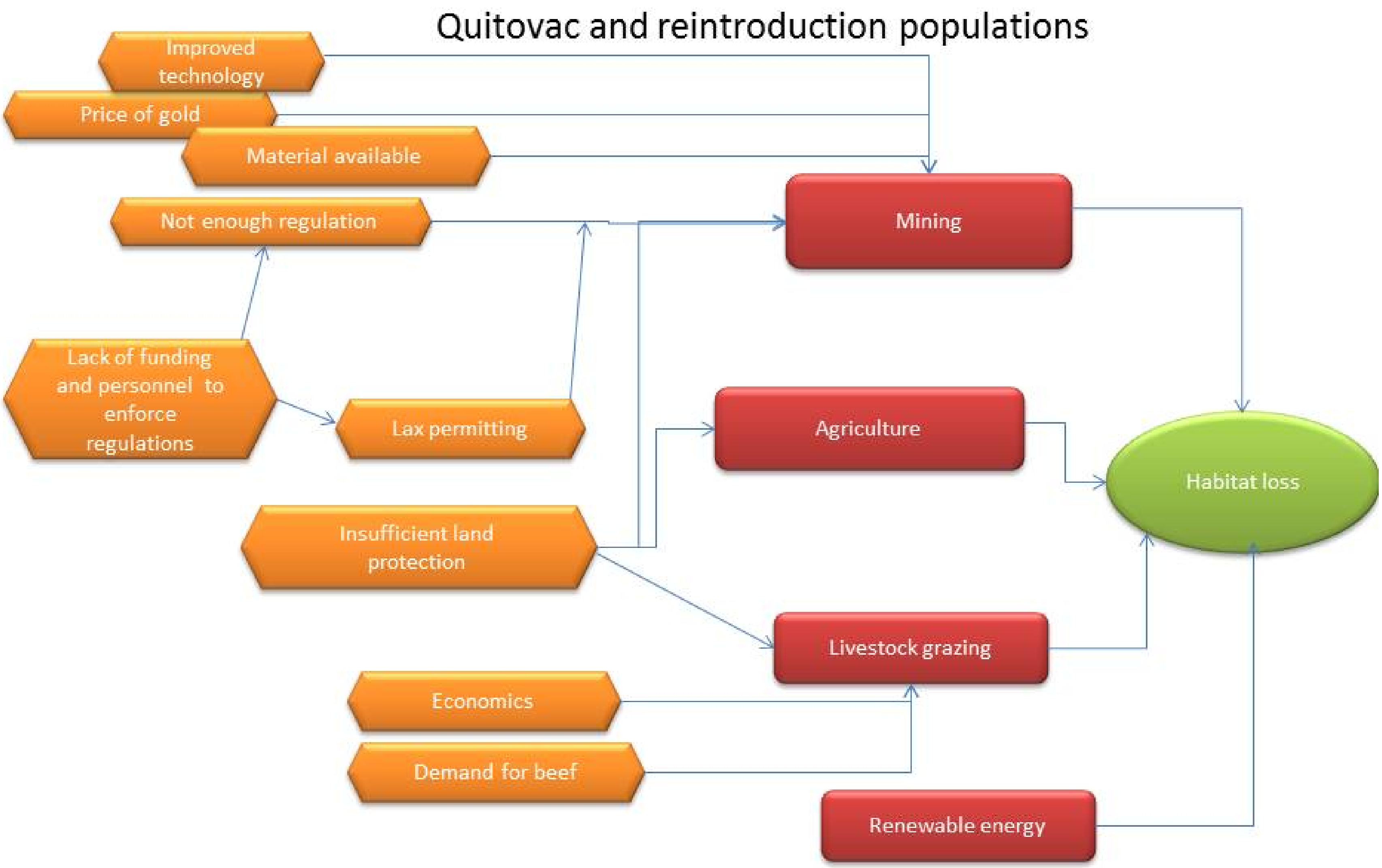
APPENDICES

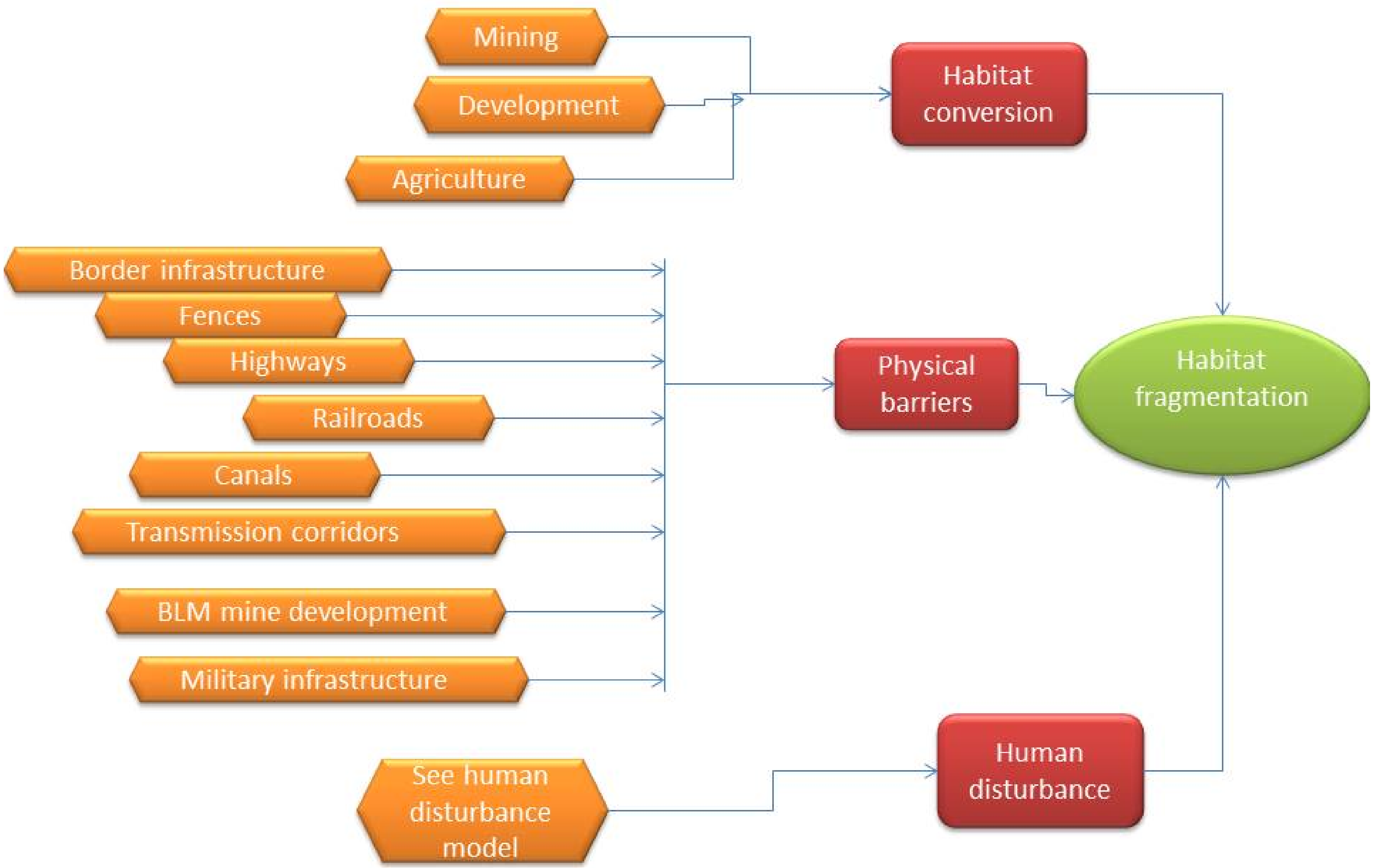
Appendix A. Conceptual Models of Threats

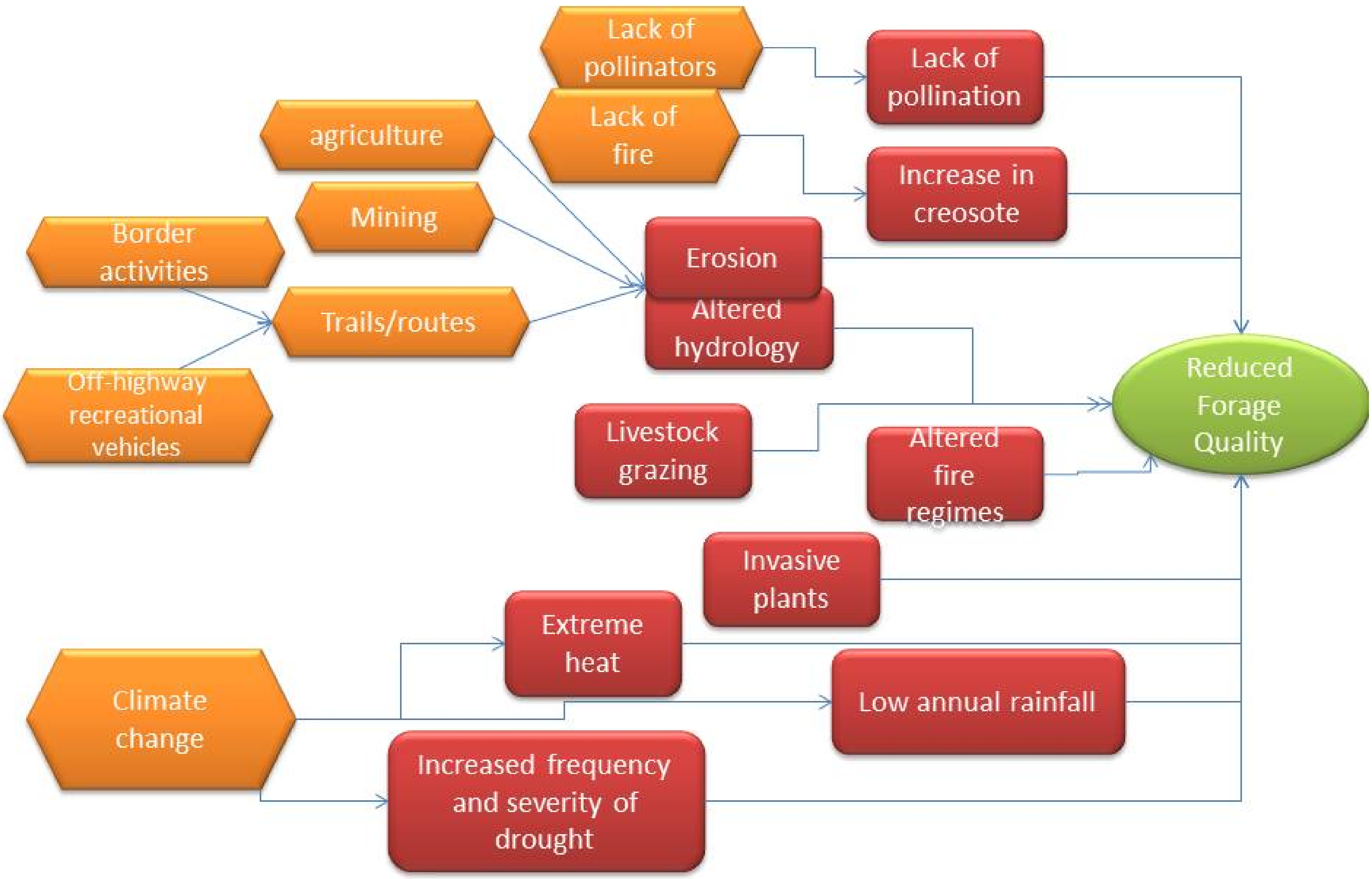
KEY

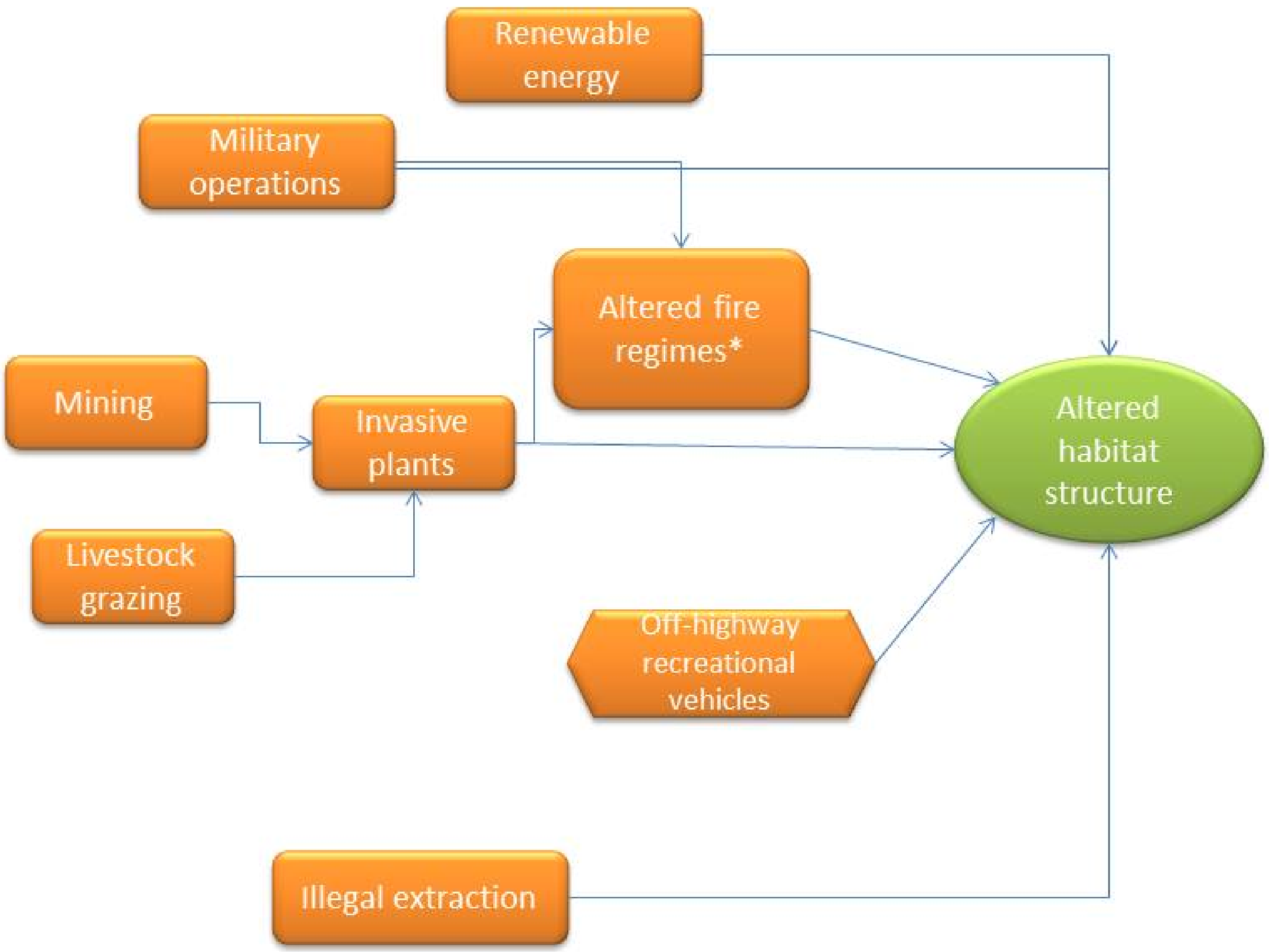
stressor	The green ovals are the key ecological attributes. A degraded key ecological attribute is a stressor. For example, a key ecological attribute may be “habitat connectivity.” “Habitat fragmentation” is a stressor.
source	A direct threat is a proximate activity or process that directly has caused, is causing, or may cause stress. It is the source of the stressor.
Indirect threat	An indirect threat is the cause of a direct threat. There can be many indirect threats.

Note: conceptual models are for all existing populations (Cabeza Prieta, Kofa, Pinacate, and Quitovac) unless noted otherwise.

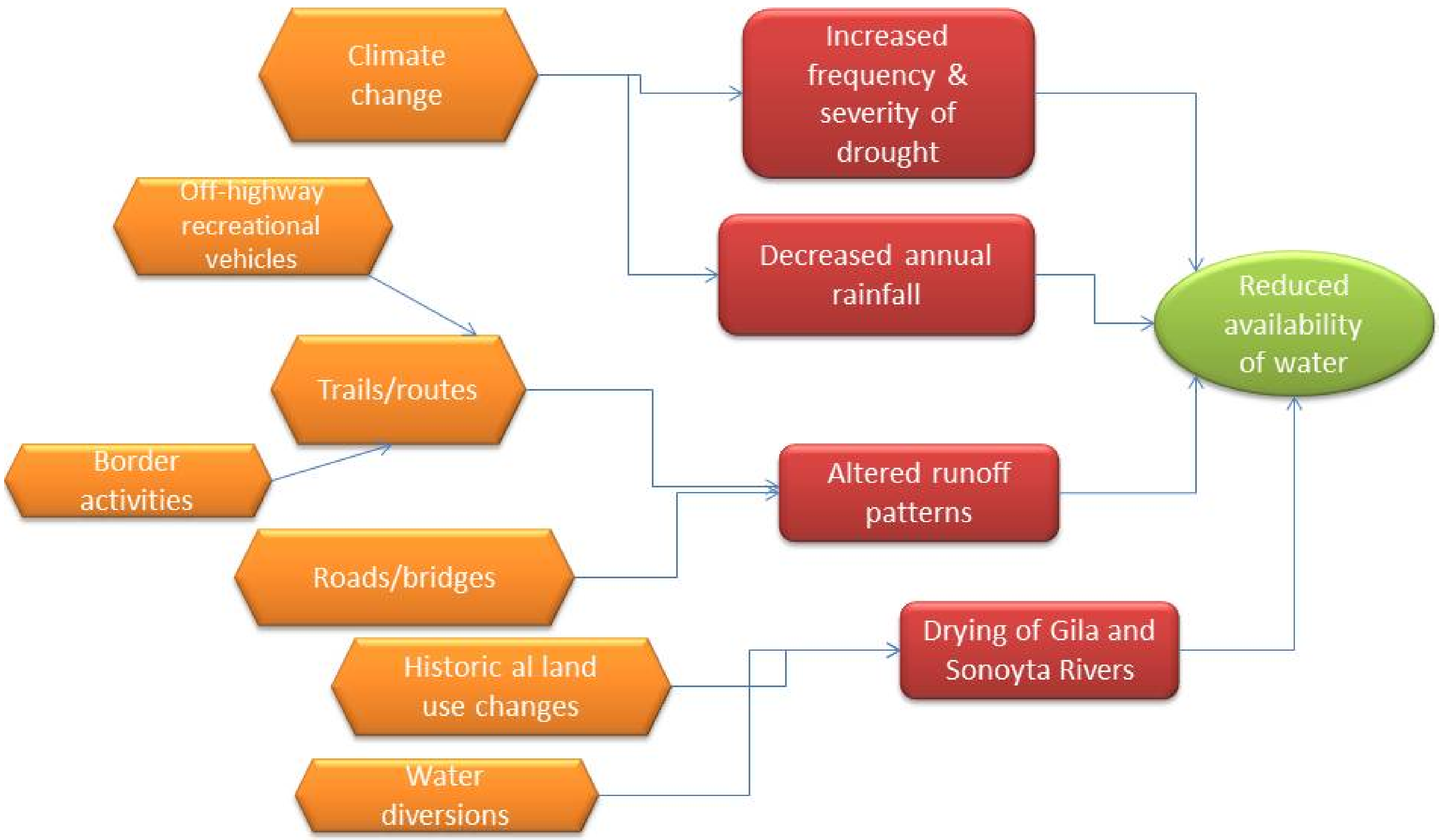

Quitovac and reintroduction populations
Improved technology
Price of gold
Material available
Not enough regulation
Lack of funding and personnel to enforce regulations
Lax permitting
Insufficient land protection
Economics
Demand for beef
Mining
Agriculture
Livestock grazing
Renewable energy
Habitat loss

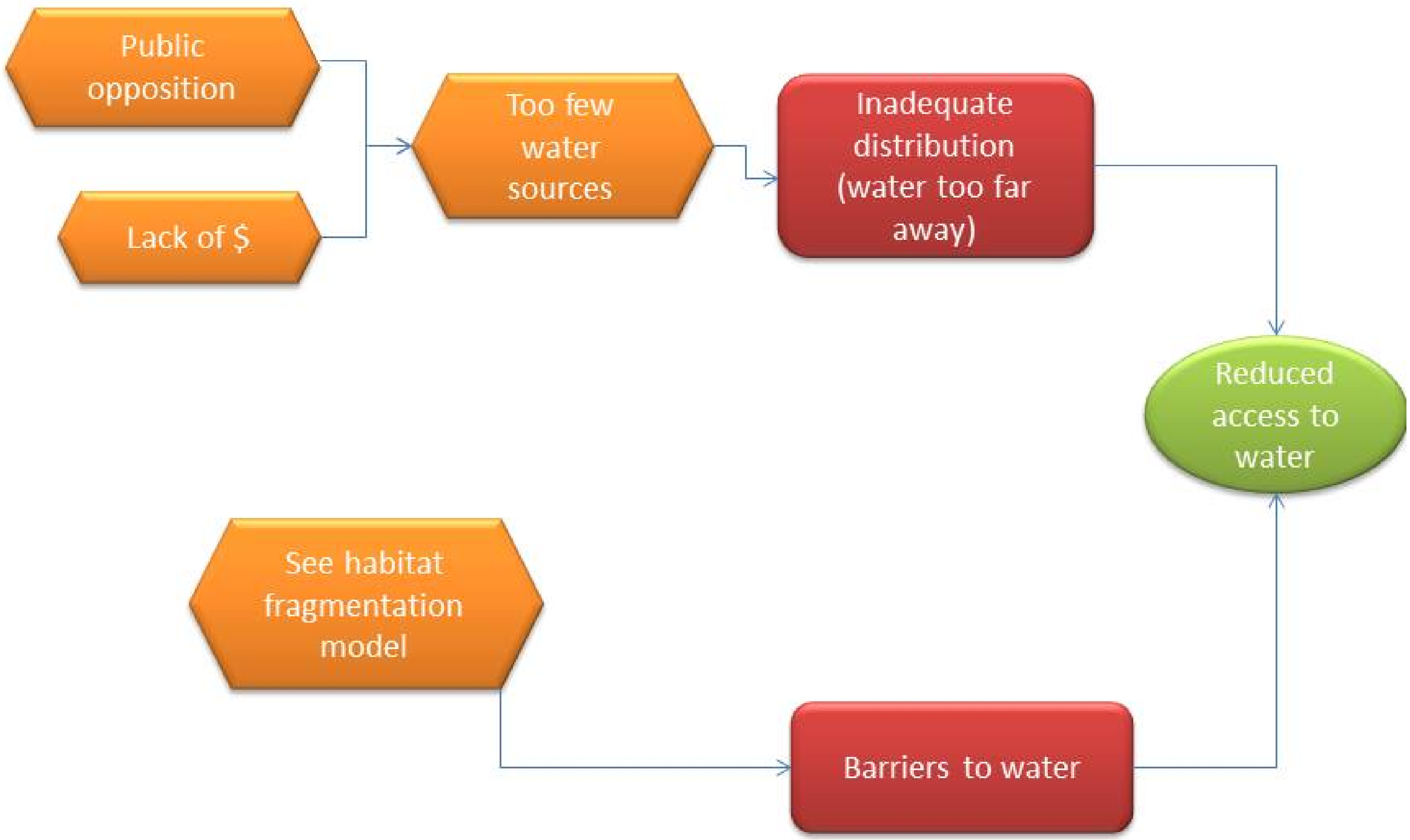

Mining
Development
Agriculture
Habitat conversion
Border infrastructure
Fences
Highways
Railroads
Canals
Transmission corridors
BLM mine development
Military infrastructure
Physical barriers
Habitat fragmentation
See human disturbance model
Human disturbance


Lack of pollinators
Lack of fire
agriculture
Mining
Border activities
Trails/routes
Off-highway recreational vehicles
Lack of pollination
Increase in creosote
Erosion
Altered hydrology
Livestock grazing
Altered fire regimes
Reduced Forage Quality
Invasive plants
Extreme heat
Low annual rainfall
Climate change
Increased frequency and severity of drought

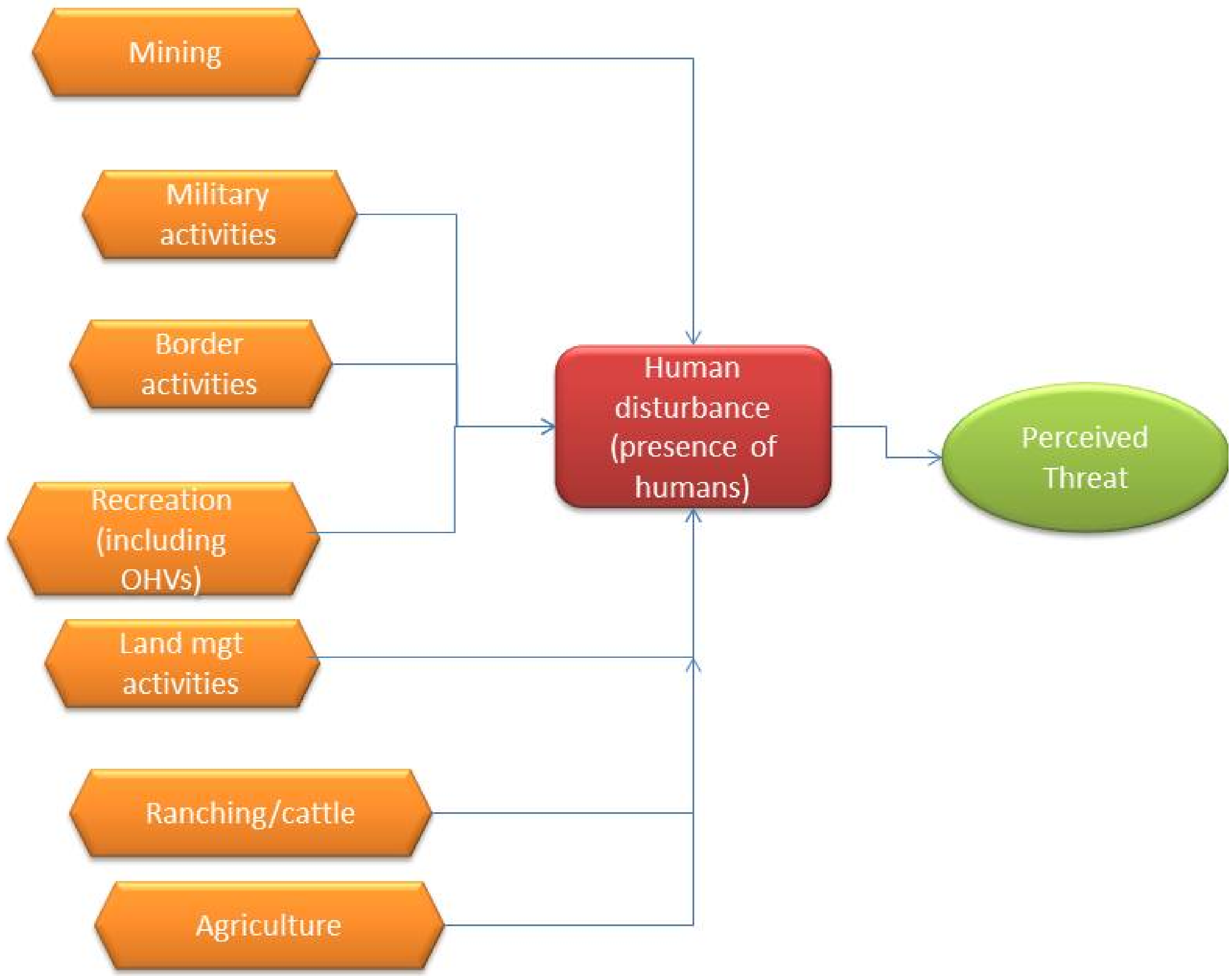


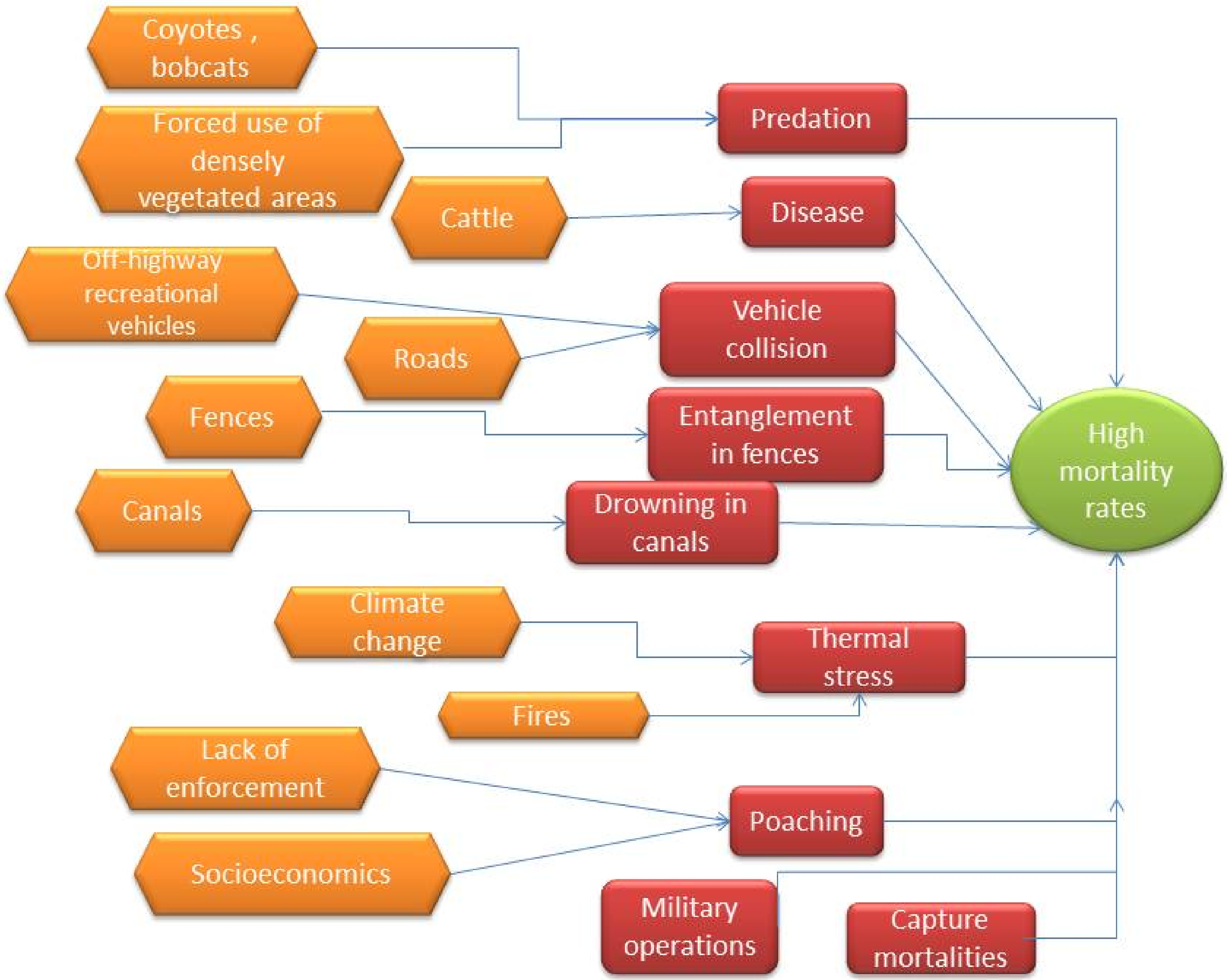
* There is debate if Sonoran desert vegetation is adapted to fire.

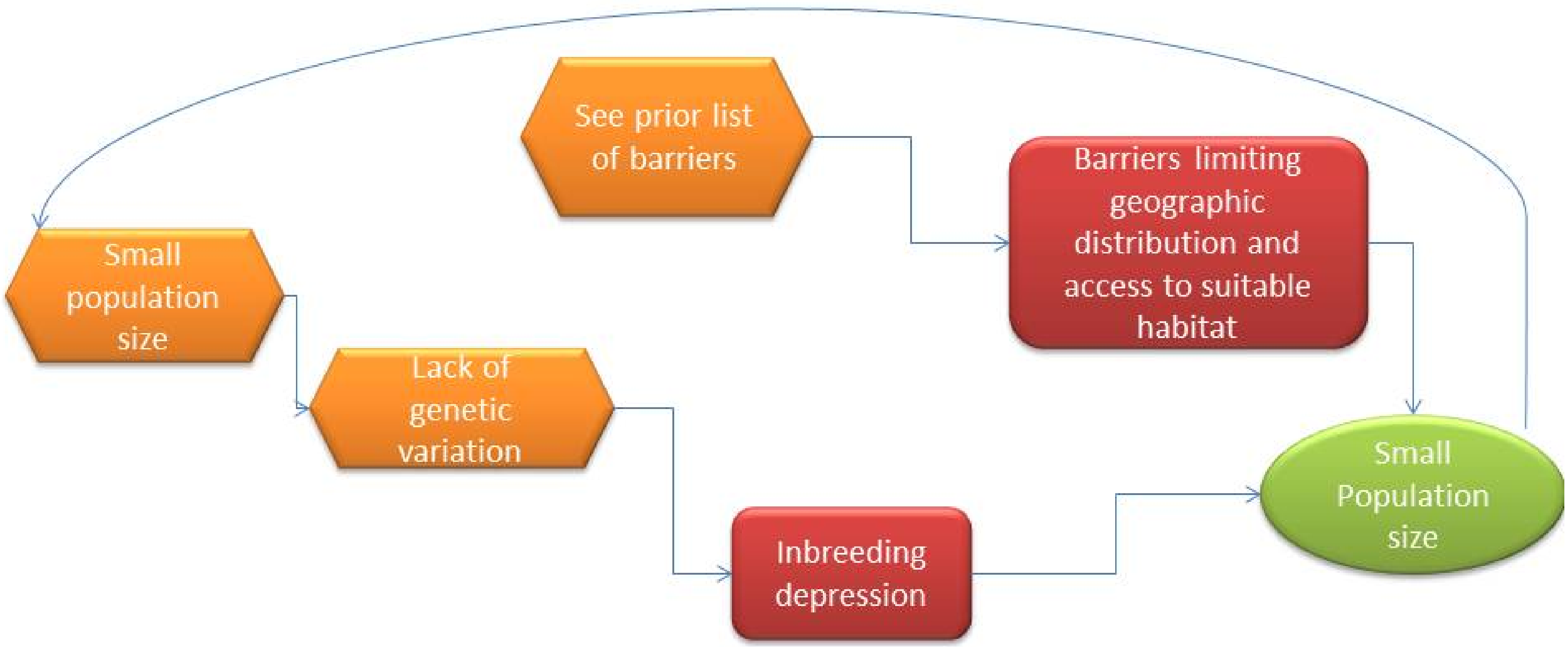

Climate change
Increased frequency & severity of drought
Off-highway recreational vehicles
Decreased annual rainfall
Reduced availability of water
Trails/routes
Border activities
Altered runoff patterns
Roads/bridges
Drying of Gila and Sonoyta Rivers
Historic al land use changes
Water diversions



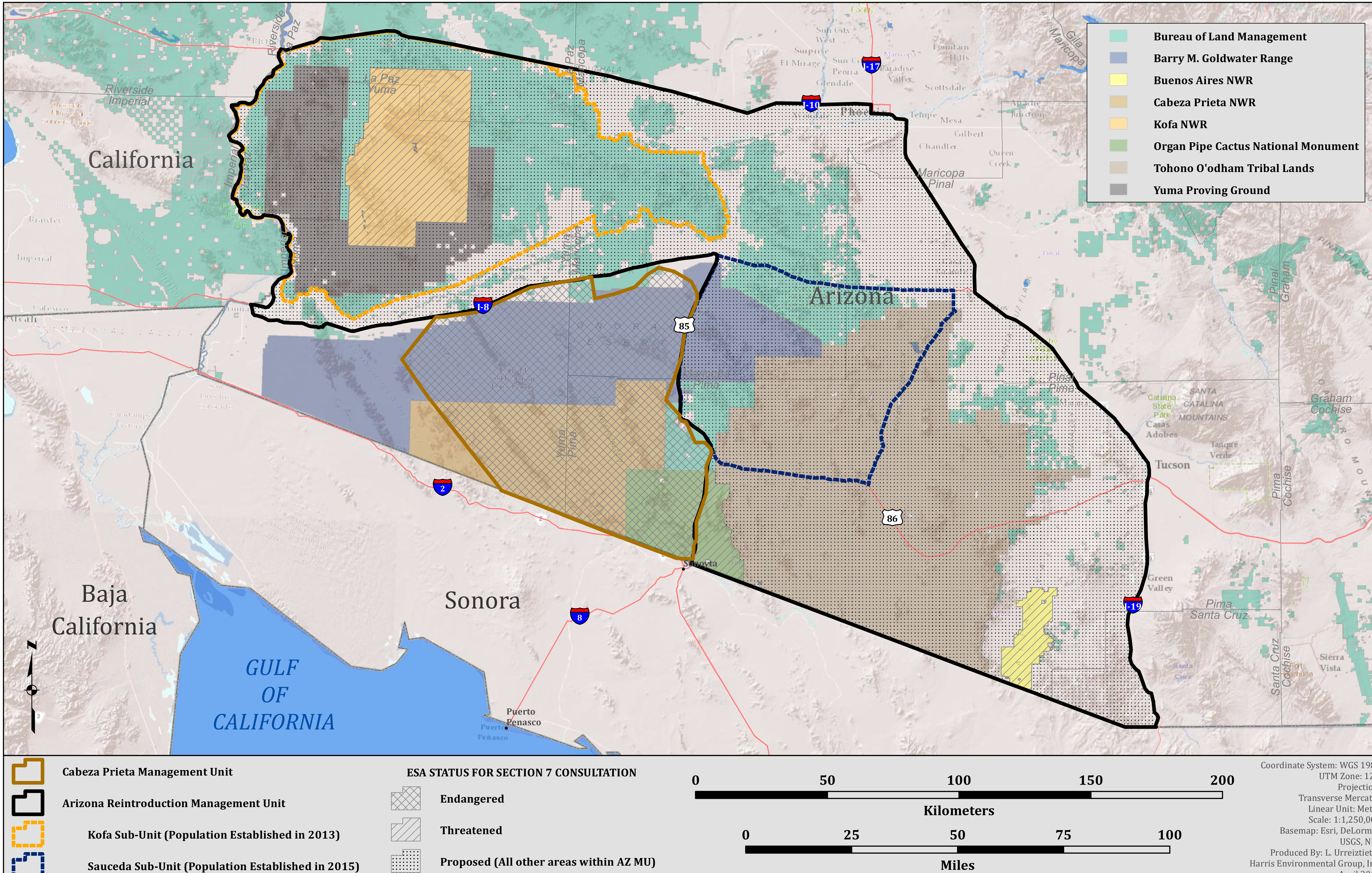
Public opposition
Lack of $
Too few water sources
Inadequate distribution (water too far away)
Reduced access to water
See habitat fragmentation model
Barriers to water


Mining
Military activities
Border activities
Recreation (including OHVs)
Land mgt activities
Ranching/cattle
Agriculture
Human disturbance (presence of humans)
Perceived Threat


Coyotes , bobcats
Forced use of densely vegetated areas
Cattle
Off-highway recreational vehicles
Roads
Fences
Canals
Climate change
Fires
Lack of enforcement
Socioeconomics
Predation
Disease
Vehicle collision
Entanglement in fences
Drowning in canals
Thermal stress
Poaching
Military operations
Capture mortalities
High mortality rates



Note: direct threats to small population size shown here include only those that were not already covered in other conceptual models.


Bureau of Land Management
Barry M. Goldwater Range
Buenos Aires NWR
Cabeza Prieta NWR
Kofa NWR
Organ Pipe Cactus National Monument
Tohono O'odham Tribal Lands
Yuma Proving Ground
California
Arizona
Baja California
Sonora
GULF OF CALIFORNIA
Tucson
Green Valley
Puerto Penasco
Sonoyta
I-8
I-10
I-17
I-19
2
8
85
86
Cabeza Prieta Management Unit
Arizona Reintroduction Management Unit
Kofa Sub-Unit (Population Established in 2013)
Sauceda Sub-Unit (Population Established in 2015)
ESA STATUS FOR SECTION 7 CONSULTATION
Endangered
Threatened
Proposed (All other areas within AZ MU)
0 50 100 150 200
Kilometers
0 25 50 75 100
Miles
Coordinate System: WGS 1984
UTM Zone: 12N
Projection:
Transverse Mercator
Linear Unit: Meter
Scale: 1:1,250,000
Basemap: Esri, DeLorme,
USGS, NPS
Produced By: L. Urreiztieta,
Harris Environmental Group, Inc.
April 2016

Appendix C. PACE

Species Conservation Action Program

Pronghorn (*Antilocapra americana*)

2009 Year of the Pronghorn

Mexico

Federal Government

SEMARNAT

August 2009

Translated to English

March 2013

I. Introduction

Natural resources represent one of the most important assets of a nation because of its environmental contribution and direct use. In northern Mexico, the diversity of hoofed species is relatively low compared with other bioregions around the world; and in most cases, populations have dramatically decreased, contributing to and even accelerating the extinction process in that area. Extinction in this case refers to the loss of the species' population and its genetic variability.

This destructive and recurrent process can presents itself in desert areas and has become more prevalent and at a faster rate during the last 50 years. This rapid increase in the destruction of the species is mainly due to the deforestation, destruction of animal species, increased rate of pasture lands for domestic animals, and aquifer reduction.

At the same time, the dysfunction of the ecosystem in desert areas is having a snowball effect on itself, by making the desert ecosystems even more arid. We should be concerned with the rapid increase in the extinction rate of the desert species and should pay more attention to the natural resources in our desert areas, which represent 60% of their area and are key for the future of the human communities which they inhabit, since these are reaching their limit, to a point of no return. Unfortunately, the actions needed to stop this dangerous process are generally perceived, in our uninformed society, as untrue and even alarmist.

This is the reason why in February in 2007, Mexican president Felipe Calderon Hinojosa presented the *Programa de Conservacion de Especies en Riesgo – PROCER* (Program for the Conservation of At Risk Species), and part of his five presidential commitments for conservation. This program is managed by the *Conservación de la Comisión Nacional de Áreas Naturales Protegidas* (Conservation of the National Commission of Protected Natural Areas) of SEMARNAT. The main objective of this program is to recover the 30 most at risk species during 2007-2012, by implementing a recovery program developed for each species *Programas de Acción para la Conservación de Especies* (Species Conservation Action Program).

This program is the result of collaboration between the *Dirección de Especies Prioritarias Para la Conservación* (Directive of Species Prioritized for Conservation) and a group of experts, who have been working on the pronghorn for several years and belong to or have been working with the *Subcomité Técnico Consultivo Para la Conservación Manejo y Aprovechamiento Sustentable del Berrendo en México* (Technical Consulting Subcommittee for the Conservation, Management and Sustainable Use of the Pronghorn in Mexico). This document summarizes the combined efforts of the experts along with the recommendations of the subcommittee, detailing the critical needs for the conservation of the species and details all steps needed to be implemented in the short, mid, and long term.

Following an information gathering process with information provided by the specialists and the contribution and participation of the *Comisión Nacional de Áreas Naturales Protegidas* (National Commission of Protected Natural Areas), they initiated the integration of the Action Plan for the Conservation of the Pronghorn in Mexico. This phase includes the integration, communication and reinforcement of local, regional, national, and international efforts. These efforts have been taking place in the country by several civil organizations, academic and research programs, government institutions, and public, social and private entities interested in collaborating in the conservation of the pronghorn.

Currently the pronghorn PACE is the most viable strategy to aid this species to continue its opportunity to recover. Without a doubt, the pronghorn can be rescued with the existing knowledge about how to manage this species, however with the current knowledge along with the technology developed, it will be necessary to double the efforts required in order to persuade SEMARNAT, in a timely manner, to guarantee the available habitat for wildlife as a natural treasure and make it a national treasure with high value with a significant meaning to the Mexican people.

Another key component to the success of this program will be to continuously incorporate landowners to conservation programs, along with the proper financial programs, combined with the development of environmental education and local conservation.

II. Background

Barely known in Mexico, the pronghorn (*Antilocapra americana*) is considered the only “antelope” of the new world. It belongs to the Artiodactyla class and it is the only living representative of the Antilocapridae family on the planet. Besides being the fastest mammal in America and the second fastest in the world, it is a species highly sought after as an endemic game animal in North America. Up until 1945, there were five described subspecies, of which three can be found in Mexico (*A. a. mexicana, A. a. peninsularis* and *A. a sonoriensis*)

Before the European colonization, it is estimated that the pronghorn population was around 50 million individuals on the North American plains. Four hundred years later, the population is estimated to be around 1,500 individuals of the three subspecies that live in Mexico. Mexican history mentions how this valuable natural resource, the pronghorn, was mismanaged and over exploited. It is historically relevant that there was an organized hunting trip, close to Pachuca Hidalgo, for the first Virrey don Antonio de Mendoza in 1540, in which Torquemada reported the capture of 600 pronghorn and deer. This was just the beginning of what repeated itself during the following four decades. In other words, in four hundred years, humans, directly or indirectly, destroyed 50 million pronghorn. It is a different situation in the United States of America, where the healthy pronghorn population is over 750,000 individuals. In Mexico, the number of pronghorn and their distribution has been heavily affected by significant habitat destruction and fragmentation, along with hunting pressures. Besides the fact that the pronghorn in Mexico is being geographically isolated and the number of free-range individuals is diminishing, their genetic load is diminishing as well, making the pronghorn in Mexico an endangered species.

Some international organizations like *Union Internacional Para la Conservación de la Naturaleza* (International Union for the Conservation of Nature), classifies the pronghorn as *Low Concern* (LC) (Hoffmann, et. al. 2008). However, several of the pronghorn populations in Mexico are in a different situation as compared to pronghorn in the United States. The circumstances that have made the Mexican pronghorn become an endangered species are anthropogenic, because the pronghorn have been exterminated by free land ownership and its habitat has been fragmented because of economic development in Mexico. For over a decade, biologists and naturalists have raised their voices in alarm without being able to produce a significant change. On the other hand, the United States and Canada implemented actions and laws allowing them to recover pronghorn populations that on their lands.

The United States has control of over one million individuals, and they could increase this number, but they lack additional available habitat. On the other hand, the pronghorn in Mexico is about to disappear even though there is sufficient habitat available to increase the population.

III. Description and Species Classification

The pronghorn looks like a cross between an antelope and a deer. Males are bigger in size with an approximate weight of 45-60 Kg (99-133 lbs.), and females weight 35-45 Kg (77-99 lbs.). Their body length is 1.30-1.50 meters (4.25-5 feet), and they are 70-80cm (2.3-2.6 feet) tall from shoulder to feet, the length of their tail is approximately 10cm (4 in), and their ears are approximately 15cm (6 in) long.

Pronghorn have a relatively robust body, with black perpendicular horns, for both sexes, with the tip curved towards the inside. Pronghorn replace their horns every year like deer replace antlers. Males' horns are bigger in size (125-450mm (5-18 in)) and are branched. Females' horns are usually straight, short spikes about 25-150mm (1-6 in) long. Both males and females have a crown of hair at the bottom of the horns and black mane along the neck. Males have glands under their ears and rump area, but females do not.

The pronghorn has a deer-like body that also reminds us of an antelope. Its back is higher than its shoulder blades, with long skinny legs. It has a tan to reddish brown body. Its cheeks, belly, rump, chest and inner legs are white. Males have a broad black mask that runs from their eyes down their snout to their nose, and black neck patches. The females do not have black markings.

An element that characterizes this species is the white hair on their rump, which can be seen from far distances. Pronghorn rump hairs will stand up, like bristles, to signal danger and it is used as an alarm signal amongst their group. The pronghorn taxonomy is detailed in the table below:

Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Artiodactyla
Suborder	Ruminantia
Infraorder	Pecora
Family	Antilocapridae
Genus	Antilocapra
Species	Antilocapra americana

IV. Evolution

Antilocaprids belong to a family in the endemic order of Artiodactyla in North America, and its origin is estimated to be 19 million years old. There is no evidence of its presence in any fossils found in the paleoarctic region, and until now nobody has found evidence showing that antilocaprids may have crossed the Bering Strait. During this period, the family diversified into 18 genera. Each one showing variation in horn structure, making horn design a specific characteristic of each family. The genus *Antilocapra* originated in the middle of the Pleistocene, a little less than a million years ago, in a time when forests and grasslands rapidly grew throughout the world. This family developed a high level of adaptation to the hypsodont dentition (molars with high crests and deep valleys, which allow the pronghorn to mill their food) since the new grasses and shrubs were hard and abrasive. As a species, it is well adapted to the big plains covered by grasslands and/or xeric shrublands. Up until 1945 there were five subspecies described, of which two can be found in shrubland areas (*A. a. peninsularis* and *A. a. sonoriensis*) and three can be found in grassland areas (*A. a. americana, A. a. mexicana* and *A. a. oregona*).

The natural history of this family indicates that during the Pliocene, this family experienced their more extensive adaptive propagation, and by the end of the Pleistocene, only the antilocaprids survived. However, the pronghorn has perfectly adapted to desert habitats and its extreme drought conditions. Hence, there is no intrinsic biological reason that could influence the endangered status that some populations are facing.

V. Reproduction

Polygamy is the characteristic reproductive behavior of the pronghorn. Females generally reach sexual maturity at 16-17 months of age, even though there have been records indicating some females who reached their reproductive stage at the age of 5 months (Mitchel, 1967). Males generally reach sexual maturity at the end of their first year, however, dominant adult males generally exclude the young individuals from the reproductive process. The males in reproductive age compete amongst themselves to win the right of reproduction. Contrary to many other ungulate species, males do not abandon the herds of females and young after the reproductive period is over; to the contrary, they stay close to them during this period.

Gestation lasts 250 days. For the first birth, females generally give birth to only one fawn, but after that they generally give birth to two fawns and in rare instances to three. Fawns are light brown and weigh 2-4 Kg (4.4-9 lbs.). Immediately after giving birth, females hide their fawns in the shrubbery and stay away from them in order to protect them from predators, even though they stay vigilant in the surroundings and go to their fawns regularly to nurse them.

Reports show that both males and females continue to reproduce until they are 10 years old and approximately 25% of females who are in reproductive capacity do not give birth every year (Mitchell, 1967).

The breeding period varies according to geographic distribution of the different populations. Peninsular populations breed in June and July (Cancino et al., 1995), Sonoran populations breed in September and October (Castillo, 1993), and Mexican populations breed in November and December (Treviño, 1978).

VI. Diet

Pronghorn eat throughout most of the day, grazing on grasses, forbs, herbs, moss, and a large variety of tender plants and on some occasion even cactus. The peninsular population consumes a diet based on 44% shrubs, 22% herbs, 4% grasses, and 30% non-identified material with reproductive structures (Cancino, 1994). The Sonoran populations consume a diet based on 69% herbs, 22% shrubs, 7% cactus, and 2% grasses.

Pronghorn satisfy their water needs through their physiological adaptation, by taking the water in the form of dew or the water contained inside the foliage that they consume (O'Gara, 1978). During the drought season, pronghorn reduce their water requirements by significantly reducing their food consumption, by staying in shady areas, reducing their mobility, and by reducing other activities that require the use of high levels of energy (Yoakum, 1990).

VII. Habitat

Pronghorn live in habitats characterized by open space such as grasslands, shrublands, plains with low hills, riverbeds and plateaus. Pronghorn prefer the wide riverbeds during the drought seasons. Generally, they avoid forests and areas with dense shrubs (O'Gara, 1978). The elevation range where pronghorn live varies according to the population. *A. a. peninsularis* and *A. a. sonoriensis* can be found between sea level and 200 msnm, while *A. a. mexicana* can be found between 1,400 and 1,600 msnm (González-Romero y Lafón, 1993). The peninsular population is found in areas characterized by xeric shrubs located in the biosphere reserve "El Vizcaíno". Vegetation more frequently consumed includes shrubs from the dunes, halophilic shrubs, and microphilic shrubs (Cancino et al., 1995). Pronghorn of the Sonoran populations are distributed in the following habitats: low dunes, sandy plains, low hill areas, and basaltic areas. The foot of low mountains represents a typical habitat, along with low granite mountains and sandy plains (Arizona Game and Fish Department, 1981). The Mexican population typically lives in grasslands with yucca, and these species dominate the area: *Bouteloua hirsuta*, *B. curtipendula*, *B. eriopoda*, *B. gracilis* and *Dalea citrina* (Treviño, 1978).

VIII. Ecology and Behavior

One of the functions of the pronghorn is the passive cultivation of the substrate and vegetation in the desert areas. Hence, it is an important contributor to the persistence and structure of the flora of its habitat. This happens through multiple interactions with its environment: the mechanic action that it produces with its hoof prints in the soil, the transportation and propagation of plant seeds that it digests, as well as the excrement and urine it deposits on the soil serves as organic fertilizer.

Pronghorn move in groups, whose members of these herds are females with their fawns and young males. Adult males are generally solitary or live in small groups, even though they sometimes form small herds with only male individuals. They are active during night and day; however there have been records of high level of activity registered at sunrise and sunset, with less frequency at sunset (Byers, 1998).

The establishment of territory is basically determined by the sexual behavior of the males. During the reproductive period, dominant males delineate their territories with urine, excrement, and secretions from the glands located in the ear areas. During this time, territories are defended by using antagonistic behaviors such as: staring, vocalizations, puffing up, drawing near, interactions and persecutions. This territorial behavior allows the stronger and more aggressive males to reproduce with the females, preventing the young males from reproducing. The size of the territory varies according to the availability of food, number of animals per group, and environmental conditions. The young males of one or two years of age and the non-reproductive adults form groups that do not defend territories. The reproductive-age females establish their own groups within and around the territories already established by the dominant males. It has been reported that the descendants of these groups become active members of the same groups after 6 weeks old and represent their own hierarchy within the group (Byers, 1998).

Map on Page 14

IX. Distribution

The historical distribution of the pronghorn covers from the south-central part of Canada, the central and west plains of the United States, through the south-central and northwest of Mexico, including the Baja California peninsula.

In the specific case of *A. a. mexicana*, distribution is from the southeast of Arizona, southwest of New Mexico, and west of Texas, in the United States, and in Mexico, includes Chihuahua, Durango, Coahuila, parts of Nuevo León, and Tamaulipas, extending towards the south at least to the state of Hidalgo. *A. a. peninsularis* was distributed historically in a wide region in the Baja California peninsula, from the San Felipe and San Quintín bay areas through the north of Magdalena bay (Nelson, 1925). Finally, *A. a. sonoriensis* was distributed historically from the south of Arizona through the desert plains of the center and west of Sonora (May, 1980; Leopold, 1959).

Currently, the Mexican subspecies can be found in some areas in the Chihuahua region, mainly in “La Perla”, “La Gregoria”, “San Luis”, “Terraceño”, “El Sueco- Moctezuma”, “Janos-Ascención” y “Coyame”, as well as in the “Valle de Colombia” and rancho “El Novillo”, Coahuila (Pallares, 1999). In the peninsula the pronghorn lives in an area of approximately 362,385 ha. Within the Biosphere Reserve of “El Vizcaíno”, pronghorn live in the plains located at the parallel 28o North, 113o 18” East, 26o 47” South y and 114o 30” West (PHVA, 1994). In the Sonora region, the habitat is limited to the northwest of the state, including Caborca, Puerto Peñasco, Plutarco Elías Calles, and San Luis Río Colorado.

X. Threats

Experts believe that the main causes of the rapid decline of pronghorn populations are the reduction and fragmentation of their habitat, uncontrolled hunting, and predation. Another cause is the increase of free-range domestic species in pronghorn habitat (CES, 1992). It has been reported in the southwestern United States, that the forage required to feed one domestic animal is equivalent to the forage required to feed 47 to 220 pronghorn (Yoakum y O'Gara, 1990).

Even though pronghorn hunting has been forbidden in Mexico since 1922, there is evidence that indicates that people continue to hunt them (locals continuously report hunting activities, there are empty bullets, and truck tracks that can be found in pronghorn habitats). Illegal pronghorn hunting is a fact in Mexico, and it obviously makes the recovery of this species even more difficult.

Predation is another cause that hinders the recovery process. In Mexico, the coyote (*Canis latrans*), is the most important predator, because it can cause a high level of mortality to pronghorn fawns.

Natural factors such as extensive drought periods are also high risk factors that affect pronghorn populations. These factors mainly affect the reproduction rate and the survival rate of the fawns (Yoakum y O´Gara, 1990).

XI. Conservation of Pronghorn in Mexico

Due to the rapid decrease of pronghorn populations in Mexico, governmental and non-governmental entities have developed action plans to aid the conservation of the pronghorn. The first efforts started back in 1922, when president Álvaro Obregón banned the hunting of the pronghorn. Later in 1952, the government created the *Federal Hunting Law*, which supports the banning of the hunting of the pronghorn in Mexico. The *Norma Oficial Mexicana* (NOM- 059-ECOL-1994) reiterated the legal protection and its update in 2001, which classifies the pronghorn populations in Mexico as endangered species.

During the 70s and 80s, there were several projects developed with the idea of starting to build the theoretical and practical foundation to initiate the recovery of the pronghorn in Mexico (Ramírez, et al., 1999).

With the creation of the *Secretary of the Environment, Natural Resources and Fish* (Secretaría de Medio Ambiente Recursos Naturales y Pesca [SEMARNAP]) in 1994, one of the areas that experimented the most development was the *Protected Natural Areas* (Áreas Naturales Protegidas [ANP]), focusing on the conservation of the habitat and the species in most endangered situations. This is the case of the Biosphere Reserve “El Vizcaíno” (ReBiVi) with an area of 2’546,790.00 ha and the Biosphere Reserve “El Pinacate y Gran Desierto de Altar” (ReBiPi) with an area of 714,556 ha. Such areas represent, without a doubt, significant habitats for the conservation of the pronghorn and other species.

The *Wildlife Conservation and Productive Diversification Program in the Rural Sector* (Programa de Conservación de Vida Silvestre y Diversificación Productiva en el Sector Rural 1997- 2000) (SEMARNAP, 1997) included among its strategies, the *Priority Species Recovery Program* (Proyectos para la Recuperación de Especies Prioritarias [PREP]) and the establishment of the *Unions System for the Conservation of Wildlife* (Sistema de Unidades para la Conservación de la Vida Silvestre [SUMA]). This program created strategies to help develop and maintain the natural process of the ecosystems, and promote the conservation of the habitats and the wildlife, reducing the extinction rate of species and increasing the development of endangered species.

The success of these strategies motivated lawmakers to include them in the *General Wildlife Law* (Ley General de Vida Silvestre [LGVS]) and the *General Law for Sustainable Rural Development* (Ley General de Desarrollo Rural Sustentable), which allowed the continuance to protect affected species. In 1999, they formed the *Technical Consulting Subcommittee for the Conservation, Management and Sustainable Use of the Pronghorn* (Subcomité Técnico Consultivo para la Conservación, Manejo y Aprovechamiento Sustentable del Berrendo, órgano técnico consultivo) of the *Secretary of the Environment and Natural Resources* (Secretaria de Medio Ambiente y Recursos Naturales [SEMARNAT]), with the mission of proposing a national strategy for the conservation and management of the pronghorn by developing the PACE, which established the foundation and rules to promote the joined participation of the federal government, state government, and local society, with the objective to help preserve the species in Mexico. The plan included an evaluation of the situation, the control of the main threats in its habitat and population, and the implementation of the actions listed in the *Conservation, Management and Sustainable Use Project for the Pronghorn in Mexico* (Proyecto para la Conservación, Manejo y Aprovechamiento Sustentable del Berrendo en México [PREPBe]).

XI. 1. Peninsular Pronghorn (*A. a. peninsularis*)

In 1978, through the Dirección General de Fauna Silvestre (DGFS), a program for the conservation of the Baja California region, was initiated along with the program for the preservation of the aquatic migrating birds of the Laguna Ojo de Liebre. Later, the protection program was extended to the pronghorn in the desert of "El Vizcaíno" because of the agreements established between the DGFS and the Servicio de Pesca y Vida Silvestre de Estados Unidos (FWS). The program received financial support from the Comité Conjunto México-Estados Unidos para la Conservación de la Vida Silvestre. Later, the Denver Wildlife Research Center provided funds for the establishment of a wildlife laboratory in La Paz, B.C.S., an aerial census, and the assessment of a group of predator's experts who will conduct the first evaluation and management of the coyote population, which was affecting the pronghorn population. The DGFS authorized five areas to form the team to work in the Estación de Aprovechamiento de Vida Silvestre (EAVS) en Guerrero Negro, BCS. Later, through the Dirección General de Parques Nacionales (1984), they conducted the first technical study that justified the establishment of the Biosphere Reserve "El Vizcaíno" (Sànchez, et. al., 2006).

In 1988 the Reserve was decreed, however they did not have enough resources to implement and manage the decree. Some institutions volunteered to conduct basic studies in the Reserve. Among them was the Centro de Investigaciones Biológicas del Noreste (CIBNOR), the Universidad Autónoma de Baja California Sur and the Instituto de Biología de la UNAM, who developed a study of the flora and fauna of the Reserve, including the pronghorn.

In 1993, they received the first financial support from the Banco Mundial through the Fondo Mundial para el Medio Ambiente (GEF) and they allocated the first significant resources to the El Vizcaíno. However, it was not until 1997 that a donation was received for the GEF I project, through the Fondo Mexicano para la Conservación de la Naturaleza, A.C., and the El Vizcaíno had a permanent annual budget.

In 1994, organized by the CIBNOR, in La Paz, B.C.S., they conducted the first Taller de Evaluación de la Población Peninsular del Berrendo y su Hábitat, in which 30 specialists participated and created the first Programa de Recuperación del Berrendo Peninsular (Program for the Recovery of the Peninsular Pronghorn), which was the beginning of the conservation program that was continued through the Biosphere Reserve El Vizcaíno.

By 1997, the Secretaría de Medio Ambiente, Recursos Naturales y Pesca, the Ford Motor Co. and the Espacios Naturales y Desarrollo Sustentable, A.C., signed a five year agreement to finance and manage the campaign "Salvemos al Berrendo", which was later renewed by the Comité Cívico de la Asociación Mexicana de Distribuidores Ford and is still in place today. In addition, the Fondo Mexicano para la Conservación de la Naturaleza approved additional resources to complement the cost of the program, and helped with the consolidation of the infrastructure needed. Since 2001, the L.A. Zoo has provided support by providing medical equipment and consulting to the project. In 2003 the REBIVI and the L.A. Zoo signed an agreement. To continue supporting this effort, the La Campania Exportadora de Sal S.A de C.V. has generously contributed and supported this cause since 1983.

Until today, we have observed positive results in the conservation and reproduction of the peninsular pronghorn. We currently have a ranch with 450 individuals, with a reproduction rate of 100 individuals a year, in addition to the wild individuals. Together we estimate a population of 600 pronghorn. The first re-introduction took place in December of 2006 and the second one in 2007, and we have observed positive results from the first introduction of the "ranch raised" individual into the wilderness.

After almost 14 years since this project started and more than 25 years of work in this pronghorn population, one can observe the positive results of this program, including the positive adaptation of the "ranch raised" pronghorn raised in a natural but controlled environment, then being introduced to the wild population. It is important to highlight that the objective of this program is to help in the recovery of the peninsular pronghorn wild population to help it live and develop freely in its natural way, without any intensive management.

Increasing the pronghorn population is the main objective of this project, hoping that the pronghorn can establish two or more permanent populations that will allow them to overcome any future environmental challenges that constantly affect their population. If we can reach this in the future, then the management required to protect and help the wild population will be minimal, and the raising of pronghorn in captivity will be a way of helping this species reach this point.

XI. 2. Sonoran Pronghorn (*A. a. sonoriensis*)

In the United States of America, the *A. a. sonoriensis* population has been protected by the Arizonan government since 1967, when this pronghorn was included in the federal list of endangered species, and it became part of the Mexican list in 1984. In addition, a significant part of the pronghorn's habitat in Arizona is legally protected.

Between 1987 and 1989, the Sonora government, through the Centro Ecológico de Sonora (CES), conducted a series of surveys on the northwest of the state, to implement their long-term project "Estrategias para la recuperación del berrendo sonorense". This project focused on educating and raising awareness in Sonora about the critical situation of the pronghorn and its biological, social, and cultural relevance in the area. At the same time, a patrol/surveillance program was implemented in the area.

Since 1988, the Sonora Government, through the El Centro Ecológico de Sonora del IMADES, currently Comisión de Ecologies y Desarrollo Sustentable del Estado de Sonora (CEDES), and in conjunction with the Arizona Game and Fish Department (AGFD) andU.S. Fish and Wildlife Service (FWS), have been evaluating and following the Sonoran pronghorn populations in the regions of the Biosphere Reserve of El Pinacate and El Gran Desierto de Altar, as well as the Enid Juan Álvarez, located 60 kilometers south of the reserve. Based on the interest that Mexico and the United States had in preserving and recovering the Sonoran pronghorn population, in April of 1992 the Core Working Group (Group Central de Trabajo de Berrendo Sonorense) was created. This group had members from the AGFD and theFWS, theNational Park Service, the Bureau of Land Management, the US Air Force, Tohono O'odham Nation and the Centro Ecológico de Sonora. This group conducted the first phase of aerial surveys within the project called Prospecciones de Pruebas Binacionales, directed by the Cabeza Prieta National Wildlife Refuge, Arizona.

Afterwards, this group changed its name to the Sonoran Pronghorn Recovery Team (Equipo de Recuperación del Berrendo Sonorense), and became part of the Biosphere Reserve El Pinacate and the Instituto del Medio Ambiente y el Desarrollo Sustentable del Estado de Sonora (IMADES, currently CEDES) continuing the efforts for the recovery of this subspecies.

With the decree of the Biosphere Reserve of El Pinacate y Gran Desierto de Altar, Sonora, in 1993 a significant area (714,556.5 hectares) was established as habitat for the conservation of the pronghorn, and it became an important area for its study and conservation. During the years of 1990, 1992, 1993, 1996, 2002, 2006, and 2007 the project captured 46 pronghorn and placed radio telemetry collars on them within the Sonora area.

In 2002, the team conducted a census of pronghorn in the Cabeza Prieta NWR in the United States, where the team was able to observe only 20 animals. This situation raised an alarm signal to those organizations interested in recovering this subspecies, and indicated the need to create a semi captivity reproduction program in the United States, similar to the one created in Mexico in the Biosphere of El Vizcaíno.

During February 2004, the Dirección General de Vida Silvestre de la SEMARNAT, gave to the AGFD and FWS, the permit to capture five pronghorn (four females and one male) to be exported from Sonora to the United States to initiate the semi captivity reproduction program in the Cabeza Prieta NWR. The capture was not successful, and 4 out of the five individuals died after the capture. Later in 2006, they conducted a new initiative with positive results. This time they captured 1 male and 3 females, with the objective of reinforcing the group of pronghorn in the encierro de Cabeza Prieta and increase the genetic variability of the population.

The implementation of some of the strategies contained in the Programa de Conservación de la Vida Silvestre y

Diversificación Productiva en el Sector Rural 1997-2000, in particular the implementation of the UMA in the South and East of the Reserve El Pinacate, that contained actions for the surveillance, habitat conservation, and management of population of species of interest to the UMA, such as mule deer, bighorn sheep, and the collared peccary, have indirectly benefitted the pronghorn, as it was planned, just by implementing a conservation mindset. In the last census conducted in Sonora in 2007, they counted 360 individuals, estimating the population as 404 with a 95% reliability rate. Such population is located on the outskirts of the Reserve (CEDES - AGFD, 2008).

XI. 3. Mexican Pronghorn (*A. a. mexicana*)

In 1978, the first study in the distribution of the pronghorn in Chihuahua was conducted (Treviño, 1978). Chihuahua was the only state that still had native populations of grassland pronghorn. The author reported ten isolated locations and an estimated population of 533 pronghorn. In 1993, González y Lafón reported a minimum population of 214 individuals, with an estimate of 307.

With the objective of updating the information about the distribution of the pronghorn in Chihuahua, researchers from the Unidos para la Conservación A.C. (UPC), the Universidad Autónoma de Chihuahua and the Dirección General de Vida Silvestre, SEMARNAP, in 1996 conducted a study that found that in at least two of the ten locations reported by Treviño —el Berrendo y Benavides— there was no presence of any pronghorn. It was not until in 2006, that the Comisión Nacional de Áreas Naturales Protegidas, published the “Estudio Previo Justificativo para el establecimiento del Área Natural Protegida: “Reserva de la Biosfera Janos, Chihuahua, México”, with the objective of protecting the habitat and a population of 30 wild individuals, and a plan for future allocation of pronghorn to the grasslands of rancho “El Uno”, administered by The Nature Conservancy (TNC).

XII. Background of the Translocation for the Repopulation in Mexico

XII. 1. Isla Tiburón

One of the first attempts at management and reintroducing the pronghorn in Mexico took place in 1967, when a group of 22 individuals from Colorado (USA) were transferred to the Isla Tiburón en Sonora, México, with the intention of implementing a population that could be managed under isolating conditions, that will allow its rapid growth, since there was no competition for the pronghorn on the island. Unfortunately, the drought conditions that prevailed in the island during those years, along with the abundant number of coyotes in the area, destroyed the efforts in no more than three years.

XII. 2. San Luís Potosí

The pronghorn disappeared from this region in the 50s. In 1972, Mexico and the state of New Mexico (USA), decided to exchange wild species for the development of some experimental work. Mexico exchanged five bighorn sheep individuals for a small herd of pronghorn from New Mexico. The herd contained 52 individuals, 19 males and 33 females, and it was sent to the Rancho Guadalupe, located in the municipio de Ramos, San Luís Potosí.

The main objective of this project was the establishment of a viable population of pronghorn, to then aid the reproduction, repopulation, and possible future use. However, the group of pronghorn disappeared in 1991 regardless of all the efforts that took place to maintain the population. Long drought periods during the first years after the introduction, the wide spread of some of the individuals in the vast territory, along with the predations of fawns by local coyotes, were some of the factors that contributed to the failure. However, this project served as the foundation for the knowledge and capacitation of most of the people that later participated in the design and implementation programs that now develop successfully in Mexico and some places in the United States of America.

XII. 3. Coahuila

The pronghorn disappeared from the state of Coahuila at the end of the 50s, beginning of the 60s. In 1993, the Unidos para la Conservación, A. C. and Agrupación Sierra Madre initiated negotiations with the New Mexico Department of Game and Fish (NMDGF), in USA, with the objective of establishing a collaboration program in the short and long term, for the reintroduction and recovery of the pronghorn in Coahuila. This program proposed the repopulation, in a big scale, of the empty areas in the state.

Its implementation was approved in 1994, by the Dirección General de Aprovechamiento Ecológico de los Recursos Naturales del Instituto Nacional de Ecología, SEMARNAP, and then later renewed by the Dirección General de Vida Silvestre; to be developed first in a meadow area of 75 thousand hectareas, divided in five private ranches, in an area known as the "Valle Colombia". Such place had the right foliage conditions, fences and surveillance needed, besides the right habitat – water, food, and protection against human activity, to be able to host at least a thousand pronghorn individuals.

In February of 1996, in Carrizozo Nuevo México, they captured a herd of 65 individuals that were transported and released in the ranch "El Cimarrón", en Valle Colombia, Coahuila.

During the first year, some individuals or small groups of pronghorn moved out of the areas where they were first introduced, reducing the size of the herd to 54%. In 1998, with the objective of reinforcing the first introduction, they conducted a second introduction with a herd of 85 individuals. The reintroductions have allowed the establishment of a herd in the wild, whose population is estimated at 45 pronghorn, and new reinforcements may be required in the future to aid in the recovery of this species in this region. The ranches involved in this region are "La Palma", "Buenavista", "El Cimarron", and "La Gorriona", all of them located in the Municipio de San Buenaventura, and they have a UMA registry, which is part of the objective and strategy of the Programa de Conservación de la Vida Silvestre y Diversificación Productiva en el Sector Rural 1997-2000. Similarly, the Instituto Nacional de Ecología de la SEMARNAP, coordinated with the support of the NMGFD, a visit to the area UMA "El Novillo" en el Municipio de Guerrero, Coahuila, with the objective of evaluating the infrastructure and habitat available to free up one of the ranches that were raising the pronghorn. In 1998, they freed in this new location 14 pronghorn (9 males and 5 females).

On the other hand, during 2005 and 2006, there was a noticeable increase in interest to support the "return of the pronghorn" to places where it had extinguished, especially in the different plains in the Altiplano Mexicano. This is how CIBOR, in coordination with WGFD and the BFA, conducted a first effort to try to repopulate these areas with individuals captured in the BFA installations, to be transported, hand raised and then weaned in the area where they were to be released. This effort, that took place in 2005, was supported by the participation of the Asociación de Manejadores de Vida Silvestre, A. C. (AMAVISI) and the rancho "El Bonito", Municipio de Acuña, Coahuila. 47 fawns were transported and 54 more in 2006. From the first group they weaned 24 individuals, 12 males and 12 females; while from the second group there are only 16 males and 17 females left. With the surviving animals from 2005, in August of 2006 there were two reproductive groups formed with 2 males and 6 females each, the rest of the males were kept segregated. Unfortunately, a bear attacked one of the reproductive groups and all the individuals died. Currently we only have one of the reproductive groups and the rest of the males, and we have already accomplished the birth of 20 fawns in the area in 2008.

XII. 4. Nuevo León

In 1999, the first request to transfer pronghorn from Wyoming to Mexico was approved. This first effort took place in the year 2000, and it involved the Dirección General de Vida Silvestre (DGVS), the Centro de Investigaciones Biológicas del Noroeste (CIBNOR, and the Bioparque Estrella from Mexico). While from the USA the participating entities were the Wyoming Game and Fish Department (WGFD), and the Air Force Base Francis E. Warren (BFA). In that year they provided 12 individuals to the BioParque Estrella de Nuevo León, leaving open the opportunity of reinforcing the project with a later transfer. The experience ended in the first attempt, and concluded with the extinction of all the pronghorn transferred four years later. However, during those four years many people had the opportunity to observe the animals and had the chance to get to know the species.

XII. 5. Zacatecas

In 2006, there were some pronghorn transferred from the BFA and the WGFD with the intent of having a first experience and training the personnel that would later manage the program on the ranches that would be participating in the repopulation program of that state. The objective was to use the same raising technique that had been used successfully in other areas in Mexico. In June 2007, there were 159 fawns captured (76 males and 83 females) and transported by plane by the SEDENA, with the support of the Gobierno del Estado de Zacatecas, the UAZ, the CIBNOR, the DGVS, and the Espacios Naturales y Desarrollo Sustentable, A. C.

The previous transfers (2005 and 2006) were based on annual transfers, showing the need to develop a short and a long-term project proposal presented to the BFA and the WGFD, requesting multi-annual transfers. Consequently, the request was accepted for the 2007-2011 period, with a limit of 250 young individuals captured per year. Even though there have been some health issues amongst the young individuals, it is still too early to issue a conclusion about this initiative. However, it is important to notice the high participation level amongst Mexican and North American institutions.

XII. 6. Regional Program for the Reintroduction and Conservation of the Pronghorn (*Antilocapra americana*) in the Northwest of Mexico.

During 2008, the state government of Coahuila and Nuevo León, began the development of the Regional Program for the Reintroduction and Conservation of the Pronghorn (*Antilocapra americana*) in the Northwest of Mexico ("Programa Regional de Reintroducción y Conservación del Berrendo (*Antilocapra americana*) en el Noreste de México"). The main objective of this program is to promote the reintroduction and the management of the pronghorn in private UMA in the states of Coahuila and Nuevo León, as areas where they can initiate the reproduction of the pronghorn, to then use the young individuals to repopulate areas where there were pronghorn in the past. This plan will allow, in the short and long term, to contribute to the financial opportunities of the local communities, by benefiting from the return of pronghorn to areas where it became extinguished 30 years ago.

The program will begin in 2009 with the reintroduction of the first group of pronghorn, to be distributed in the UNA of El Rincón de la Madera – La Mesa, located in the municipio de Cuatro Ciénegas; in the El Valle de Colombia y Maderas del Carmen, and the UMA San Rafael y Rancho Pilares, respectively. Management will be done on a semi-extensive basis, with hopes of a short period of adaptation to then release groups in the region. These pronghorn will come from New Mexico, and some of the captured groups will be allocated to El Valle de Colombia, and Maderas in the UMA San Rafael y Rancho Pilares, respectively.

XIII. Objectives

XIII. 1. General Objectives

The objectives begin with the identification of the critical needs for the conservation of the species, and the planning of the actions needed to cover these needs in the short and long term. In addition, objective will include to execute, unify, and consolidate the different initiatives and strategies that have been developed for the conservation of this species presented in the Proyecto para la Conservación, Manejo y Aprovechamiento Sustentable del Berrendo en México (PREPBe), as well as other ones considered relevant to help recover and preserve the populations of this species in Mexico.

XIII. 2. Specific Objectives

- Generate the biological, ecological, and social information about the pronghorn, as an input for the decision making process that will issue effective actions for the management, recovery, conservation, and protection of this species and its habitat.
- Promote and generate the social participation from different areas as a strategy focused on the management, recovery, conservation, and protection of the pronghorn populations.
- Promote the consolidation of a group of specialists, through the continuous use of their technical knowledge as consultants in the process, as well as providing resources (mainly financial) for the management, recovery, conservation, and protection of the pronghorn.
- Strengthen the protection and surveillance for the conservation of the pronghorn populations.
- Increase the number of individuals in the different populations classified as low management, as well as, increase the number of areas with actual population where there used to be pronghorn populations historically in Mexico.
- Generate the right conditions for successful implementation of the strategies developed in this program for the management, recovery, conservation, and protection of the pronghorn.

XIV. Goals

XIV. 1. General Goals

- Establish a program with prioritized actions focused on the management, recovery, conservation, protection, and sustainable benefit of the pronghorn at the national and regional level.
- Rely on updated technical and scientific information to determine the true state of the pronghorn populations, to then efficiently take actions on the management, recovery, conservation, protection, and sustainable benefit of the pronghorn.
- Preserve, and even increase, the areas considered as important habitat for the conservation of the species, to facilitate the recovery of the biological and ecological processes, with the objective of helping this species to recover.
- Consolidate a process for the participation of all the agencies and institutions that participated in this project, in order to keep the communication channels open to facilitate the protection and conservation of the populations of the species.
- Manage and facilitate the resources needed for the enforcement of the actions needed for the conservation and management of the species and its habitats.
- Boost the active participation of academic institutions, ONG, government, and the general society, in steps to help the conservation of the pronghorn and its habitats.

XIV. 2. 2012 Goals

- Have a solid group of specialists that will work along with other groups in the conservation of species that share a habitat, with the objective of developing strategies and actions that will focus on the ecosystem, helping to continue the natural ecologic and evolution processes.
- Have a solid database with data from national projects, monitoring projects, recovery, conservation, protection, and sustainable benefit projects done in the areas of historical distribution of the species.
- Establish, along with the Procuraduría Federal de Protección al Ambiente (PROFEPA), the outline for the reinforcement of the surveillance and protection of the pronghorn, its habitat and species that share the same habitat. Furthermore, have specific projects with surveillance committees that will focus on communities where there are areas with pronghorn presence.
- Increase the size of the areas considered as pronghorn habitats, under a conservation scheme (ANP, UMA, Institutes with conservation certificates, ecological organizations, programs for the environmental services, etc.) by promoting conservation proposals or agreements with institutions in the environmental areas at any governmental level, as well as, private sector.
- Increase the number of pronghorn populations and individuals by at least 30%, by taking advantage of the collaborations between Mexico and the international entities, as well as, utilizing the progress of the current projects.
- Generate and distribute informational materials about the pronghorn.
- Complete at least 100% of the activities detailed in this document (PACE: Pronghorn), by conducting a follow up and evaluation of the program and its link to the Programa de Conservación de las Especies en Riesgo PROCER, and all of its subprograms.

XV. General Conservation Strategies

XV. 1. Protection Components

XV. 1. 1. Habitat Protection Components

- Reinforce, coordinate, and implement the mechanisms to protect the distribution areas for the pronghorn.

XV. 1. 1. 1. Activities

- Promote the conservation and protection of the priority areas for the conservation of the pronghorn and its habitat. Such areas include Áreas Naturales Protegidas (Protected Natural Areas), Predios Certificados para la Conservación (Certified Properties for the Conservation), Reservas comunales y/o privadas (Common and/or private reserves), as well as, Unidades de Manejo para la Conservación de la Vida Silvestre (UMA).
- Achieve the incorporation of properties where there currently exist activities related to the conservation of the pronghorn and its habitat, for the benefit of the Pago por Servicios Ambientales (PSA - Captura de carbono, Hidrológicos y para Conservación de Biodiversidad), Programas de Conservación para el Desarrollo Rural Sustentable (PROCODES) and all of those who help with the productive activities.
- Promote the productive activities within the zones classified as priority.
- Promote the steps that will help reduce the risks and threats for the pronghorn populations, such as, exclusion of free-range cattle that may compete for the same habitat as the pronghorn's, stimulation of the habitat, and management or even control the predators in those areas.
- Promote through an institutional coordination, the Ordenamientos Territoriales Municipales (Municipal territory laws) in the areas with conservation priorities for the pronghorn.
- Consolidate, along with the authorities, the outline for the participation of different sectors to avoid the destruction of the pronghorn habitat, due to changes in the use of the land.

XV. 1. 2. Components of the Protection Plan for Pronghorn Populations and its Grazing Areas

- Reinforce the existing mechanisms for the protection and recovery of the pronghorn populations and their habitat, especially those in rehabilitation process.

XV. 1. 2. 1. Activities

- Contribute with the recovery of the pronghorn populations through mechanisms of breeding more fawns, repopulation, reallocation, and sustainable benefit.
- Contribute with the implementation of mechanisms of inspection and surveillance in order to detect and prevent any damage to the pronghorn populations and their habitats.
- Categorize and prioritize the action needed to guarantee the protection of the pronghorn and its habitat.
- Design and implement strategies for the protection of specific pronghorn populations and their habitats, based on their situation and specific problems.

XV. 1. 3. Legal Components

- Conduct the necessary efforts to ensure the proper legal actions required to ensure the management, protection, conservation, and sustainable benefit of the pronghorn in Mexico.

XV. 1. 3. 1. Activities

- Promote and spread the information amongst the institutions involved in the conservation, protection, and management of the evaluation mechanisms and in some instances, the modification of the current laws.
- Establish the general guidelines for the implementation of prevention and impact mitigation actions that may generate as projects to be developed are implemented in the distribution areas for the pronghorn.
- Propose mechanisms to strengthen the compliance of the environmental rules and regulations in the national territories, including the close monitoring of the relationship with the countries involved in the existing International projects.
- Promote evaluation mechanisms to evaluate the management projects in the ANP where pronghorn are distributed.
- Provide technical information about the species, to help those local authorities, which request such information, to make the right decisions.

XV. 1. 4. Inspection and Surveillance Component

- Avoid and detect illegal activities related with hunting and poaching, trade, and possession of any specimen, parts, or by-product of any pronghorn, and the destruction or illegal modification of its habitat.

XV. 1. 4. 1. Activities

- Create an efficient system for the uptake and processing of complaints to the pertinent authorities that will require an immediate set of actions with the objective of stopping and discouraging any illegal attempts that may be taking place in those areas designated for pronghorn.
- Promote social participation strategies for the environmental surveillance, with different approaches that will target several sectors, for the conservation of areas designated for pronghorn.
- Promote, closely with the Procuraduría Federal de Protección al Ambiente (PROFEPA), the timely processing of any complaints that are related with affecting, directly or indirectly, the pronghorn and its habitat.
- Recognize and involve the legal hunting departments, to request their assistance in spreading the regulations and conservation efforts for the species, with the objective of reducing any pronghorn hunting by designing actions for each kind of identified hunting.
- Promote inspection and surveillance rounds in the areas where pronghorn are distributed, during the seasons when hunting is allowed for other species that share the habitat with the pronghorn.
- Collaborate with the Procuraduría Federal de Protección al Ambiente (PROFEPA), in training federal inspectors and the community surveillance group, whose main objective is to help prevent and detect pronghorn illegal hunting and any activities related to the destruction and fragmentation of its habitat.
- Reinforce inspection and surveillance activities with state and municipal governments.

- Promote amongst the general society the detection and denunciation of illegal hunting of the pronghorn.

XVI. Recovery Strategies

XVI. 1. Recovery Component for Populations and Habitat

- Promote the recovery of the population and areas disturbed and that are located within the priority areas for the pronghorn conservation, with emphasis in the Natural Areas and areas of historical distribution.

XVI. 1. 1. Activities

- Identification of "critica" (critical) zones within the current pronghorn distribution areas that are key for the continuation of the genetic flow of this species and to promote the fixing or removal of the fences built to contain the livestock.
- Determine the possibility and mechanisms necessary for the recovery of the populations and the identification of critical areas.
- Coordinate, across and within institutions, actions to implement the recovery of populations and improvement of disturbed areas identified as "critical".
- Implement actions for the restoration of critical areas identified as distribution areas for the pronghorn along with the ANP.

XVI. 2. Impact Mitigation and Prevention Components

- Reduce the impact generated by the property fencing, changes in the use of the land, and other factors, in the pronghorn populations and their habitats.

XVI. 2. 1. Activities

- Establish preventive and corrective actions, in coordination with the local authorities and property owners, to prevent the fencing needed for the cattle, thus allowing the free flow of pronghorn between different areas.
- Monitor the effect that the main risk factors identified may have in the pronghorn populations.
- Periodically evaluate the impact of the main risk factors in the pronghorn populations.
- Establish mechanisms, within the institutions, that will guarantee the prevention of impacts in the pronghorn population and its habitat.

Management Strategies

XVII. 1 Habitat Management Component

- Develop and implement actions and activities that will guarantee the existence of enough habitats to be able to maintain viable pronghorn populations in the areas of distribution of this specie.

XVII. 1. 1. Activities

- Promote and manage payment programs for environmental services with the Comisión Nacional Forestal (CONAFOR) for the areas with pristine habitat for the pronghorn.
- Promote the creation of new federal, state, or governmental natural areas, the certification of the properties for the conservation and establishment of the Unidades de Manejo para la Conservación de la

Vida Silvestre, in distribution areas for the pronghorn, as a tool for the conservation and restoration of the habitat for the species.

- Accomplish the implementation of the properties where conservation efforts for the pronghorn and its habitat are taking place, with the benefits from the Pago por Servicios Ambientales (PSA), Programas de Empleo Temporal (PET), and Programas de Conservación para el Desarrollo Rural Sustentable (PROCODES), in priority areas that may be under any protection status or that may have been identified as important for this species, as well as, limit and/or regulate the productive activities and the infrastructure that can threaten such areas.
- Promote the review and follow up of the management programs of the ANP and UMA located in the distribution areas with the objective of proposing adaptations and improvements, in an agreeable way with the property and landowners in these areas.
- Promote and follow up the Programas de Ordenamiento Territorial in the elected municipality and communities settled in regions with conservation priority for the pronghorn, with the objective of promoting the continuity of the habitat that will allow the genetic flow of the species.
- Promote the productive diversification in areas located within the pronghorn distribution areas, with low impact activities that will benefit the conservation of the wildlife and their habitats.
- Establish, organize and coordinate agricultural and livestock activities in, or around, the important habitat for the pronghorn.
- Promote the recovery of the habitat throughout the implementation of sustainable tourism programs that will increase the interest of the pronghorn in the society (showing live individuals, guided tours, camping, nature tourism through the protected areas, etc).

XVII. 2. Species Management Component

- Determine and standardize the procedures for the management of individuals and populations.

XVII. 2. 1. Activities

- Elaborate a standard manual of procedures for the management of individuals, focused on reproduction, and of populations, focused on recovery and sustainable benefit.
- Continue with the reproduction, breeding, and translocation for the creation of new populations.
- Develop regional diagnosis with the objective of promoting intersectional meetings according to the priority to be addressed.
- Coordinate the Programa de Fomento Ganadero (PROGAN) de la SAGARPA, mainly in the natural areas located in the distribution areas for the pronghorn, with the objective of organizing the livestock activity.
- Subscribe the production organizations to the Sistema- Producto Ganadería Diversificada SAGARPA, with the objective of financing the recovery, repopulation, and reproduction projects for the pronghorn.
- Promote an agreement between SEMARNAT and SAGARPA, for the implementation of an improvement program for cattle management in the distribution areas for the pronghorn.
- Promulgate a directory of specialists and working groups that will conduct studies or actions for the management, recovery, conservation, and protection of the pronghorn at the regional, national, and international level.

XVII. Strategies to Develop Knowledge

XVIII. 1. Components in the Priority Areas

- Generate information about the distribution and abundance of the pronghorn in the priority areas for its conservation that will support the management, recovery, conservation and protection efforts of this species and its habitat within the conservation priority areas in Mexico.

XVIII. 1. 1. Activities

- Identify the critical sites for the recovery of the pronghorn in Mexico, particularly the main populations and the dynamics between populations, through a monitoring and population density study at the national level.
- Identify the priority areas (actual and potential) for the distribution, repopulation, and reproduction of the pronghorn.
- Estimate the populations of pronghorn in the priority areas.
- Estimate the availability of the habitat for the pronghorn in the priority areas.
- Promote, in a coordinated way, technical assessments in the livestock subject amongst communities within the influential areas.
- Promote coordinated action for the territorial laws at the municipal and state level, focused on avoiding changes in the use of the land in the priority areas for the conservation of the pronghorn.
- Promote the active social participation in the protection of the pronghorn and its habitat, beginning by acknowledging the cultural and environmental heterogeneity existing in each region.

XVIII. 2. Scientific Research Component

- Promote, support, and direct solid researches about the biology and ecology of the pronghorn, as well as, the risks that their populations are facing in the national territory, that will support the decision making process and the establishment of actions in the management, recovery, conservation, protection, and sustainable benefit.

XVIII.2.1 Activities

- Create a geographic information system with information regarding the geographic location of the pronghorn's habitats, the physical and biological characteristics of the area and the changes tendencies of the land.
- Review the availability of areas in zones with habitat potential.
- Review the availability of food source areas within the potential habitats.
- Boost the generation of maps that will include the main risk factors that affect the different pronghorn populations in Mexico.
- Describe the demography and reproductive biology of the pronghorn in Mexico (with emphasis in the reproduction rate, the survival of the fawns, and more)
- Determine the actual distribution of the pronghorn in Mexico, with emphasis on the identification of the priority areas for its conservation.
- Estimate the size of the pronghorn population in Mexico, with emphasis on the priority areas for its conservation.
- Describe the genetic structure of the pronghorn populations in Mexico.

- Evaluate the real and potential effect that competition for food with the cattle has on the pronghorn populations.
- Identify the priority areas for the conservation of the habitat of the pronghorn.
- Define the best techniques for the controlled reproduction, population management, capture, translocations, and follow up of the populations.
- Manage the search for financial support for the identified projects, as a key strategy for the conservation of the species.

XVIII.3 Biological Monitoring Component

- Periodically monitor the pronghorn populations at the national level, with the objective of getting to know the tendencies of the populations of the species (density, abundance, recruitment, etc.) inside and outside of the natural areas.

XVIII.3.1 Activities

- Systematically follow up the pronghorn populations and its reproductive activities.
- Conduct longitudinal demographic analysis in the different pronghorn populations.
- Monitor the quality of the habitat in the critical locations for the distribution of the pronghorn.
- Periodically recollect and analyze the information about demographic tendencies for the pronghorn populations, the availability of its habitat, and its relation with the identified risk factors.
- Design, in coordination with the ANP and institutions involved, a protocol for the monitoring of the pronghorn, to unify the criteria for all the priority areas and initiate the creation of a database for the CONANP and the participating institutions.
- Systematically implement national census for the pronghorn every three years, with the objective of knowing the changes and pressures that the populations are been exposed to.
- Monitor the distribution, feeding, and influence areas in the critical locations for its distribution.
- Periodically gather and analyze the information regarding the demographic tendencies of the pronghorn populations and their relation with the risk factors identified.
- Determine the dispersion of the pronghorn populations through the use of known techniques.

XVIII. Cultural Strategies

XIX. 1. Environmental Education Component

- Develop a conservation and management culture for the pronghorn and its habitat amongst the Mexicans, based on the acknowledgment of its cultural and biological value, risk situation of the species, and its potential for sustainable rural development.
- Promote the knowledge about biology, ecology, and financial potential of the species and its habitat in the Mexican society, with emphasis on the people living in the distribution areas of the pronghorn.
- Promote the understanding of the problems of the pronghorn and its habitat in Mexico.

XIX.1.1 Activities

- Identify the sectors that directly influence the pronghorn populations and its habitat, in order apply the environmental education strategies.
- Define the priorities, focus, and diffusion methods necessary for the conservation of the pronghorn and its habitat, in the general population.
- Update the information regarding the pronghorn and its habitat, included in the basic school education programs in the country.
- Design a manual for the environmental educator about the pronghorn in Mexico, and distribute it amongst professors and environmental educators.
- Provide training to professors and environmental educators about the biology of the pronghorn, its habitat, problematic, and potential use.
- Promote the presence of individuals of the species in zoos, with the objective of educating the population about the pronghorn and the problems that are affecting them, hoping that people will become sensitive about it.
- Build a data base including information about people, institutions, organizations, interest groups, and facilities, that can support and influence the environmental education, research, management, protection, conservation, recovery, and diffusion activities about the biology and problematic of the pronghorn and its habitat.

XIX. 2. 1. Communication and Diffusion Component

- Boost a communication and diffusion campaign that will allow the ability to position the pronghorn as a key species in the general population, and reinforce that historical value of the species, to recover its high cultural value and belonging to the Mexicans.
- Develop communication strategies oriented to specific subjects and people.
- Develop the appropriate subjects and materials to deploy such strategies.
- Establish a signaling program for the sites identified as critical for the conservation of the species.

XIX. 2. 2. Activities

- Spread the scientific information about the pronghorn to the different areas of the society in an appropriate language for their comprehension, awareness, and higher participation.
- Design the definition of the contents and optimal communication media, with a regional emphasis.
- Promote and manage events for pronghorn conservation.

- Make available educational materials about the species to institutions involved and guarantee the availability of the materials.
- Spread the importance of the pronghorn and its habitat for the ethnical groups.
- Spread the importance of the influence of the society in the protection, conservation, and recovery of the pronghorn and its habitat.
- Establish technical and financial synergies amongst the different communication resources for the development and distribution of informational material.
- Develop a proposal to make a year, like “The Year of the Pronghorn”.
- Develop a program of activities about the species for the year designated as “The Year of the Pronghorn”.
- Promote the integration, diffusion, and participation of all the responsible parties involved; in the activation of a web site for the consulting of general people and specialists, with the objective of developing the interest and participation in the conservation of the pronghorn at the national and international level.
- Promote and manage a communication strategy to sensitize the population at two levels:
    1. In the rural sector, to promote the coexistence, convenience, and respect of the species, by using speeches, conferences, videos, radio, television, and brochures.
    2. In the urban sector, utilize mass communication with explicit messages and accessible to the entire population.

XIX. 3. Social Capacitation Component

- Diminish the activities with potential to destroy habitat and individuals, and/ or pronghorn populations in the Áreas Prioritarias de Conservación, through the finding and promotion of social participation, represented by a higher level of information, participation, and involvement of the locals, and property owners of lands located in these areas.
- Involve the different sectors and responsible entities to collaborate in the activities created for the recovery, protection, and conservation of the pronghorn.

XIX. 3. 1. Activities

- Promote best practice exchanges amongst communities, with the objective of sensitizing and educating the locals about their importance in the cultural recovery of the pronghorn and its importance for the ecosystems, as well as, developing educational forums focused on:
    - Promoting the productive activities that are compatible with the conservation of the pronghorn and its habitat.
    - Environmental regulations.
    - Biological monitoring of the species.
- Educate and sensitize the locals about the importance of the conservation of the habitat, as a resource with ecological value.
- Educate the people in local rural communities, who are culturally linked to the pronghorn, to obtain their assistance on the monitoring, surveillance, and environmental education.
- In coordination with the sectors involved, create a technical manual with the recommendations for the installation of pronghorn friendly fences and structures.
- Educate personnel in the CONANP, and other federal, and state institutions, organizations, technicians, and property owners in the identification of the pronghorn habitat, in the monitoring procedures for the areas that the species visits, and the protection and surveillance strategies.

XIX. Management

XX. 1. Components of the Responsible Parties Involved

- Create the organization, administration, and financing conditions that will guarantee accomplishing the objectives of this program.
- Identify the different working groups that will conduct the investigation, management, protection, conservation, and recovery of the pronghorn.
- Integrate the identified people and organizations that will conduct the investigation, management, protection, conservation, sustainable benefit, and recovery of the pronghorn in one group.
- Promote the collaboration of the different working groups related to the pronghorn population, to align strategies, efficiently utilize resources, create synergy in the investigations, management, protection, conservation, repopulation, and recovery.
- Obtain financial support, as well as materials and logistics materials for the implementation and continuity of the actions and activities included in this program.
- Establish working networks with Subcomités Técnicos Consultivos and other working groups for other species that share the habitat with the pronghorn, to incorporate their activities to preserve the ecosystem.

XX.1.1 Activities

- Establish a schedule for regular meetings for the evaluation and follow up of PACE, with the participation of the Subcomité Técnico Consultivo para la Conservación, Manejo y Aprovechamiento Sustentable of the pronghorn and subject experts.
- Establish a communication mechanism for the continuous communication between the members of the Subcomité Técnico Consultivo para la Conservación, Manejo y Aprovechamiento Sustentable of the pronghorn in addition to the web site.
- Establish a collaboration program and meeting agenda for the working groups and committees of the species that share habitat with the pronghorn.
- Promote a collaboration agreement between the SEMARNAT and SAGARPA for the installation of pronghorn friendly fences.
- Build a financial strategy for the activities in this program, which involves the government, general society, and private industries through agreements, contracts, or donations for technical support, cash, or donated species.
- Promote the participation of the general society in activities included in this document, through volunteering, technical support, or financing.

XX. 2. Programming Component

- Create a calendar of activities and projects to be completed in the Programa de Acción, establishing long and short-term goals.
- Identify the action steps necessary to reach the goals and objectives of this program, as well as, the priority of the diverse activities within each phase.

- Identify opportunities for activities that could be done simultaneously, by efficiently utilizing resources or by using synergies between different conservation initiatives.
- Plan the development of the activities proposed in this program, for the short and long term.

XX. 2. 1. Activities

- Program the execution of the activities described in this program.
- Create a list of the activities and projects with timelines that need to be developed and assign the responsible parties.
- Plan the financial needs for the different projects, and decide how they will be met, considering the timeframe to obtain such financial support.

XX. 3. Evaluation and Follow-Up Component

- Guarantee the accomplishment of the objectives and goals of this program, through the evaluation and follow up of the milestones and strategy implemented. For such purpose, there has to be indicators and goals that can be measured, are specific, well-defined, achievable, and meaningful in the short and long term.

XX. 3. 1. Activities

- Identify the critical timeframes to conduct evaluations during the project's execution.
- Establish regular meetings with the involved entities (nationals and internationals) for the evaluation and updating of the actions needed for the conservation of the species.
- Evaluate the success of the program and make the pertinent updates for the short and long term.
- Use indicators to qualify the development of the objectives and goals of the activities planned.
- Build diffusion mechanisms to communicate the partial and final results of the different projects, to help the working groups identify the progress and difficulties faced during the implementation of any programs, hence, to be able to make changes to the programs when deemed necessary.

XX. Success Indicators

Note: Short term 1-2 years, Medium term 3-4 years, Long term 5 or more years.

Conservation Strategy	No.	Success Indicator	Short term	Medium term	Long term
Protection and surveillance	1	Reduce the number of illegal hunting claims.		x	x
	2	Increase the number of participating groups from the society (environmental surveillance committees, conservation networks, and environmental supporters within the community) focused on the conservation of the pronghorn.		x	
	3	Number of meetings, benchmarking, community workshops, with the social participation groups interested in the conservation of the species and its habitat.	x	x	x
Recovery	4	Increase the number of responsible parties and programs focused on the identification and restoration of the habitat.		x	x
Management	5	Increase the size of the areas for the available habitat for the conservation of the pronghorn incorporated to the conservation programs (ANP, UMA, etc.)	x	X	x
	6	Increase the abundance of the wild pronghorn populations.		x	x
	7	Increase the number of individuals through the breeding programs and by increasing the number of relocated individuals.	x	x	x
	8	Increase the livestock production programs under technical assistance in the Áreas Prioritarias (Priority Areas).		x	
Knowledge	9	Number of the scientific researches focused in the	x	x	

		biological and ecological monitoring of the species.			
	10	Increase the number of Áreas Prioritarias (Priority Areas) where programs for the conservation and research of the pronghorn will develop.	x	x	
Culture	11	Increase the awareness and distribution of available information with emphasis in the regions of natural distribution of the species, by using electronic or printed media.	x	x	X
	12	Increase the number of events for environmental education, capacitation and information.	X	x	x
	13	Increase the participation in disclosure forums about the species and conservation efforts.	x	x	x
Management and Programming	14	Increase the number of agreements amongst institutions, focused on programs for the conservation of the habitat of the pronghorn.	x		
	15	Increase the financial and number of human resources needed for conservation programs of the species.	x	x	
	16	Increase the number of communities participating in ecotourism.		x	x
	17	Increase the number of international agreements for the conservation of the species and its habitat.	x	x	x
	18	Increase the number of parties involved in the conservation of the species and its habitat.		x	x
Evaluation and Follow up	19	Number of goals reached with the development of the planned steps in PACE of the pronghorn.		x	x
	20	Number of evaluation	x	x	x

		meetings with the Grupo de Especialistas (Specialists Group).			

XXI. Programmed Activities Chart

Activity	Success indicator	Short term	Medium term	Long term
1.1 Habitat Protection Components				
Promote the conservation and protection of the priority areas for the conservation of the pronghorn and its habitat. Such areas include Áreas Naturales Protegidas (Protected Natural Areas), Predios Certificados para la Conservación (Certified Properties for the Conservation), Reservas comunales y/o privadas (Common and/or private reserves), as well as, Unidades de Manejo para la Conservación de la Vida Silvestre (UMA).	5, 7, 10	x	x	X
Achieve the incorporation of properties where there currently exist activities related to the conservation of the pronghorn and its habitat, for the benefit of the Pago por Servicios Ambientales (PSA - Captura de carbono, Hidrológicos y para Conservación de Biodiversidad), Programas de Conservación para el Desarrollo Rural Sustentable (PROCODES) and all of those who help with the productive activities.	5, 7, 8	x	x	x
Promote the productive activities within the zones classified as priority.	5, 7, 8, 10, 14			X
Promote through an institutional coordination, the Ordenamientos Territoriales Municipales (Municipal territory laws) in the areas with conservation priorities for the pronghorn.	5, 7, 8, 10, 14			X
Establish a signaling program for the sites identified as critical for the conservation of the specie.	2, 5, 11, 18		x	x
Consolidate, along with the authorities, the outline for the participation of different sectors to avoid the destruction of the pronghorn habitat, due to changes in the use of the land.	4, 5, 14		x	x
1.2 Components of the protection plan for the pronghorn populations and its distribution areas				
Categorize and prioritize the action needed to guarantee the protection of the pronghorn and its habitat.	6, 8, 9, 10, 13, 14	x	x	x
Design and implement strategies for the protection of specific pronghorn populations and their habitats, based on their situation and specific problems.	2, 7,5, 6, 15, 16		x	X
1.3 Legal Components				
Promote and spread the information amongst the institutions involved in the conservation,	14, 15, 17, 18	X	x	

protection, and management of the evaluation mechanisms and in some instances, the modification of the current laws.				
Establish the general guidelines for the implementation of prevention and impact mitigation actions that may generate as projects to be developed are implemented in the distribution areas for the pronghorn.	14, 15, 18, 20	x	x	x
Propose mechanisms to strengthen the compliance of the environmental rules and regulations in the national territories, including the close monitoring of the relationship with the countries involved in the existing International projects.	4, 5, 6, 7		x	x
Promote evaluation mechanisms to evaluate management projects in the ANP where pronghorn are distributed.	5, 8, 10, 20	x	x	x
Provide technical information about the species, to help those local authorities, which request such information, to make the right decisions.	2, 3, 12, 13, 20	x	x	x
1.4 Inspection and Surveillance Component				
Create an efficient system for the uptake and processing of complaints to the pertinent authorities that will require an immediate set of actions with the objective of stopping and discouraging any illegal attempts that may be taking place in those areas designated for pronghorn.	1, 2, 3	x	x	x
Promote social participation strategies for the environmental surveillance, with different approaches that will target several sectors, for the conservation of areas designated for pronghorn.	1, 2, 3	x	x	
Promote, closely with the Procuraduría Federal de Protección al Ambiente (PROFEPA), the timely processing of any complaints that are related with affecting, directly or indirectly, the pronghorn and its habitat.	1, 2	x	x	
Generation of maps that will include the main risk factors that affect (directly or indirectly) the pronghorn populations, to be able to prioritize the required legal and preventive actions needed to preserve the species.	1, 4, 14	x	x	
Recognize and involve the legal hunting departments, to request their assistance in spreading the regulations and conservation efforts for the species, with the objective of reducing any pronghorn hunting by designing actions for each kind of identified hunting.	2, 8, 16	x	x	

Promote inspection and surveillance rounds in the areas where pronghorn are distributed, during the seasons when hunting is allowed for other species that share the habitat with the pronghorn.	2, 3, 14, 18	x	x	
Collaborate with the Procuraduría Federal de Protección al Ambiente (PROFEPA), in training federal inspectors and the community surveillance group, whose main objective is to help prevent and detect pronghorn illegal hunting and any activities related to the destruction and fragmentation of its habitat.	1, 2, 3, 4, 13, 15	x	x	
Reinforce inspection and surveillance activities with state and municipal governments.	2, 4	x	x	x
Promote amongst the general society the detection and denunciation of illegal hunting of the pronghorn.	1, 2, 3, 4	x	x	x
Coordinate, across and within institutions, the participation of communities in rural areas in the conservation of the pronghorn and its habitat.	5, 8, 11, 12, 13	x	x	
Design and spread programs that will stop and discourage any illegal activities related with hunting of the pronghorn. The development of such programs should include academic members and government representatives, and other institutions involved in the conservation of the pronghorn.	2, 15	x	x	x
2.1 Habitat and Ecosystem Restoration Component				
Identification of “critical” (critical) zones within the current pronghorn distribution areas that are key for the continuation of the genetic flow of this species.	4, 9, 14	x	x	
Determine the possibility and mechanisms necessary for the recovery of the populations and the identification of critical areas.	5	x	x	x
Coordinate, across and within institutions, actions to implement the recovery of populations and improvement of disturbed areas identified as “critical”.	4, 14, 15	x	x	
Implement actions for the restoration of critical areas identified as distribution areas for the pronghorn along with the ANP.	4, 5, 14, 15	x	x	
3.1 Impact Mitigation and Prevention Components				
Establish preventive and corrective actions, in coordination with the local authorities and property owners, to prevent the fencing needed for the cattle, thus allowing the free flow of pronghorn between different areas.	10	x	x	x
Monitor the effect that the main risk factors	10	x	x	x

identified may have in the pronghorn populations.				
Periodically evaluate the impact of the main risk factors in the pronghorn populations.	10, 11	x	x	x
Establish mechanisms, within the institutions, that will guarantee the prevention of impacts in the pronghorn population and its habitat.	10	x	x	x
3.2 Habitat Management Component				
Promote and manage payment programs for environmental services with the Comisión Nacional Forestal (CONAFOR) for the areas with pristine habitat for the pronghorn.	5, 8	x	x	
Promote the creation of new federal, state, or governmental natural areas, the certification of the properties for the conservation and establishment of the Unidades de Manejo para la Conservación de la Vida Silvestre, in distribution areas for the pronghorn, as a tool for the conservation and restoration of the habitat for the species.	5, 7, 8	x	x	
Accomplish the implementation of the properties where conservation efforts for the pronghorn and its habitat are taking place, with the benefits from the Pago por Servicios Ambientales (PSA), Programas de Empleo Temporal (PET), and Programas de Conservación para el Desarrollo Rural Sustentable (PROCODES), in priority areas that may be under any protection status or that may have been identified as important for this species, as well as, limit and/or regulate the productive activities and the infrastructure that can threaten such areas.	5, 6, 8, 9	x	x	x
Promote the review and follow up of management programs of the ANP and UMA located in the distribution areas with the objective of proposing adaptations and improvements, in an agreeable way with the property and landowners in these areas.	5, 16	x	x	x
Promote and follow up the Programas de Ordenamiento Territorial in the elected municipality and communities settled in regions with conservation priority for the pronghorn, with the objective of promoting the continuity of the habitat that will allow the genetic flow of the species.	5, 16		x	x
Promote the productive diversification in areas located within the pronghorn distribution areas, with low impact activities that will benefit the conservation of the wildlife and their habitats.	8, 14, 18, 19		x	x

Promote the recovery of the habitat throughout the implementation of sustainable tourism programs that will increase the interest of the pronghorn in the society (showing live individuals, guided tours, camping, nature tourism through the protected areas, etc).	8, 14, 18, 19		x	x
3.3 Species Management Component				
Elaborate a standard manual of procedures for the management of individuals, focused on reproduction, and of populations, focused on recovery and sustainable benefit.	11	x		
Develop regional diagnosis with the objective of promoting intersectional meetings according to the priority to be addressed.	2, 3, 4, 9, 15	x	x	
Coordinate the Programa de Fomento Ganadero (PROGAN) de la SAGARPA, mainly in the natural areas located in the distribution areas for the pronghorn, with the objective of organizing the livestock activity.	1, 4, 7, 15		x	
Subscribe the production organizations to the Sistema- Producto Ganadería Diversificada SAGARPA, with the objective of financing the recovery, repopulation, and reproduction projects for the pronghorn.	1, 4, 7, 15		x	
Promote an agreement between SEMARNAT and SAGARPA, for the implementation of an improvement program for cattle management in the distribution areas for the pronghorn.	8, 14, 18, 19	x	x	
Promulgate a directory of specialists and working groups that will conduct studies or actions for the management, recovery, conservation, and protection of the pronghorn at the regional, national, and international level.	1, 4, 7, 9, 15	x	x	
4.1 Components in the Priority Areas				
Identify the critical sites for the recovery of the pronghorn in Mexico, particularly the main populations and the dynamics between populations, through a monitoring and population density study at the national level.	9, 10	x	x	
Identify the priority areas (actual and potential) for the distribution, repopulation, and reproduction of the pronghorn.	9, 10, 15	x	x	
Estimate the populations of pronghorn in the priority areas.	9, 10, 15	x	x	x
Estimate the availability of the habitat for the pronghorn in the priority areas.	9, 10, 15	x	x	x
Promote, in a coordinated way, technical assessments in the livestock subject amongst communities within the influential areas.	8, 9, 15	x	x	x

Promote coordinated action for the territorial laws at the municipal and state level, focused on avoiding changes in the use of the land in the priority areas for the conservation of the pronghorn.	11	x	x	x
Promote the active social participation in the protection of the pronghorn and its habitat, beginning by acknowledging the cultural and environmental heterogeneity existing in each region.	2, 14, 18	x	x	
4.2 Scientific Research Component				
Create a geographic information system with information regarding the: 1. Geographic location of the pronghorn's habitats, the physical and biological characteristics of the area and the changes tendencies of the land. 2. Availability of areas in zones with habitat potential. 3. Availability of food source areas within the potential habitats. 4. Generation of maps that will include the main risk factors that affect the different pronghorn populations in Mexico.	9, 11, 15, 18	x	x	
Describe the demography and reproductive biology of the pronghorn in Mexico (with emphasis in the reproduction rate, the survival of the fawns, and more).	11	x	x	x
Determine the actual distribution of the pronghorn in Mexico, with emphasis on the identification of the priority areas for its conservation.	5, 11	x	x	x
Estimate the size of the pronghorn population in Mexico, with emphasis on the priority areas for its conservation.	9, 15, 18	x	x	
Describe the genetic structure of the pronghorn populations in Mexico.	9, 10, 11, 13	x	x	
Evaluate the real and potential effect that competition for food with the cattle has on the pronghorn populations.	9, 10, 11, 13	x	x	x
Identify the priority areas for the conservation of the habitat of the pronghorn.	9, 10, 11, 13	x	x	x
Define the best techniques for the controlled reproduction, population management, capture, translocations, and follow up of the populations.	9, 10, 11, 13	x	x	x
Manage the search for financial support for the identified projects, as a key strategy for the conservation of the species.	15, 19, 20	x	x	x
4. 3 Biological Monitoring Component				

Systematically follow up the pronghorn populations	5, 9	x	x	
Systematically follow up the pronghorn reproductive activities.	5, 9	x	x	x
Conduct longitudinal demographic analysis in the different pronghorn populations.	4, 7, 9, 11	x	x	x
Monitor the quality of the habitat in the critical locations for the distribution of the pronghorn.	4, 7, 9, 11	x	x	x
Periodically recollect and analyze the information about demographic tendencies for the pronghorn populations, the availability of its habitat, and its relation with the identified risk factors.	4, 7, 8, 9, 11	x	x	X
Design, in coordination with the ANP and institutions involved, a protocol for the monitoring of the pronghorn, to unify the criteria for all the priority areas and initiate the creation of a database for the CONANP and the participating institutions.	9, 20	x	x	x
Systematically implement national census for the pronghorn every three years, with the objective of knowing the changes and pressures that the populations are been exposed to.	9, 20	x	x	X
Monitor the distribution, feeding, and influence areas in the critical locations for its distribution.	4, 7, 8, 9, 11	x	x	x
Periodically gather and analyze the information regarding the demographic tendencies of the pronghorn populations and their relation with the risk factors identified.	4, 11	x	x	x
Determine the dispersion of the pronghorn populations through the use of known techniques.	4, 7, 8, 9, 11	x	x	x
5.1 Environmental Education Component				
Identify the sectors that directly influence the pronghorn populations and its habitat, in order apply the environmental education strategies.	11, 12, 13, 16	x	x	
Define the priorities, focus, and diffusion methods necessary for the conservation of the pronghorn and its habitat, in the general population.	12, 13, 16	x	x	
Update the information regarding the pronghorn and its habitat, included in the basic school education programs in the country.	12, 13, 14, 16	x	x	
Design a manual for the environmental educator about the pronghorn in Mexico, and distribute it amongst professors and environmental educators.	12, 13	x	x	
Provide training to professors and environmental educators about the biology of the pronghorn, its	12, 13	x	x	

habitat, problematic, and potential use.				
Promote the presence of individuals of the species in zoos, with the objective of educating the population about the pronghorn and the problems that are affecting them, hoping that people will become sensitive about it.	12, 13, 15		x	
Build a data base including information about people, institutions, organizations, interest groups, and facilities, that can support and influence the environmental education, research, management, protection, conservation, recovery, and diffusion activities about the biology and problematic of the pronghorn and its habitat.	12, 14, 16	x	x	
5.2 Communication and Diffusion Component				
Spread the scientific information about the pronghorn to the different areas of the society in an appropriate language for their comprehension, awareness, and higher participation.	9, 11, 12, 13	x	x	x
Design the definition of the contents and optimal communication media, with a regional emphasis.	11, 12, 13	x	x	
Promote and manage events for pronghorn conservation.	12, 14	x	x	x
Make available educational materials about the species, to institutions involved, and guarantee the availability of the materials.	3, 4, 11, 12, 13, 14,15	x	x	
Spread the importance of the influence of the society in the protection, conservation, and recovery of the pronghorn and its habitat.	3, 4, 11, 12, 13, 14	x	x	x
Establish technical and financial synergies amongst the different communication resources for the development and distribution of informational material.	3, 4, 11, 12	x	x	x
Develop a proposal to make a year, like "The Year of the Pronghorn".	9, 14, 15, 17	x	x	x
Develop a program of activities about the species for the year designated as "The Year of the Pronghorn".	14	x	x	x
Promote the integration, diffusion, and participation of all the responsible parties involved; in the activation of a web site for the consulting of general people and specialists, with the objective of developing the interest and participation in the conservation of the pronghorn at the national and international level.	12	x	x	
Promote and manage a communication strategy to sensitize the population at two levels: 1. In the rural sector, to promote the coexistence, convenience, and respect of the species, by using speeches,	2, 3, 4, 12	x	x	

conferences, videos, radio, television, and brochures. 2. In the urban sector, utilize mass communication with explicit messages and accessible to the entire population.				
5.3 Social Capacitation Component				
Promote best practice exchanges amongst communities, with the objective of sensitizing and educating the locals about their importance in the cultural recovery of the pronghorn and its importance for the ecosystems, as well as, developing educational forums focused on: o Promoting the productive activities that are compatible with the conservation of the pronghorn and its habitat. o Environmental regulations. o Biological monitoring of the species.	2, 3, 12, 13	x	x	x
Educate and sensitize the locals about the importance of the conservation of the habitat, as a resource with ecological value.	2, 3, 12, 13	x	x	x
Educate the people in local rural communities, who are culturally linked to the pronghorn, to obtain their assistance on the monitoring, surveillance, and environmental education.	2, 3, 12, 13	x	x	x
In coordination with the sectors involved, create a technical manual with the recommendations for the installation of pronghorn friendly fences and structures.	2, 3, 12, 13	x	x	x
Educate the people in local communities, who are culturally linked to the pronghorn, to obtain their assistance on the monitoring, surveillance, and environmental education.	2, 3, 12, 13	x	x	x
Educate personnel in the CONANP, and other federal, and state institutions, organizations, technicians, and property owners in the identification of the pronghorn habitat, in the monitoring procedures for the areas that the species visits, and the protection and surveillance strategies.	2, 3	x	x	x
6. 1 Components of the Responsible Parties Involved				
Establish a schedule for regular meetings for the evaluation and follow up of PACE, with the participation of the Subcomité Técnico Consultivo para la Conservación, Manejo y Aprovechamiento Sustentable of the pronghorn and subject experts.	11, 12, 14, 15, 20	x	x	
Establish a communication mechanism for the	2, 13, 15, 17,	x	x	X

continuous communication between the members of the Subcomité Técnico Consultivo para la Conservación, Manejo y Aprovechamiento Sustentable of the pronghorn in addition to the web site.	20			
Establish a collaboration program and meeting agenda for the working groups and committees of the species that share habitat with the pronghorn.	2, 3, 9, 13, 15, 18	x	x	X
Promote a collaboration agreement between the SEMARNAT and SAGARPA for the installation of pronghorn friendly fences.	9, 14, 15	x	x	x
Build a financial strategy for the activities in this program, which involves the government, general society, and private industries through agreements, contracts, or donations for technical support, cash, or donated species.	15, 18, 19	x	x	x
Promote the participation of the general society in activities included in this document, through volunteering, technical support, or financing.	14, 15	x	x	x
6.2 Programming Component				
Create a calendar of activities and projects to be completed in the Programa de Acción, establishing long and short-term goals.	15, 19, 20	x	x	
Identify the action steps necessary to reach the goals and objectives of this program, as well as, the priority of the diverse activities within each phase.	10, 14, 15	x	x	x
Plan the financial needs for the different projects, and decide how they will be met, considering the timeframe to obtain such financial support and the resources needed.	2, 10, 11, 14, 15	x	x	
6.3 Evaluation and Follow up Component				
Identify the critical timeframes to conduct evaluations during the project's execution.	19, 20	x		
Establish regular meetings with the involved entities (nationals and internationals) for the evaluation and updating of the actions needed for the conservation of the species.	11,12,13 20	x		
Evaluate the success of the program and make the pertinent updates for the short and long term.	18, 19	x	x	x
Use indicators to qualify the development of the objectives and goals of the activities planned.	18, 19	x	x	x
Build diffusion mechanisms to communicate the partial and final results of the different projects, to help the working groups identify the progress and difficulties faced during the implementation of any programs, hence, to be able to make changes to the programs when deemed	12	x		

necessary.				

XXII. Specific Activities

XXIII.1 Peninsular Pronghorn

Component	Activity	Goals 09-10	Goals 11-12
Protection of the habitat	Establish the UMA	2 UMA	2 UMA
Protection of the populations	Protection of the breeding sites	200 pronghorn	200 pronghorn
	Repopulation and transfer	100 pronghorn	100 pronghorn
	Sustainable use	1 functional UMA	2 functional UMA
Legal Area	Evaluate the pronghorn management programs with ANP	1 ANP	1 ANP
	Establish the general guidelines for the implementation of prevention and impact mitigation actions		1 written document
Inspection and surveillance	Incorporate UMA in the continuous surveillance efforts	2 UMA	2 UMA
	Incorporate the hunting departments in the surveillance efforts	Creation of a regional association	Creation of a regional association
Populations and habitat restoration	Identify critical zones within the Baja California peninsula	1 written document	
	Coordinate activities amongst institutions	1 program	
Prevention and impact mitigation	Coordinate activities amongst institutions	1 program	
Habitat management	Incorporate the already established UMA to the benefits of the governmental programs developed	2 UMA	2 UMA
	Promote the productive diversification	1 UMA to serve a role model for the region	
Management of the species	Create a standardized handbook for the management of the	1 handbook	

	species		
Knowledge development	Conduct a census in the entire Baja California peninsula	1 census	
Scientific investigation	Generation of maps that will include the main risk factors that affect the peninsular pronghorn	1 document	
	Determine the genetics of the subspecies	1 document	
Biological monitoring	Continuous follow up of the wild population and its habitat in the REBIVI and APFF Valle de los Cirios	2 reports	2 reports
Environmental education	Define and prioritize the promotion and spread of information for the conservation, protection, and management of the pronghorn, in the local communities	1 environmental education program	
	Increase the number of peninsular individuals in the local zoos.	1 zoo	2 zoos
Communication and spread	Define and prioritize the promotion and spread of information for the conservation, protection, and management of the pronghorn, in the local communities	1 program	
Social capacitation	Educate the people in local communities in the rural areas, who are culturally linked to the pronghorn	10 workshops	10 workshops

Parties involved	Establish meeting agendas and regular meetings for the evaluation and follow up of PACE	2	2

XXIII.2 Sonoran Pronghorn

Component	Activity	Goals 09-10	Goals 11-12
Protection of the populations	Protection of the breeding sites		50 pronghorn
	Sustainable use		1 functional UMA
Legal Area	Evaluate the pronghorn management programs with ANP	1 ANP	
	Establish the general guidelines for the implementation of prevention and impact mitigation actions		1 written document
Inspection and surveillance	Incorporate UMA in the continuous surveillance efforts	3 UMA	3 UMA
	Incorporate the hunting departments in the surveillance efforts	Creation of a regional association	Creation of a regional association
Populations and habitat restoration	Identify critical zones in Sonora	1 written document	
	Coordinate activities amongst institutions	1 program	
Prevention and impact mitigation	Coordinate activities amongst institutions	1 program	
Habitat management	Incorporate the already established UMA to the benefits of the governmental programs developed	3 UMA	3 UMA
	Promote the productive diversification	1 UMA to serve a role model for the region	
Management of the species	Create a standardized handbook for the management of the species	1 handbook	
Knowledge development	Conduct a census in the distribution areas	1 census	
Scientific investigation	Generation of maps that will include the main risk factors that affect the	1 document	

	Sonoran pronghorn		
	Determine the genetics of the subspecies	1 document	
Biological monitoring	Continuous follow up of the wild population and its habitat in the REBIPI and surrounding areas		1 report
Environmental education	Define and prioritize the promotion and spread of information for the conservation, protection, and management of the pronghorn, in the local communities	1 environmental education program	
Communication and spread	Define and prioritize the promotion and spread of information for the conservation, protection, and management of the pronghorn, in the local communities	1 program	
Social capacitation	Educate the people in local communities in the rural areas, who are culturally linked to the pronghorn	2 workshops	
Parties involved	Establish meeting agendas and regular meetings for the evaluation and follow up of PACE	2	2

XXIII.3 Mexican Pronghorn

Component	Activity	Goals 09-10	Goals 11-12
Protection of the habitat	Establish the UMA	4 UMA	2 UMA
Protection of the populations	Protection of the breeding sites		50 pronghorn
	Repopulation and	300 pronghorn	100 pronghorn

	transfer		
	Sustainable use	1 functional UMA	2 functional UMA
Legal Area	Evaluate the pronghorn management programs with ANP	1 ANP	
	Establish the general guidelines for the implementation of prevention and impact mitigation actions		1 written document
Inspection and surveillance	Incorporate UMA in the continuous surveillance efforts	4 UMA	2 UMA
	Incorporate the hunting departments in the surveillance efforts	Creation of a regional association	Creation of a regional association
Populations and habitat restoration	Identify critical zones in Chihuahua	1 written document	
	Coordinate activities amongst institutions	1 program	
Prevention and impact mitigation	Coordinate activities amongst institutions	1 program	
Habitat management	Incorporate the already established UMA to the benefits of the governmental programs developed	4 UMA	2 UMA
	Promote the productive diversification	1 UMA to serve a role model for the region	
Management of the species	Create a standardized handbook for the management of the species	1 handbook	
Knowledge development	Conduct a census in the entire Chihuahua state	1 census	
Scientific investigation	Generation of maps that will include the main risk factors that affect the peninsular pronghorn	1 document	
	Determine the	1 document	

	genetics of the subspecies		
Biological monitoring	Continuous follow up of the wild population and its habitat in the Chihuahua, Coahuila, and Nuevo León states	2 reports	2 reports
Environmental education	Define and prioritize the promotion and spread of information for the conservation, protection, and management of the pronghorn, in the local communities	1 environmental education program	
Communication and spread	Define and prioritize the promotion and spread of information for the conservation, protection, and management of the pronghorn, in the local communities	1 program	
Social capacitation	Educate the people in local communities in the rural areas, who are culturally linked to the pronghorn	10 workshops	10 workshops
Parties involved	Establish meeting agendas and regular meetings for the evaluation and follow up of PACE	2	2

XXIII. Pronghorn in the Rest of the Mexican Plateau

XXIV.1 Zacatecas

Component	Activity	Goals 09-10	Goals 11-12
Protection of the habitat	Establish the UMA	2 UMA	2 UMA
Protection of the populations	Protection of the breeding sites	100 pronghorn	100 pronghorn
	Repopulation and transfer	100 pronghorn	100 pronghorn
	Sustainable use	1 functional UMA	2 functional UMA
Legal Area	Legally establish a ANP with habitat for the pronghorn	1 ANP	
	Establish the general guidelines for the implementation of prevention and impact mitigation actions		1 written document
Inspection and surveillance	Incorporate UMA in the continuous surveillance efforts	2 UMA	2 UMA
	Incorporate the hunting departments in the surveillance efforts	Creation of a regional association	Creation of a regional association
Populations and habitat restoration	Identify areas in critical conditions	1 written document	
	Coordinate activities amongst institutions	1 program	
Prevention and impact mitigation	Coordinate activities amongst institutions	1 program	
Habitat management	Incorporate the already established UMA to the benefits of the governmental programs developed	2 UMA	2 UMA
	Promote the productive diversification	1 UMA to serve a role model for the region	
Management of the species	Create a standardized handbook for the management of the species	1 handbook	
Knowledge development	Evaluate the techniques and		1 document

	procedures used for the pronghorn repopulation		
Scientific investigation	Generation of maps that will include the main risk factors that affect the transferred pronghorn		1 document
Biological monitoring	Continuous follow up of the transferred populations	2 reports	2 reports
Environmental education	Define and prioritize the promotion and spread of information for the conservation, protection, and management of the pronghorn, in the local communities	1 environmental education program	
Communication and spread	Define and prioritize the promotion and spread of information for the conservation, protection, and management of the pronghorn, in the local communities	1 program	
Social capacitation	Educate the people in local communities in the rural areas, who are culturally linked to the pronghorn	2 workshops	2 workshops
Parties involved	Establish meeting agendas and regular meetings for the evaluation and follow up of PACE	2	2

XXIV.2 Durango

Component	Activity	Goals 09-10	Goals 11-12
Protection of the habitat	Establish the UMA	2 UMA	2 UMA
Protection of the populations	Protection of the breeding sites	50 pronghorn	100 pronghorn
	Repopulation and transfer	100 pronghorn	100 pronghorn
	Sustainable use	1 functional UMA	2 functional UMA
Legal Area	Establish the general guidelines for the implementation of prevention and impact mitigation actions		1 written document
Inspection and surveillance	Incorporate UMA in the continuous surveillance efforts	2 UMA	2 UMA
	Incorporate the hunting departments in the surveillance efforts	Creation of a regional association	Creation of a regional association
Populations and habitat restoration	Identify areas in critical conditions in the Durango state		1 written document
	Coordinate activities amongst institutions	1 program	
Prevention and impact mitigation	Coordinate activities amongst institutions	1 program	
Habitat management	Incorporate the already established UMA to the benefits of the governmental programs developed	2 UMA	2 UMA
	Promote the productive diversification	1 UMA to serve a role model for the region	
Management of the species	Create a standardized handbook for the management of the species	1 handbook	
Knowledge development	Evaluate the techniques and procedures used for the pronghorn repopulation		1 document
Scientific	Generation of maps		1 document

investigation	that will include the main risk factors that affect the transferred pronghorn		
Biological monitoring	Continuous follow up of the transferred populations	2 reports	2 reports
Environmental education	Define and prioritize the promotion and spread of information for the conservation, protection, and management of the pronghorn, in the local communities	1 environmental education program	
Communication and spread	Define and prioritize the promotion and spread of information for the conservation, protection, and management of the pronghorn, in the local communities	1 program	
Social capacitation	Educate the people in local communities in the rural areas, who are culturally linked to the pronghorn	2 workshops	2 workshops
Parties involved	Establish meeting agendas and regular meetings for the evaluation and follow up of PACE	2	2

Acronym Appendix

AGFD	Arizona Game and Fish Department
AMAVISI	Asociación de Manejadores de Vida Silvestre, A. C. (Wildlife Management Association)
ANP	Áreas Naturales Protegidas (Protected Natural Areas)
BFA	Base de la Fuerza Aérea Francis E. Warren (Air Force Base Francis E. Warren)

CEDES	Comisión de Ecología y Desarrollo Sustentable del Estado de Sonora (Ecology and Sustainable Development Department of the Sonora State)
CES	Centro Ecológico de Sonora (Ecological Center of Sonora)
CIBNOR	Centro de Investigaciones Biológicas del Noreste (Biological Research Center of the Northeast)
CONAFOR	Comisión Nacional Forestal (National Forest Department)
CONANP	Comisión Nacional de Áreas Naturales Protegidas (National Department of the Protected Natural Areas)
DGFS	Dirección General de Fauna Silvestre (Wild Fauna General Department)
DGVS	Dirección General de Vida Silvestre (Wildlife General Department)
EAVS	Estación de Aprovechamiento de Vida Silvestre (Wildlife Use Station)
FWS	Servicio de Pesca y Vida Silvestre de Estados Unidos (Fish and Wildlife Service in the USA)
GEF	Fondo Mundial para el Medio Ambiente (Global Environmental Facility)
IMADES	Instituto del Medio Ambiente y el Desarrollo Sustentable del Estado de Sonora, (currently CEDES) (Environmental and Sustainable Development Institute in the Sonora State)
INE	Instituto Nacional de Ecología (Ecology National Institute)
L. A. Zoo	Zoológico de Los Ángeles (Los Angeles Zoo)
LGVS	Ley General de Vida Silvestre (Wildlife Law)
NMDGF	Departamento de Caza y Pesca de Nuevo México (New Mexico Department of Game and Fish)
ONG	Organización No Gubernamental (Non-governmental Organization)
PACE	Programa de Acción Para la Conservación de La Especie (Species Conservation Action Program)
PET	Programas de Empleo Temporal (Temporary Employment Program)
PREP	Proyectos para la Recuperación de Especies Prioritarias (Project for the Recovery of the Priority Species)
PREPBe	Proyecto para la Conservación, Manejo y Aprovechamiento Sustentable del Berrendo en México (Project for the Conservation, Management, and Sustainable Benefit of the Pronghorn in Mexico)
PROCER	Programa de Conservación de Especies en Riesgo (Program for the Conservation of the Endangered Species)
PROCODES	Programas de Conservación para el Desarrollo Rural Sustentable (Conservation Program for the Sustainable Rural Development)
PROFEPA	Procuraduría Federal de Protección al Ambiente (Federal Department for the Environmental Protection)
PROGAN	Programa de Fomento Ganadero (Livestock Development Program)
PSA	Pago por Servicios Ambientales (Payment for Environmental Services)
ReBiPi	Reserva de la Biosfera “El Pinacate y Gran Desierto de Altar” (Biosphere Reserve)
ReBiVi	Reserva de la Biosfera “El Vizcaíno” (Biosphere Reserve)
SAGARPA	Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (Agriculture, Livestock, Rural Development, Fish, and Feeding Department)
SEDENA	Secretaría de la Defensa Nacional (National Defense Department)
SEMARNAP	Secretaría de Medio Ambiente, Recursos Naturales y Pesca (currently

	SEMARNAT) (Environment, Natural Resources, and Fish Department)
SEMARNAT	Secretaría de Medio Ambiente y Recursos Naturales (Environment and Natural Resources Department)
SUMA	Sistema de Unidades para la Conservación de la Vida Silvestre (Units System for the Wildlife Conservation)
TNC	The Nature Conservancy
UAZ	Universidad Autónoma de Zacatecas
UICN	Unión Internacional para la Conservación de la Naturaleza (International Committee for the Conservation of Nature)
UMA	Unidad de Manejo para la Conservación de Vida Silvestre (Management Unit for the Wildlife Conservation)
UNAM	Universidad Nacional Autónoma de México
UPC	Unidos para la Conservación A.C. (United for the Conservation)
WGFD	Wyoming Game and Fish Department

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Appendix D. Population Viability Assessment

REVISION
Population Viability Analysis for the Sonoran Pronghorn (*Antilocapra americana sonoriensis*)

Report prepared by

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Population Viability Analysis for the Sonoran Pronghorn (*Antilocapra americana sonoriensis*)

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Introduction

Population viability analysis (PVA) can be an extremely useful tool for investigating current and future demographic dynamics of Sonoran pronghorn populations within the species' range. The need for and consequences of alternative management strategies can be modeled to suggest which practices may be the most effective in managing Sonoran pronghorn populations. *VORTEX*, a simulation software package written for PVA, was used here as a vehicle to study the interaction of a number of Sonoran pronghorn life history and population parameters, and to test the effects of selected management scenarios.

The *VORTEX* package is a simulation of the effects of a number of different natural and human-mediated forces – some, by definition, acting unpredictably from year to year – on the health and integrity of wildlife populations. *VORTEX* models population dynamics as discrete sequential events (e.g., births, deaths, sex ratios among offspring, catastrophes, etc.) that occur according to defined probabilities. The probabilities of events are modeled as constants or random variables that follow specified distributions. The package simulates a population by recreating the essential series of events that describe the typical life cycles of sexually reproducing organisms.

PVA methodologies such as the *VORTEX* system are not intended to give absolute and accurate "answers" for what the future will bring for a given wildlife species or population. This limitation arises simply from two fundamental facts about the natural world: it is inherently unpredictable in its detailed behavior; and we will never fully understand its precise mechanics. Consequently, many researchers have cautioned against the exclusive use of absolute results from a PVA in order to promote specific management actions for threatened populations (e.g., Ludwig 1999; Beissinger and McCullough 2002; Reed et al. 2002; Ellner et al. 2002; Lotts et al. 2004). Instead, the true value of an analysis of this type lies in the assembly and critical analysis of the available information on the species and its ecology, and in the ability to compare the quantitative metrics of population performance that emerge from a suite of simulations, with each simulation representing a specific scenario and its inherent assumptions about the available data and a proposed method of population and/or landscape management. Interpretation of this type of output depends strongly upon our knowledge of pronghorn biology, the environmental conditions affecting the species, and possible future changes in these conditions.

The *VORTEX* system for conducting population viability analysis is a flexible and accessible tool that can be adapted to a wide variety of species types and life histories as the situation warrants. The program has been used around the world in both teaching and research applications and is a trusted method for assisting in the definition of practical wildlife management methodologies. For a more detailed explanation of *VORTEX* and its use in population viability analysis, refer to Lacy (2000) and Miller and Lacy (2005).

Primary Questions for PVA Modeling

The Sonoran Pronghorn Recovery Team's Technical Subgroup identified a set of primary questions for which PVA model construction and implementation could be useful in addressing:

1. What are the most sensitive demographic parameters that drive population growth in our simulation models?
2. Can we use the PVA to derive reasonable population abundance estimates to be used as recovery criteria?
3. Is there a genetic "founder effect" that may impact long-term viability of newly established populations like Kofa NWR?
4. What are the relative impacts of linking to a captive program?
5. How long do we need to maintain semi-captive breeding programs?
6. What are the relative impacts of other pronghorn population/habitat management actions?
7. What are the most effective management actions to undertake in Mexico?
8. What are the benefits of demographic linkage between U.S. and Mexico populations?
9. Is a captive program important to augment populations in Mexico?

This report addresses questions 1 and 2; other questions listed above may be addressed in future efforts.

Baseline Input Parameters for Population Viability Simulation Models

Much of the data used to derive input parameters for the population dynamics models discussed were gleaned from Bright and Hervert (2005, 2011), Hosack et al. (2002), and various internal reports compiled by the Arizona Game and Fish Department. When specific published or unpublished data were not available, expert judgment was used to derive appropriate parameter values.

Timestep for all simulations: Since pronghorn reproductive ecology is easily described on an annual basis, we have chosen the timestep for our simulations as one year.

Metapopulation structure: A subset of pronghorn models constructed for this project – namely, those for the Cabeza Prieta and Kofa populations – include a type of "managed metapopulation" structure. Specifically, the existing wild population is linked to its corresponding pen population through managed translocation. More on the specifics of this translocation will be presented in later versions of this report.

Breeding system: Pronghorn are known to display a polygynous breeding system, where a single male may mate with multiple females during a give year. This is simulated in *VORTEX* by allowing adult males to be sampled multiple times as mates for available females.

Age of first offspring: *VORTEX* considers the age of first reproduction as the age at which the first fawn is born, not simply the onset of sexual maturity. Female pronghorn in the wild will successfully produce their first fawn at two years of age. In highly managed pen populations, a few adult females may produce their first fawn at just one year of age.

Maximum age of reproduction: In its simplest form, *VORTEX* assumes that animals can reproduce (at the normal rate) throughout their adult life. We assume here that pronghorn live no more than 13 years in the wild.

Reproductive events per year: We assume that an adult female will produce only once per year, and will produce no more than two fawns in any one reproductive event.

Offspring sex ratio: Without data to the contrary, we assume a 50:50 sex ratio across all fawns produced in a given year.

% Adult females breeding: This describes the average proportion of females that reproduce in a year. We assume that nearly all (specifically, 95%) adult females produce fawns in a given year in the wild. In pen populations, we additionally assume that 5% of all one-year-old fawns will reproduce.

Density dependent reproduction: *VORTEX* can model density dependence with an equation that specifies the proportion of adult females that reproduce as a function of the total population size. In addition to including a more typical reduction in breeding in high-density populations, the user can also model an Allee effect: a decrease in the proportion of females that bread at low population density due, for example, to difficulty in finding mates that are widely dispersed across the landscape.
The equation that *VORTEX* uses to model density dependence is:

$$P(N) = \left(P(0) - \left[\left(P(0) - P(K)\right)\left(\frac{N}{K}\right)^{B}\right]\right)\frac{N}{N+A}$$

in which $P(N)$ is the percent of females that breed when the population size is N, $P(K)$ is the percent that breed when the population is at carrying capacity, and $P(0)$ is the percent breeding when the population is close to zero (in the absence of any Allee effect). The exponent B can be any positive number and determines the shape of the curve relating the percent breeding to population size, as the population becomes large. If $B = 1$, the percent breeding changes linearly with population size. If $B = 2$, $P(N)$ is a quadratic function of N. The parameter A defines the magnitude of the Allee effect.

There appears to be little evidence for strong density dependence in reproduction in wild pronghorn populations. In light of this information, we do not include this process in our models described here.

Environmental variation (EV) in % breeding: Annual environmental variation in female reproductive success is modeled in *VORTEX* by specifying a standard deviation (SD) for the proportion of adult females that successfully produce offspring in a given year. In the absence of specific data on this parameter, we assume that the variation is equal to 3%, thereby producing a full statistical distribution of female breeding rates between 89% - 100% (mean ± 2SD). Given the high rate of reproductive success seen in pronghorn populations, this relative low level of inter-annual variability is thought to be reasonable for this species.

Distribution of litter size: The table below gives the probability of a given breeding female producing a litter of the specified size. These values are based on a mean litter size observed across multiple years of 1.8 fawns per doe (Bright and Hervert).

Number of offspring	Probability (%)
1	20
2	80

Mate monopolization: In many species, some adult males may be socially restricted from breeding despite being physiologically capable. This can be modeled in *VORTEX* by specifying a portion of the total pool of adult males that may be considered “available” for breeding each year. We assume here that pronghorn exhibit this type of social stratification of breeding success, although quantitative data are lacking. In absence of specific data, we assume that only about 60% of adult Sonoran pronghorn are available for breeding in any given year.

Mortality rates: *VORTEX* defines mortality as the annual rate of age-specific death from year x to $x + 1$; in the language of life-table analysis, this is equivalent to $q(x)$. We assume that our model, intended to reflect the current pronghorn populations in Arizona and Sonora, will include the effects of human disturbance among age-specific mortality rates.

Little data exist on accurate estimates of age-specific mortality rates in wild Sonoran pronghorn populations. In light of this, we rely on information from recent pen populations and expert judgment to derive rates that are consistent with general knowledge of pronghorn demography and observed trends in wild population abundance. We assume here that, in wild pronghorn populations, mean fawn mortality is 70% among females and 65% among males. The mechanism explaining this slight increase in female mortality is not yet known. After the high first-year mortality, mean annual mortality declines to a stable rate of approximately 10 – 15%, with slightly higher rates of mortality among males as they endure additional stress from competing amongst each other for access to breeding females.

Captive pen populations experience significantly lower mortality rates through intense active management. To simulate this difference, we assume that fawn mortality in the pens is just 10% for females (5% for males). Subadult and adult rates are set to 5% for both males and females.

We have adjusted simulated mortality rates in Mexico's Quitovac Management Unit to at least partially account for the apparent decline in population abundance observed in this population since a maximum abundance observed in 2004. This assumes, of course, that (i) the observed decline in population abundance as measured by the recent aerial surveys is real, and (ii) increases in both fawn and adult mortality are major factors contributing to the observed decline in abundance. For our initial models here, we assume Quitovac fawn mortality is 80% for females and 70% for males. Female mortality for those individuals age 2+ years is 17%, while male mortality is 15% for subadults and 20% for adults.

Inbreeding depression: *VORTEX* includes the ability to model the detrimental effects of inbreeding, most directly through reduced survival of offspring through their first year. While specific data on inbreeding depression in either captive or wild pronghorn populations are not available for this analysis, the preponderance of evidence for the deleterious impacts of inbreeding in mammal populations suggests that it can be a real factor in small populations. We therefore elected to include this process in our models, with a genetic load of 3.14 lethal equivalents, and with approximately 50% of this load expressed as lethal genes. These values are in accordance with the median value of inbreeding depression severity calculated for captive mammal populations assessed by Ralls et al. (1988).

Catastrophes: Catastrophes are singular environmental events that are outside the bounds of normal environmental variation affecting reproduction and/or survival. Natural catastrophes can be tornadoes, floods, droughts, disease, or similar events. These events are modeled in *VORTEX* by assigning an annual probability of occurrence and a pair of severity factors describing their impact on mortality (across all age-sex classes) and the proportion of females successfully breeding in a given year. These factors range from 0.0 (maximum or absolute effect) to 1.0 (no effect), and in its most basic implementation in *VORTEX*, are imposed during the single year of the catastrophe, after which time the demographic rates rebound to their baseline values.

While pronghorn are surely well-adapted to desert environments, they must also suffer from periods of extremely low rainfall in any given year. The 2002 drought event in southern Arizona and the apparent toll it took on the Cabeza Prieta pronghorn population suggests that this is indeed a realistic addition to our population dynamics model. We have therefore elected to include severe single-year drought as a catastrophe in our models. Specifically, based on simple analysis of recent historic records we assume that a severe drought occurs in this area on average once in approximately ten years. Therefore we set our catastrophe frequency at 10% in all models. For wild populations, we also assume that survival across all pronghorn age classes would drop by approximately 15 – 20% during the year of the drought event. We therefore set our drought survival severity to 0.83; in other words, we expect survival in drought years to be reduced by approximately 17% across all age classes. Because of the intensive management of pen populations, we assume that survival during drought years would decline by only 5% (drought severity = 0.95).

Because of comparatively lower levels of active management of pronghorn populations and their habitat, we assume that the impact of a severe drought event in the two Mexico populations will be greater than in Arizona's Cabeza Prieta and Kofa populations. Specifically, we assume that the drought survival severity factors are 0.75 and 0.65 for the Pinacate and Quitovac populations, respectively.

Initial population size: *VORTEX* operates on a pre-breeding census model; therefore, all models are initialized with animals at least one year of age, i.e., including those youngest individuals that were born the previous breeding cycle and have survived to just before one year of age. Initial abundance estimates for Cabeza Prieta, Pinacate and Quitovac wild populations are based on the latest estimates derived from aerial surveys. The Kofa wild initial abundance is based on the first group of animals translocated to this area in early 2013. Initial abundances for the two pen populations are based on the most recent (April 2013) census data. Initial abundance estimates for each population included in this analysis are given in the table below.

Carrying capacity: How close is a given subpopulation to its maximum, long-term equilibrium abundance – is there an opportunity for the population to grow to a larger size? This is simulated through specifying a given habitat's population carrying capacity, K. The carrying capacity for a given habitat defines an upper limit for the population size, above which additional mortality is imposed randomly across all age classes in order to return the population at the end of a specific timestep to the value set for K.

An estimate for the carrying capacity in the Cabeza Prieta habitat is based on a simple analysis of the size and general habitat quality/availability within the area. Given this simple estimate, carrying capacity estimates for the Kofa, Pinacate and Quitovac populations were scaled appropriately. We assume that the two pen populations are already at carrying capacity through the management of high reproductive output of the available females. Carrying capacity estimates for each population included in this analysis are given in the table below.

Population	**N_0**	**K**
Cabeza Prieta Wild	159	400
Cabeza Prieta Pen	57	57
Kofa Wild	9	700
Kofa Pen	22	25
Pinacate Wild	52	150
Quitovac Wild	189	700

A summary of the population-specific model input for each population is provided in Table 1.

Cabeza Prieta population: Demographic linkage between captive and wild components: Beginning in 2006, pronghorn raised in the Cabeza Prieta pens were used to supplement the wild population that had experienced a dramatic decline during the period 1996 – 2002, most likely due to severe drought impacting both reproductive success and adult survival. Data from AGFD Updates and other sources allow us to estimate that an average of 21 pronghorn were released into Cabeza Prieta each year, in a roughly 2:1 ratio of males to females. To simulate this linkage between the two populations in our PVA, we set up a “metapopulation” model structure with explicit connectivity between the Cabeza Prieta Wild and Pen populations. However, we do not want animals to move between the populations in a stochastic fashion that results from allowing dispersal to control individual movement. To gain more explicit control of animal movement, we used a special feature within Vortex that “harvests” a given number of individuals of a given age-sex cohort from the Wild population, and then uses these same animals to “supplement” the Pen population immediately thereafter. This allows us to more carefully control the specific number, demographic characteristics, and identity of the animals as they transition from pen-reared animals to wild animals occupying the Refuge site.

To generate a simulated population trajectory that is similar to what we have observed in the wild over the period of supplementation, we set the model to remove (”harvest”) each year eight adult females and approximately 14 males (12 yearlings and 2 adults). We also assume a 10% risk of mortality for each individual being translocated from pen to wild; this translates into an average of (0.9)(22) = 20 animals supplemented to the wild each year.

We set the following rules which the software must follow in all translocation scenarios:

1. The total number of adult males and females in the pen must exceed 25 in order for removal to take place
2. There must be at least four adult males in order to trigger the removal of two individuals from this cohort

Iterations and years of projection: All population projections (scenarios) were simulated 1000 times, with each projection extending to 50 years. All simulations were conducted using *VORTEX* version 9.99b (May 2010).

Table 1. Summary of population-specific demographic parameters used as input to Vortex simulation models as part of the Sonoran pronghorn PVA.

Parameter	Cabeza Wild	Cabeza Pen	Kofa Wild	Kofa Pen	Pinacate Wild	Quitovac Wild
Breeding Age (♀/ ♂)	1 / 2	1 / 2	1 / 2	1 / 2	1 / 2	1 / 2
Maximum Age	13	13	13	13	13	13
Broods per Year	1	1	1	1	1	1
Maximum Progeny per Brood	2	2	2	2	2	2
Sex Ratio at Birth (%♂)	50	50	50	50	50	50
Density Dependent Breeding?	No	No	No	No	No	No
% ♀♀ Breeding Annually	Age 2+: 95	Age 1: 5 Age 2+: 95	Age 2+: 95	Age 1: 5 Age 2+: 95	Age 2+: 95	Age 2+: 95
EV (% ♀♀)	3	3	3	3	3	3
Offspring Distribution	1 Fawn: 20% 2 Fawns: 80%	1 Fawn: 20% 2 Fawns: 80%	1 Fawn: 20% 2 Fawns: 80%	1 Fawn: 20% 2 Fawns: 80%	1 Fawn: 20% 2 Fawns: 80%	1 Fawn: 20% 2 Fawns: 80%
Annual Mortality (%) (♀/ ♂)						
Age 0 – 1	70 / 65	10 / 5	70 / 65	10 / 5	70 / 65	80 / 70
Age 1 – 2	12/10	5 / 5	12/10	5 / 5	12/10	17/15
Age 2 +	12 / 15	5 / 5	12 / 15	5 / 5	12 / 15	17 / 20
Drought Catastrophe						
Frequency (%) (Alt 1 / Alt 2)	5/10	5/10	5/10	5/10	5/10	5/10
Severity (Survival)	0.83	0.95	0.83	0.95	0.75	0.65
% ♂♂ in Breeding Pool	60	60	60	60	60	60
Initial Population Size	159	57	9	22	52	189
Carrying Capacity	400	57	700	25	150	700
Inbreeding Depression?	Yes	Yes	Yes	Yes	Yes	Yes
Lethal Equivalents	3.14	3.14	3.14	3.14	3.14	3.14

Results from Simulation Models

Baseline Model Analysis

Separate models were developed for each of the four pronghorn populations (Cabeza Prieta, Kofa, Pinacate, and Quitovac) and, where appropriate, were evaluated initially in a simple manner for their ability to track existing wild population trends estimated from aerial survey data. [Note that the Kofa population is not included in this particular baseline model analysis as the wild population was initiated only in early 2012.] This preliminary analysis is presented in Table 2.

Table 2. Population growth rates inferred from aerial surveys for three Sonoran pronghorn populations currently in the wild, and growth rates calculated from *VORTEX* demographic models constructed using input described in this report. Time period in parentheses associated with observed growth rates indicates the period in which the rates were estimated.

Population	Observed Growth Rate (Dates)	Growth Rate (Model)
Cabeza Prieta (Linked Wild – Pen)	1.09 (2006 – 2012)	1.10
Pinacate	1.10 (2002 – 2011)	1.03
Quitovac	0.89 (2004 – 2011)	0.92

Simulated growth rates for the Cabeza Prieta and Quitovac model populations are very similar to those estimated from data on population trends from aerial surveys. The simulated Pinacate population growth rate is considerably lower than the rate estimated from aerial survey data over the last decade, which will likely require some modification of model input parameters to align the model trajectory more closely to the observed abundance trajectory (assuming, of course, some degree of confidence in the trajectory inferred from the aerial survey data).

Despite some of these population-specific adjustments that may need to be made to simulated model input, it is clear that the model structure and the associated demographic input parameters developed in this project can lead to a reasonable depiction of Sonoran pronghorn population dynamics. It is therefore possible to use this model structure to evaluate comparative sensitivity of model performance to uncertainty in specific demographic input, and to provide preliminary guidance on identifying population abundance thresholds that may relate to long-term species recovery criteria.

Sensitivity Analysis

During the development of the baseline input dataset, it quickly became apparent that a number of demographic characteristics of Sonoran pronghorn populations in Arizona and especially Mexico are highly uncertain. This type of measurement uncertainty, which is distinctly different from the annual variability in demographic rates due to extrinsic environmental stochasticity and other factors, impairs our ability to generate precise predictions of population dynamics with any degree of confidence. Nevertheless, an analysis of the sensitivity of our models to this measurement uncertainty can be an invaluable aid in identifying priorities for detailed research and/or management projects targeting specific elements of the species' population biology and ecology.

A first step in a more broad sensitivity analysis focused on the relative impact of changes in survival of both male and female juveniles (one year old) and adults. A suite of models was constructed using a baseline input dataset similar to a Cabeza Prieta-type population that is not linked to a separate pen population. Numerous scenarios were then built in which individual age/sex-specific survival rates were incrementally changed by 10% or 20% above and below the baseline value of the specific parameter. This systematic perturbation allows for more direct comparison of model results. The output metric of choice for this analysis is the mean stochastic population growth rate calculated directly from the model results.

The results of this analysis are shown as a "spider plot" in Figure 1.

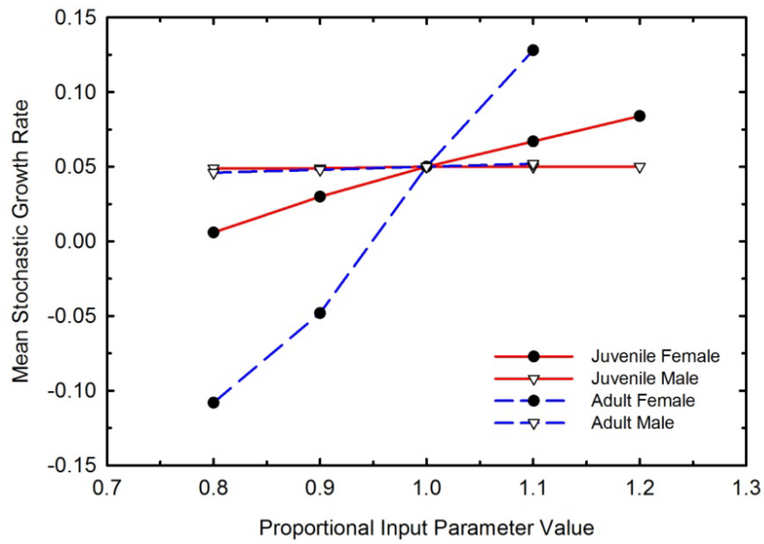

Figure 1. "Spider plot" of stochastic growth rate among alternative demographic models of Sonoran pronghorn population dynamics. See accompanying text for additional information on model structure and interpretation of results.

The central data point in the plot is the population growth rate from the baseline model, with all input parameters at their consensus value. [Note that this growth rate of r = 0.05 is different from that rate reported for the other Cabeza Prieta model in Table 2. This is because we assume an isolated population in this analysis, while the other model assumed explicit connection to the associated pen population.] Other data points in this plot give the population growth rate for a scenario in which male or female juvenile or adult survival is adjusted to 10% or 20% higher or lower than the baseline value.

Figure 1 shows that, on a per-unit basis, changes to adult female survival lead to larger changes in population growth rates than changes of the same magnitude in juvenile female survival. In other words, these results indicate that our models are highly sensitive to changes in adult female survival. In contrast, changes to male survival of either juveniles or adults lead to very small changes in population growth, suggesting considerably lower levels of model sensitivity in these parameters. This type of result is consistent with general principles of population biology, in which relatively long-lived species of mammals with relatively lower levels of reproductive output are characterized by greater importance of adult female survival.

Note that this result is contrary to that reported by Hosack et al. (2002), where the authors identify fawn survival rates as the most sensitive model parameter. The analysis described here is a more rigorous approach to the issue of model sensitivity than that reported in the earlier paper, and the conclusions of Hosack et al. (2002) are not well-supported by the quantitative data presented therein. It is also important to note that those parameters to which a demographic model is most sensitive may **not** be the same parameters that are most directly affected by human activities and are therefore putting the population at risk (e.g., Mills et al. 1999). Successful conservation requires careful additional study to identify the specific risks the populations face and to develop appropriate remedial actions.

Risk Analysis: Derivation of Preliminary Recovery Criteria

In addition to the sensitivity analysis described above, this PVA project was designed to help provide some guidance on the derivation of recovery criteria for individual wild Sonoran pronghorn populations, i.e., those not receiving animals from intensively managed pen populations . Given a Recovery Team definition of “viability” as a probability of population extinction of no more than 10% in 50 years, the PVA model platform can be used to help focus on the long-term population abundance required, given a specific set of demographic characteristics, to maintain extinction risk below the specified threshold. Specifically, we would like to know the population abundance that would be required to minimize the risk of population instability and, ultimately, extinction due to negative effects of stochastic fluctuations in population demographic processes. This process requires, of course, some specification of at least minimum demographic conditions that do not send the population into long-term deterministic decline. In other words, the population must have birth and death rates that confer at least a long-term stochastic growth rate of $r = 0.0$ (or, equivalently, $\lambda = 1.0$).

To begin this analysis, we started with population-specific baseline models, and then constructed a suite of additional scenarios with different combinations of values for initial population size, drought frequency and for adult female mortality – the parameter identified as highly sensitive in our earlier analysis. All other model input parameters were held at their baseline values. The range of initial population size values was bounded roughly by the current size of a given population and a value of at least 50% of the estimated carrying capacity. We elected to evaluate alternative drought frequency estimates of 5% or 10% per year as there is some uncertainty in the true value of this parameter. We used these models to first identify the lowest levels of annual adult female mortality necessary to maintain positive long-term population growth. The results of this analysis are shown in Figure 2.

A comparison of mean stochastic growth rates as a function of drought frequency shows that, not surprisingly, growth rates decline when severe drought occurs more frequently. Moreover, the consequences of more frequent drought are more severe when adult female mortality increases, demonstrating a type of synergistic interaction between these two processes. We also see that, across all existing pronghorn populations, mean stochastic growth rate declines rather strongly as adult female mortality increases. Again this is not surprising, especially given the previously observed sensitivity of these models to small changes in this mortality parameter.

If we adopt a conservative approach to our risk analysis by focusing on those models featuring the relatively higher 10% drought frequency (right column of Figure 2), we can identify a correspondingly conservative threshold value for adult female mortality that is associated at least implicitly with a high probability of long-term population persistence. Under the conditions assessed in these models, both the Cabeza Prieta and Kofa populations demonstrate long-term positive mean growth when the annual adult female mortality rate is no greater than 16%. [Remember that this analysis assumes no linkage between the Cabeza Prieta pen and wild population.] Note that the Kofa surface shows a higher sensitivity to higher levels of mortality than Cabeza Prieta. This is due to the fact that we included smaller initial population size values for the Kofa population – as low as 50 animals – since the current abundance there is considerably smaller than its counterpart at Cabeza Prieta.

The two populations in Mexico show a more restricted range of mortality values that are associated with long-term positive population growth. At 10% drought frequency, positive growth in Pinacate occurs when adult female mortality does not exceed approximately 15%, while positive growth in Quitovac is possible only when annual adult female mortality does not exceed 14%. These more restrictive conditions stem for our assumption that both these population suffer more from a severe drought than those populations farther to the north.

Taken together, these results suggest that a common value of 15% annual adult female mortality is a reasonable threshold to use when assessing population abundance targets as recovery criteria. It is clear, however, that this threshold does not satisfy the conditions necessary for positive population growth in the Quitovac population – and arguably also fails to satisfy the required conditions in the Pinacate population. The applicability of this threshold mortality is highly dependent on the frequency of drought used in the risk analysis – a parameter that is not known with confidence. All in all, it is recognized that for this threshold to apply to Sonoran pronghorn populations in Mexico, more intensive drought management may be required to reduce its demographic impacts.

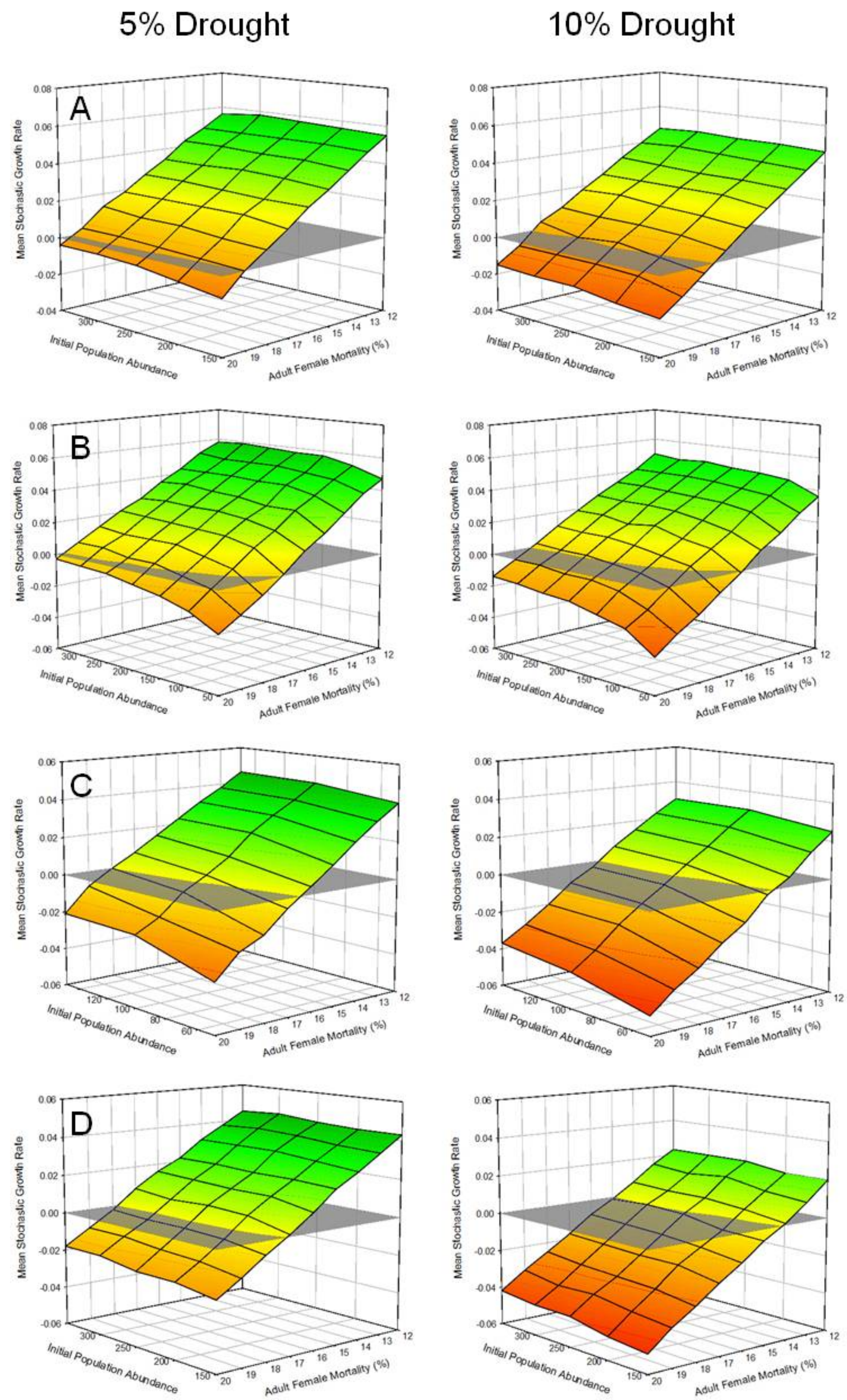

Figure 2. Stochastic growth rate for the four wild populations of Sonoran pronghorn currently in the United States and Mexico. The surfaces show growth rate as a function of both initial population abundance and annual mean adult female mortality, under conditions of relatively lower (left column) or higher (right column) frequency of a drought catastrophe. Gray horizontal plane identifies the region where long-term mean stochastic growth rate is 0.0 A, Cabeza Prieta; B, Kofa; C, Pinacate; D, Quitovac. See text for more information on model structure.

With this information on growth rate thresholds in place, we can then evaluate the extinction risk displayed by our models across the ranges of both initial population sizes and adult female mortality presented previously. These data are presented in Figure 3. It is important to note in these analyses that the initial population size represents the abundance only at the beginning of the simulation, and that each of these populations can grow to their corresponding carrying capacity values as governed by the underlying growth rate – itself a function of the model input parameters and, perhaps most importantly, the adult female mortality rate. Therefore, the initial abundance values are not to be taken as a long-term abundance value but only a starting point for the simulations.

In general, we see that the risk of extinction for all four populations increases with greater drought frequency, higher adult female mortality, and with smaller initial population sizes. Looking at the model results in more detail, we see that the Cabeza Prieta models show extinction risks that fall below the identified 10% threshold for all combinations of initial abundance and adult female mortality. This means that, for example, if the population begins the simulation comprised of 150 individuals – much like the Cabeza Prieta population in 2012 – and if adult female mortality is approximately 15% annually, the population will be able to grow towards its ecological carrying capacity and be buffered against extinction, even when drought is thought to occur more frequently (right-hand column of Figure 3). As adult female mortality increases, the underlying population growth rate for the Cabeza Prieta population will decline and could even become negative which will lead to an associated increase the risk of extinction. However, because of the relatively large initial abundances used in this analysis, the population shows relatively lower extinction risk over the 50 years of the simulation.

The extinction risk surface for the Kofa population shows some important differences in the region of low initial population abundance. This is because we initiated some Kofa population simulations with just 50 individuals since the actual current abundance is just 10-20 animals. This analysis shows us that, even if the carrying capacity for the Kofa habitat is large, a relatively small population in the early stages of establishment in the wild may still be relatively unstable demographically and therefore more prone to extinction – even at moderate levels of adult female mortality. At these moderate mortality rates, this risk drops dramatically to near 0.0 as the initial population size increases to 100 – 150 individuals.

In keeping with the results we saw for the stochastic growth rate analysis presented in Figure 2, the two populations in Mexico demonstrate considerably higher risks of extinction under a greater range of demographic characteristics. The Pinacate population shows consistently higher extinction risks across nearly the full range of conditions modeled in this analysis. An important factor in understanding these results is the relatively restricted carrying capacity of this habitat, which restricts the long-term population abundance. This is particularly important when also considering our assumption of relatively greater sensitivity of this population to the detrimental effects of severe drought in the absence of intensive population management to mitigate its effects. Under the range of conditions evaluated here, the Pinacate population shows acceptable levels of extinction risk with an initial population size of no less than 100 individuals.

The extinction risk surface for the Quitovac population is qualitatively similar to that for the Cabeza Prieta population, but the actual risk values are considerably higher because of the drought sensitivity defining these models. While extinction probabilities approach 30% for the highest adult female mortality values, our threshold rate of 15% leads to extinction risks that fall below the 10% viability threshold for all initial population sizes – although the smallest initial abundance of 150 individuals confers a risk of nearly 5% over the timeframe of the simulation. Once again, the presumed severe impact of drought in these southern populations means comparatively larger estimates of long-term population abundance required to achieve the desired level of viability.

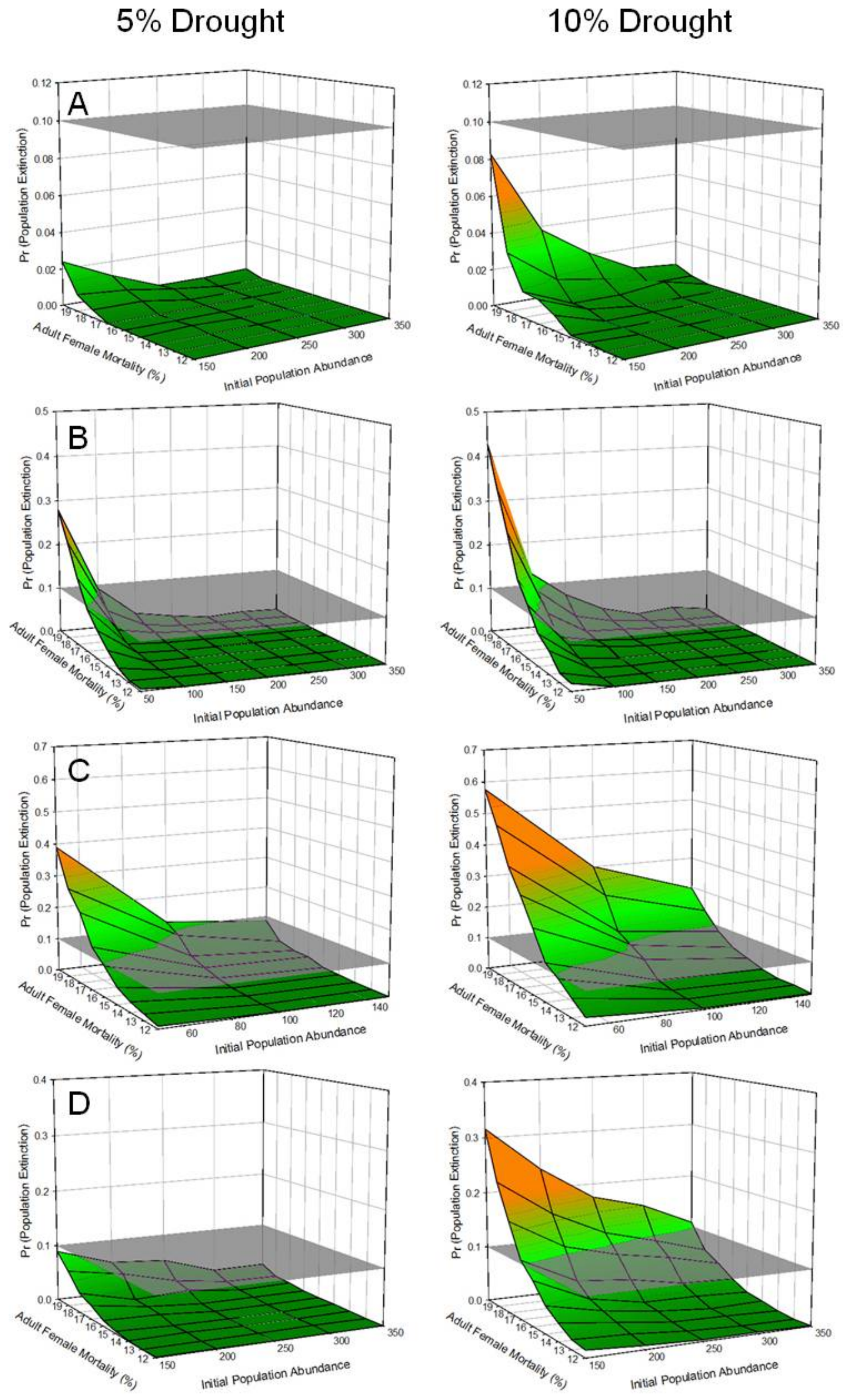

Figure 3. Extinction risk over the 50-year simulation timeframe for the four wild populations of Sonoran pronghorn currently in the United States and Mexico. The surfaces show extinction risk as a function of both initial population abundance and annual mean adult female mortality, under conditions of relatively lower (left column) or higher (right column) frequency of a drought catastrophe. Gray horizontal plane identifies the 10% risk threshold identified as minimal conditions for population viability. A, Cabeza Prieta; B, Kofa; C, Pinacate; D, Quitovac. See text for more information on model structure.

From this demographic analysis, and given the assumption that a management strategy is in place to maintain average adult female mortality at levels that would support population growth, it is possible to derive minimum pronghorn population abundance estimates that confer long-term demographic stability and can therefore be used as preliminary population recovery criteria, in accordance with the Recovery Team definition of population viability. Abundance estimates for the Mexico populations require additional comment. The Pinacate estimate may appear relatively low in comparison to other populations and thus may be interpreted as indicative of relatively greater population stability. This is not the case; the target abundance for this population will likely be constrained by the habitat carrying capacity. Consequently, the lower amount of habitat available to the Pinacate population may require more dedicated management activity to maintain high levels of long-term population stability. Similarly, a large abundance estimate for Quitovac would reflect that population's comparatively higher levels of instability, based on the expert judgment of species experts participating in this analysis and the preliminary observations of strong declines in pronghorn abundance over the past decade.

The model output used to create Figures 2 and 3 are presented in Appendix I.

Additional Notes on Model Structure

Two issues are of particular importance in our discussions of the results presented here. Firstly, it is important to remember that despite considerable effort directed at better understanding Sonoran pronghorn population abundance and demography, the models described here are based on knowledge that remains incomplete. This is especially true for the Pinacate and Quitovac populations in Mexico, for which few relevant population-level studies have been initiated. Consequently, it may be prudent to adopt a conservative and precautionary approach to assigning recovery criteria for these populations in the face of considerable uncertainty. This approach may take the form of adding a buffer to abundance targets, perhaps as a proportion of the minimum abundance estimates derived from the simulation modeling exercise.

Secondly, the issue of climate change may be of special importance when trying to understand the future dynamics of desert wildlife populations. For example, a recent study on sensitivity of various species in Arizona to climate change (Bagne and Finch 2012) concludes that Sonoran pronghorn may be among the most vulnerable species to the detrimental impact of climate change. Early efforts in this PVA project (not reported here) have attempted to explore the potential mechanisms by which climate change in the southwestern United States and northern Mexico may impact Sonoran pronghorn population demography. While speculative, the analyses provide a framework within which hypotheses can be formulated and tested, thereby possibly helping to guide species management within a critically important adaptive framework. Additionally, consideration of the future destabilizing impacts of large-scale ecological processes such as climate change may prompt the species Recovery Team to further buffer recovery criteria abundance estimates. Future work on this issue, in both research and management contexts, may be beneficial to developing more effective long-term Sonoran pronghorn conservation strategies.

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Appendices

Appendix A. Additional Drought Simulation Model Analysis

After completing the original PVA report in February 2014, a request was made to further investigate the impact of drought on Sonoran pronghorn population dynamics. Specifically, the team wanted to look at the impact of drought that was more frequent than the events originally modeled. To satisfy this request, a third set of drought analysis models were created with the frequency of drought (defined here as probability of occurrence in a given year) increased from the original values of 5% and 10% per year to 15% per year. This frequency is more in line with recent observations of drought in the region of existing Sonoran pronghorn habitat, where such severe rainfall deficit events have occurred about once every 6 – 7 years since 1992.

All new models were constructed in a manner identical to the original models described in this report, with the exception of changing the probability of drought to 15% per year for each of the four populations studied in this analysis. The impact of drought in each specific population was not altered.

As expected, an increase in the frequency of drought reduces mean stochastic growth rate (Figure A1; Tables A1 – A4) in all scenarios. Under the assumption of this higher drought frequency, the Cabeza Prieta population shows a positive mean population growth rate when mean annual adult female mortality is no greater than about 16%. Similarly, the Kofa population shows a positive growth rate when adult female mortality does not exceed 15-16%, with the greatest sensitivity to mortality seen at the lowest initial population sizes. In contrast to the US populations, the two Mexico populations show significantly lower growth rates at higher drought frequencies. The Pinacate population shows positive mean annual growth rates only at the lowest mortality rates tested here, at 12-13%, while the Quitovac population shows negative mean growth rates at all tested combinations of initial population size and mean annual adult female mortality. These results are driven in large part by the assumption of greater drought impact in these two populations.

In a manner similar to that seen for population growth, an increase in drought frequency also increases the risk of population extinction in all scenarios (Figure A2; Tables A5 – A8). The Pinacate and Quitovac populations in Mexico show the greatest increase in risk, again largely due to the assumption of a greater impact of drought in these areas that see relatively lower levels of active habitat and population management compared to their counterpart populations in the United States.

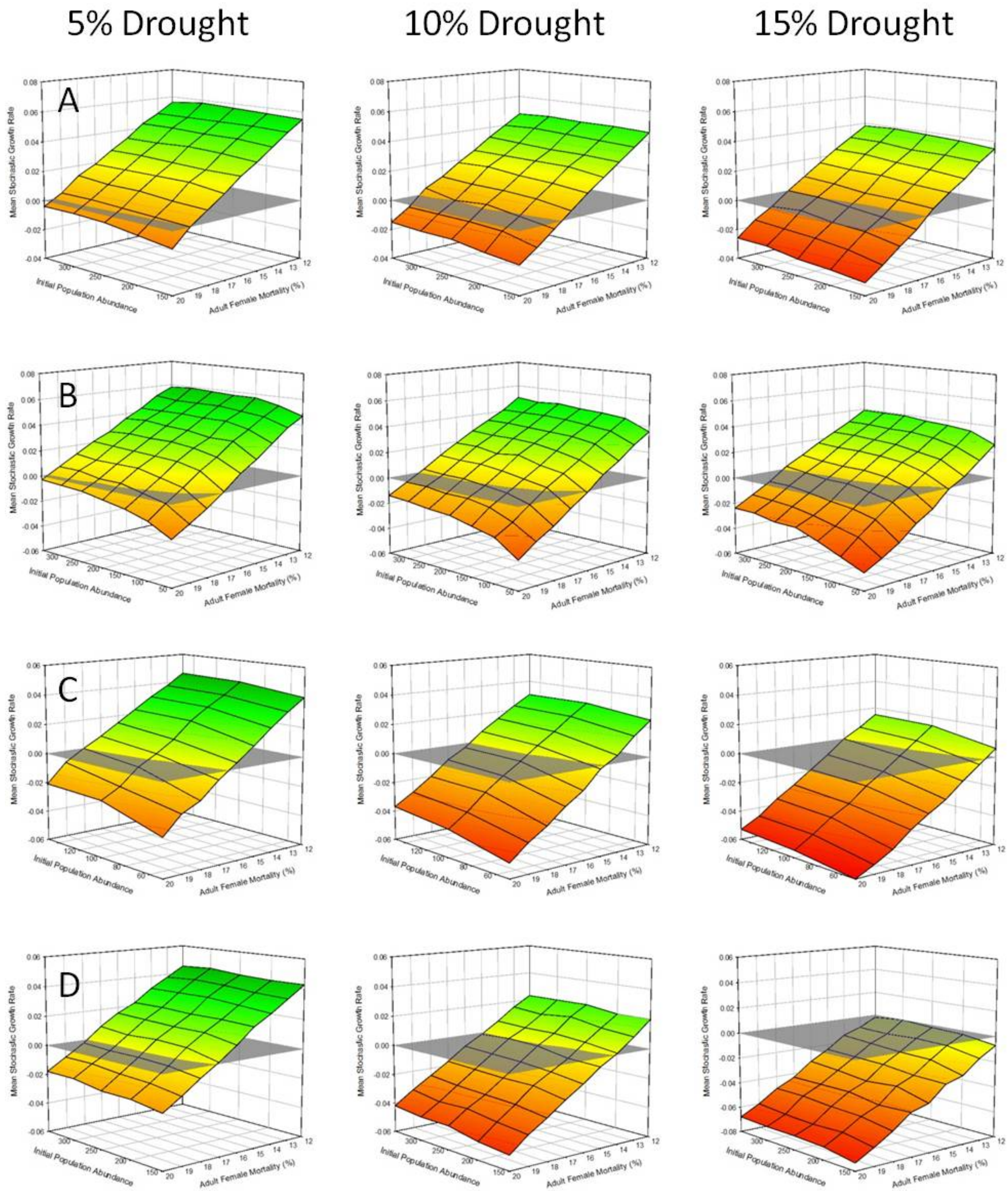

Figure A1. Mean stochastic growth rate over the 50-year simulation timeframe for the four wild populations of Sonoran pronghorn currently in the United States and Mexico. The surfaces show growth rate as a function of both initial population abundance and annual mean adult female mortality, under alternative assumptions of drought frequency (probability of occurrence: 5% (left column), 10% (middle column) or 15% (right column). Gray horizontal plane identifies the region where long-term mean stochastic growth rate is 0.0. Top row (A), Cabeza Prieta; second row (B), Kofa; third row (C), Pinacate; bottom row (D), Quitovac. See text for more information on model structure.

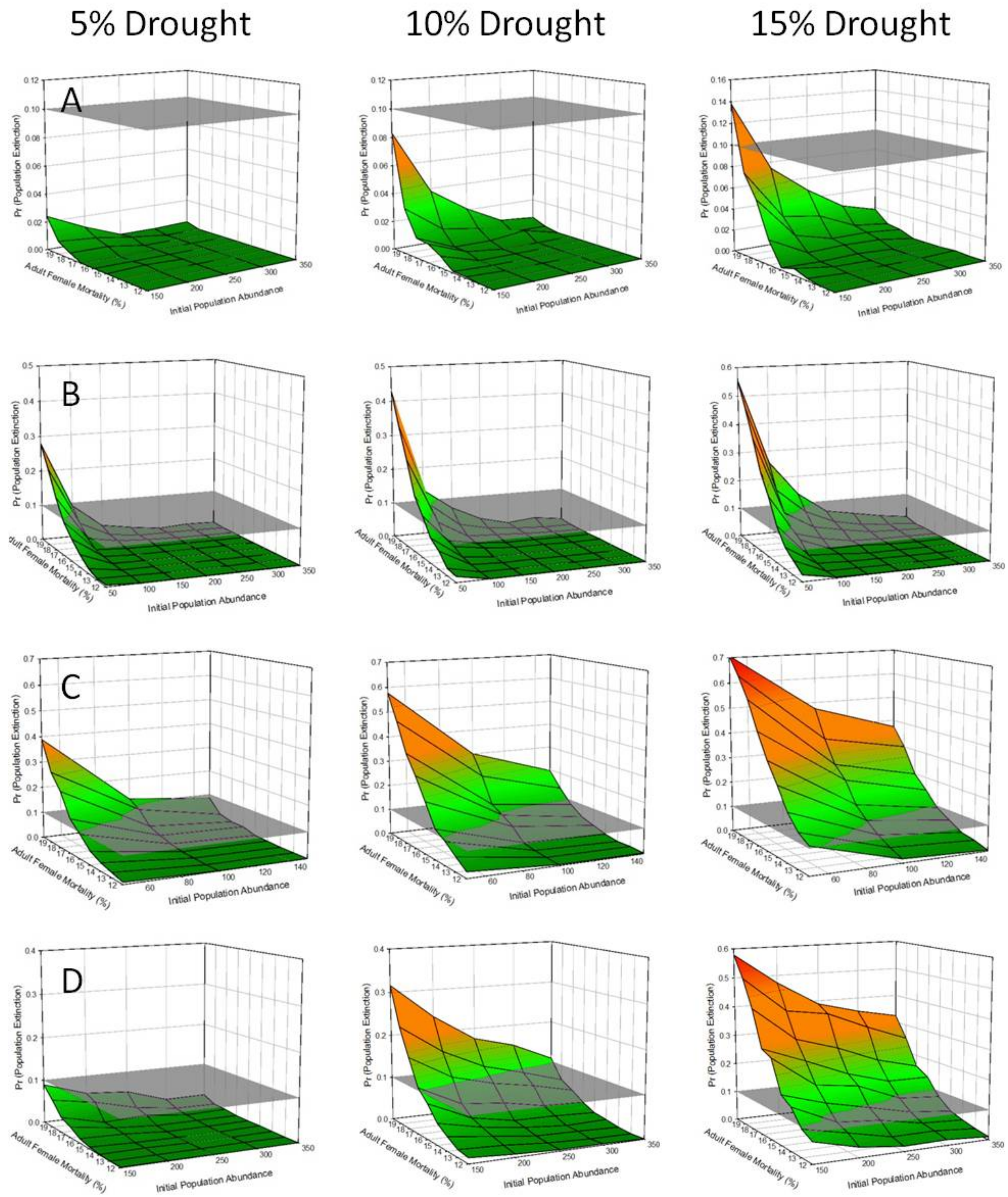

Figure A2. Extinction risk over the 50-year simulation timeframe for the four wild populations of Sonoran pronghorn currently in the United States and Mexico. The surfaces show extinction risk as a function of both initial population abundance and annual mean adult female mortality, under alternative assumptions of drought frequency (probability of occurrence: 5% (left column), 10% (middle column) or 15% (right column). Gray horizontal plane identifies the region where long-term mean stochastic growth rate is 0.0. Top row (A), Cabeza Prieta; second row (B), Kofa; third row (C), Pinacate; bottom row (D), Quitovac. See text for more information on model structure.

Table A1a. Mean stochastic population growth rates for a simulated Cabeza Prieta Sonoran pronghorn population with the assumption of a 5% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
150	0.055	0.048	0.040	0.032	0.025	0.016	0.008	0.000	-0.011
200	0.056	0.049	0.042	0.035	0.025	0.019	0.009	0.001	-0.008
250	0.057	0.049	0.042	0.035	0.026	0.019	0.011	0.002	-0.005
300	0.058	0.049	0.043	0.034	0.027	0.019	0.011	0.003	-0.004
350	0.056	0.049	0.043	0.034	0.027	0.019	0.013	0.003	-0.004

Table A1b. Mean stochastic population growth rates for a simulated Cabeza Prieta Sonoran pronghorn population with the assumption of a 10% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
150	0.046	0.038	0.030	0.022	0.014	0.005	-0.004	-0.013	-0.021
200	0.047	0.039	0.031	0.025	0.016	0.008	-0.001	-0.008	-0.019
250	0.047	0.040	0.031	0.025	0.017	0.009	0.002	-0.007	-0.016
300	0.048	0.041	0.032	0.025	0.019	0.009	0.000	-0.007	-0.016
350	0.047	0.040	0.033	0.025	0.019	0.010	0.004	-0.007	-0.016

Table A1c. Mean stochastic population growth rates for a simulated Cabeza Prieta Sonoran pronghorn population with the assumption of a 15% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
150	0.035	0.028	0.019	0.012	0.004	-0.007	-0.015	-0.024	-0.032
200	0.037	0.029	0.021	0.013	0.005	-0.004	-0.011	-0.020	-0.030
250	0.038	0.029	0.022	0.015	0.005	-0.002	-0.01	-0.018	-0.029
300	0.039	0.031	0.024	0.015	0.007	0.000	-0.007	-0.017	-0.026
350	0.038	0.031	0.024	0.016	0.008	0.000	-0.009	-0.016	-0.026

Table A2a. Mean stochastic population growth rates for a simulated Kofa Sonoran pronghorn population with the assumption of a 5% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
50	0.047	0.040	0.030	0.020	0.012	0.001	-0.008	-0.017	-0.025
100	0.053	0.046	0.038	0.031	0.021	0.013	0.003	-0.006	-0.016
150	0.057	0.048	0.042	0.031	0.025	0.017	0.007	-0.002	-0.011
200	0.057	0.050	0.042	0.034	0.027	0.018	0.011	0.002	-0.008
250	0.058	0.050	0.043	0.035	0.027	0.019	0.011	0.002	-0.005
300	0.059	0.050	0.043	0.037	0.028	0.020	0.011	0.005	-0.004
350	0.058	0.053	0.043	0.036	0.027	0.021	0.013	0.005	-0.003

Table A2b. Mean stochastic population growth rates for a simulated Kofa Sonoran pronghorn population with the assumption of a 10% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
50	0.036	0.028	0.018	0.010	-0.001	-0.010	-0.020	-0.028	-0.038
100	0.044	0.036	0.028	0.018	0.010	0.002	-0.008	-0.018	-0.026
150	0.046	0.038	0.031	0.022	0.013	0.005	-0.003	-0.011	-0.022
200	0.047	0.040	0.032	0.025	0.018	0.008	-0.001	-0.008	-0.018
250	0.049	0.041	0.033	0.026	0.016	0.010	0.001	-0.008	-0.017
300	0.048	0.041	0.034	0.026	0.019	0.010	0.001	-0.006	-0.015
350	0.050	0.041	0.034	0.027	0.019	0.011	0.002	-0.006	-0.014

Table A2c. Mean stochastic population growth rates for a simulated Kofa Sonoran pronghorn population with the assumption of a 15% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
50	0.026	0.016	0.006	-0.001	-0.013	-0.021	-0.032	-0.040	-0.047
100	0.034	0.024	0.016	0.008	-0.001	-0.009	-0.019	-0.029	-0.040
150	0.036	0.028	0.019	0.013	0.004	-0.005	-0.015	-0.025	-0.033
200	0.037	0.030	0.022	0.015	0.006	-0.002	-0.013	-0.021	-0.027
250	0.039	0.030	0.023	0.016	0.006	-0.002	-0.010	-0.018	-0.027
300	0.039	0.031	0.024	0.016	0.007	0.000	-0.008	-0.017	-0.024
350	0.039	0.031	0.024	0.017	0.009	0.002	-0.008	-0.016	-0.024

Table A3a. Mean stochastic population growth rates for a simulated Pinacate Sonoran pronghorn population with the assumption of a 5% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
50	0.040	0.032	0.023	0.013	0.004	-0.005	-0.016	-0.022	-0.034
100	0.045	0.037	0.030	0.022	0.011	0.003	-0.004	-0.015	-0.022
150	0.046	0.038	0.031	0.023	0.015	0.007	0.000	-0.008	-0.021

Table A3b. Mean stochastic population growth rates for a simulated Pinacate Sonoran pronghorn population with the assumption of a 10% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
50	0.025	0.016	0.005	-0.002	-0.014	-0.022	-0.032	-0.040	-0.020
100	0.030	0.022	0.013	0.005	-0.004	-0.012	-0.021	-0.032	-0.041
150	0.030	0.023	0.015	0.007	-0.003	-0.010	-0.020	-0.029	-0.037

Table A3c. Mean stochastic population growth rates for a simulated Pinacate Sonoran pronghorn population with the assumption of a 15% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
50	0.006	-0.003	-0.012	-0.022	-0.029	-0.3037	-0.047	-0.054	-0.060
100	0.014	0.005	-0.004	-0.013	-0.021	-0.031	-0.038	-0.047	-0.055
150	0.015	0.007	0.000	-0.010	-0.019	-0.028	-0.036	-0.046	-0.053

Table A4a. Mean stochastic population growth rates for a simulated Quitovac Sonoran pronghorn population with the assumption of a 5% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
150	0.043	0.035	0.027	0.020	0.010	0.001	-0.007	-0.016	-0.024
200	0.043	0.036	0.029	0.021	0.014	0.006	0.004	-0.013	-0.021
250	0.044	0.038	0.031	0.021	0.014	0.007	-0.003	-0.012	-0.021
300	0.046	0.039	0.031	0.022	0.015	0.006	-0.003	-0.010	-0.018
350	0.045	0.038	0.031	0.022	0.016	0.008	-0.002	-0.010	-0.018

Table A4b. Mean stochastic population growth rates for a simulated Quitovac Sonoran pronghorn population with the assumption of a 10% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
150	0.020	0.010	0.001	-0.006	-0.015	-0.023	-0.032	-0.040	-0.05
200	0.020	0.012	0.004	-0.005	-0.012	-0.019	-0.029	-0.038	-0.048
250	0.023	0.016	0.006	-0.001	-0.010	-0.019	-0.028	-0.035	-0.044
300	0.023	0.014	0.006	0.000	-0.009	-0.018	-0.027	-0.036	-0.044
350	0.023	0.016	0.007	-0.001	-0.008	-0.017	-0.025	-0.033	-0.024

Table A4c. Mean stochastic population growth rates for a simulated Quitovac Sonoran pronghorn population with the assumption of a 15% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
150	-0.007	-0.015	-0.026	-0.030	-0.042	-0.046	-0.057	-0.066	-0.074
200	-0.003	-0.010	-0.019	-0.029	-0.035	-0.047	-0.0536	-0.062	-0.070
250	-0.002	-0.009	-0.018	-0.026	-0.037	-0.043	-0.052	-0.063	-0.069
300	0.000	-0.010	-0.016	-0.025	-0.034	-0.043	-0.050	-0.062	-0.069
350	-0.002	-0.009	-0.014	-0.024	-0.032	-0.043	-0.050	-0.060	-0.068

Table A5a. Extinction probabilities for a simulated Cabeza Prieta Sonoran pronghorn population with the assumption of a 5% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
150	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.009	0.024
200	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.007	0.012
250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.002
300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002
350	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003

Table A5b. Extinction probabilities for a simulated Cabeza Prieta Sonoran pronghorn population with the assumption of a 10% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
150	0.000	0.000	0.000	0.001	0.008	0.013	0.014	0.032	0.083
200	0.000	0.000	0.000	0.000	0.000	0.003	0.003	0.013	0.038
250	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.009	0.021
300	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.002	0.008
350	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.006

Table A5c. Extinction probabilities for a simulated Cabeza Prieta Sonoran pronghorn population with the assumption of a 15% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). Numbers in red denote growth rates that exceed the identified extinction threshold of 0.10. See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
150	0.000	0.000	0.002	0.006	0.002	0.023	0.056	0.077	0.138
200	0.000	0.000	0.000	0.001	0.001	0.005	0.017	0.031	0.074
250	0.000	0.000	0.000	0.000	0.002	0.006	0.008	0.026	0.048
300	0.000	0.000	0.000	0.000	0.000	0.005	0.008	0.011	0.027
350	0.000	0.000	0.001	0.000	0.000	0.000	0.005	0.007	0.018

Table A6a. Extinction probabilities for a simulated Kofa Sonoran pronghorn population with the assumption of a 5% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). Numbers in red denote growth rates that exceed the identified extinction threshold of 0.10. See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
50	0.005	0.004	0.013	0.034	0.061	0.093	0.148	0.260	0.279
100	0.000	0.002	0.000	0.001	0.004	0.007	0.024	0.053	0.091
150	0.000	0.000	0.000	0.000	0.000	0.002	0.009	0.012	0.025
200	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.002	0.011
250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002
300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.005
350	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003

Table A6b. Extinction probabilities for a simulated Kofa Sonoran pronghorn population with the assumption of a 10% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). Numbers in red denote growth rates that exceed the identified extinction threshold of 0.10. See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
50	0.016	0.021	0.050	0.070	0.117	0.159	0.250	0.335	0.428
100	0.000	0.001	0.004	0.009	0.022	0.024	0.062	0.099	0.131
150	0.000	0.000	0.000	0.000	0.009	0.008	0.013	0.033	0.070
200	0.000	0.000	0.001	0.000	0.002	0.001	0.009	0.014	0.029
250	0.000	0.000	0.000	0.000	0.002	0.001	0.004	0.006	0.008
300	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.016
350	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.001	0.005

Table A6c. Extinction probabilities for a simulated Kofa Sonoran pronghorn population with the assumption of a 15% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). Numbers in red denote growth rates that exceed the identified extinction threshold of 0.10. See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
50	0.022	0.047	0.071	0.123	0.204	0.270	0.373	0.468	0.554
100	0.003	0.002	0.007	0.014	0.048	0.053	0.107	0.172	0.258
150	0.001	0.001	0.002	0.008	0.007	0.024	0.047	0.085	0.135
200	0.001	0.000	0.001	0.000	0.008	0.006	0.027	0.040	0.062
250	0.000	0.000	0.000	0.001	0.002	0.002	0.010	0.019	0.044
300	0.001	0.000	0.000	0.000	0.000	0.002	0.006	0.011	0.026
350	0.000	0.000	0.000	0.000	0.001	0.001	0.003	0.002	0.013

Table A7a. Extinction probabilities for a simulated Pinacate Sonoran pronghorn population with the assumption of a 5% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). Numbers in red denote growth rates that exceed the identified extinction threshold of 0.10. See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
50	0.008	0.019	0.031	0.051	0.093	0.131	0.218	0.275	0.389
100	0.001	0.003	0.003	0.005	0.005	0.026	0.043	0.091	0.117
150	0.000	0.000	0.000	0.003	0.003	0.020	0.021	0.033	0.084

Table A7b. Extinction probabilities for a simulated Pinacate Sonoran pronghorn population with the assumption of a 10% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). Numbers in red denote growth rates that exceed the identified extinction threshold of 0.10. See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
50	0.025	0.057	0.092	0.119	0.205	0.288	0.361	0.475	0.577
100	0.004	0.009	0.014	0.023	0.067	0.094	0.120	0.120	0.301
150	0.003	0.007	0.006	0.015	0.031	0.047	0.082	0.082	0.196

Table A7c. Extinction probabilities for a simulated Pinacate Sonoran pronghorn population with the assumption of a 15% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). Numbers in red denote growth rates that exceed the identified extinction threshold of 0.10. See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
50	0.109	0.137	0.191	0.273	0.350	0.446	0.556	0.637	0.707
100	0.016	0.037	0.064	0.100	0.143	0.224	0.271	0.361	0.474
150	0.004	0.021	0.031	0.061	0.092	0.148	0.199	0.300	0.373

Table A8a. Extinction probabilities for a simulated Quitovac Sonoran pronghorn population with the assumption of a 5% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
150	0.001	0.000	0.001	0.004	0.010	0.024	0.034	0.063	0.089
200	0.001	0.000	0.002	0.001	0.008	0.010	0.011	0.047	0.058
250	0.000	0.000	0.000	0.000	0.001	0.003	0.016	0.023	0.051
300	0.000	0.001	0.000	0.000	0.001	0.003	0.005	0.010	0.021
350	0.000	0.000	0.001	0.002	0.002	0.003	0.007	0.009	0.022

Table A8b. Extinction probabilities for a simulated Quitovac Sonoran pronghorn population with the assumption of a 10% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). Numbers in red denote growth rates that exceed the identified extinction threshold of 0.10. See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
150	0.013	0.017	0.032	0.049	0.081	0.106	0.165	0.227	0.316
200	0.007	0.013	0.020	0.028	0.037	0.058	0.110	0.161	0.236
250	0.003	0.005	0.008	0.015	0.019	0.049	0.085	0.116	0.175
300	0.003	0.001	0.006	0.007	0.018	0.031	0.069	0.091	0.150
350	0.001	0.000	0.003	0.009	0.014	0.028	0.047	0.063	0.108

Table A8c. Extinction probabilities for a simulated Quitovac Sonoran pronghorn population with the assumption of a 15% frequency of drought. Each growth rate corresponds to a scenario defined by a specific value for the initial population size (left-hand column) and the mean annual adult female mortality rate (column headings). Numbers in red denote growth rates that exceed the identified extinction threshold of 0.10. See report text for additional information on model construction and input parameterization.

	Adult Female Mortality Rate (%)								
N_0	12	13	14	15	16	17	18	19	20
150	0.071	0.092	0.145	0.168	0.274	0.291	0.414	0.506	0.597
200	0.034	0.061	0.078	0.124	0.169	0.236	0.298	0.385	0.474
250	0.017	0.029	0.066	0.092	0.150	0.177	0.254	0.364	0.389
300	0.019	0.030	0.038	0.059	0.091	0.136	0.197	0.304	0.352
350	0.010	0.019	0.031	0.045	0.080	0.135	0.161	0.251	0.324

Appendix E. Threats Indicators For Delisting And Downlisting

The following list includes indicators of each threat to Sonoran pronghorn habitat quality referenced in Criteria #3. The list was developed by referencing the conceptual models (Appendix A) for threats and indirect threats. It does not include uncertain or minor threats (i.e. poaching and disease). It also does not include indices for threats which cannot be abated as part of Sonoran pronghorn recovery actions (threats caused by weather or climate change). The list also does not include indices for the threats of habitat loss or fragmentation (which are discussed separately in Criteria #2) or human disturbance (discussed separately in criteria #4).

<u>Threats Indicators:</u>

1. Number or length of barriers to pronghorn, including fences, roads, railroads, and canals.
2. Number of annual canal-related incidences.
3. Distance between water sources.
4. Number of livestock, particularly in the Mexico Conservation Unit.
5. Area with livestock utilization rates that have negatively affected quality of Sonoran pronghorn forage.
6. Area with fire frequencies outside the natural range of variation.
7. Spread of invasive plants (area by species).
8. Extent (area) of native shrub invasions (e.g., Creosotebush).
9. Altered runoff patterns due to infrastructure such as roads and bridges (area or length).
10. Miles of new drag roads and undesignated vehicle routes.

Appendix F. Threats Tracking Table

Threat - stress	Threat - source	Population	Recovery Criteria	Recovery Actions (from recovery action outline)
Listing Factor A: Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range				
Habitat loss	All sources	All	2	All of 2.1. Assess the quantity and quality of habitat. All of 2.2. Protect and/or increase the amount of existing habitat range-wide. All of 2.3. Prevent or minimize the loss of habitat to land use impacts. All of 2.4. Implement environmental services, employment programs, rural development programs in priority conservation areas in Sonora, and limit and/or regulate activities and infrastructure that can threaten those areas.
	Mining	Cabeza Kofa Sauceda	2	2.3.2.2. Work with authorities in the U.S. to prevent, minimize, and/or mitigate habitat loss or future detrimental land use changes.
	Mining	Quitovac	2	2.2.4.3. Work with La Herradura and Noche Buena mines to restore Sonoran pronghorn habitat. 2.3.1. Cooperate with La Herradura mine on their mining plan to prevent and minimize habitat loss. 2.3.2.1 Work with agencies and authorities (federal, state, municipal) to monitor, prevent, minimize, and/or mitigate habitat loss or future detrimental land use changes in Mexico. 2.3.3. Monitor hectares (acres) of Sonoran pronghorn habitat lost and extent of habitat fragmentation caused by all land uses by land use type.

Threat - stress	Threat - source	Population	Recovery Criteria	Recovery Actions (from recovery action outline)
	Agriculture	Pinacate	2	2.2.1.1. Expand Pinacate core area. 2.3.2.1. Work with agencies and authorities (federal, state, municipal) to monitor, prevent, minimize, and/or mitigate habitat loss or future land use changes in Mexico. 2.3.3. Monitor hectares (acres) of Sonoran pronghorn habitat lost and extent of habitat fragmentation caused by all land uses by land use type. 2.4. Implement environmental services, employment programs, and rural development programs in priority conservation areas in Sonora, and limit and/or regulate activities and infrastructure that can threaten those areas.
	Agriculture	Quitovac	2	2.2.1.2. Create a protected reserve in the Quitovac Management Unit. 2.3.2.1. Work with agencies and authorities (federal, state, municipal) to monitor, prevent, minimize, and/or mitigate future land use changes in Mexico. 2.2.4.1. Identify and prioritize areas where restoration is needed. 2.2.4.2. Restore and protect potential Sonoran pronghorn habitat that is highly degraded. 2.2.5. Promote the conservation and protection of ANPs and UMAs. 2.2.6. Ask existing UMAs to incorporate Sonoran pronghorn in their list of protected animals. 2.4. Implement environmental services, employment programs, and rural development programs in priority conservation areas in Sonora, and limit and/or regulate activities and infrastructure that can threaten those areas.
	Livestock grazing	Pinacate	2	2.2.1.1. Expand Pinacate core area. 2.4. Implement environmental services, employment programs, and rural development programs in priority conservation areas in Sonora, and limit and/or regulate activities and infrastructure that can threaten those areas.
	Livestock grazing	Quitovac	2	2.2.1.2. Create protected reserve(s) for Sonoran pronghorn in the Quitovac management unit. 2.2.1.3. Identify and designate priority conservation areas (Area Prioritaria para la Conservacion-CONANP/CONABIO) or State designation for the conservation of pronghorn. 2.4. Implement environmental services, employment programs, and rural development programs in priority conservation areas in Sonora, and limit and/or regulate activities and infrastructure that can threaten those areas. 2.2.5. Promote the conservation and protection of ANPS and UMAS.

Threat - stress	Threat - source	Population	Recovery Criteria	Recovery Actions (from recovery action outline)
				2.2.6. Ask existing UMAS to incorporate Sonoran pronghorn in their list of protected animals.
	Renewable energy	Kofa	2	2.2.2. Acquire more land for Sonoran pronghorn conservation in the U.S. 2.2.3. Protect, through appropriate laws, regulations, and policies, Sonoran pronghorn habitat in the U.S. 2.3.3. Monitor hectares (acres) of Sonoran pronghorn habitat lost and extent of Sonoran pronghorn habitat fragmentation caused by all land uses by land use type.
Habitat fragmentation	All sources	All	2	All of 2.6. Protect and/or improve the connectivity of habitat. 2.3.3. Monitor hectares (acres) of Sonoran pronghorn habitat lost and extent of habitat fragmentation caused by all land uses by land use type. 2.4. Implement environmental services, employment programs, rural development programs in priority conservation areas in Sonora, and limit and/or regulate activities and infrastructure that can threaten those areas.
	Habitat conversion (caused by agriculture, mining, livestock grazing)	All	2	2.6.1.5. Protect corridors used for seasonal movements. All of 2.6.3. Minimize current and avoid future Sonoran pronghorn habitat fragmentation. 2.3.2. Work with agencies and authorities (federal, state, municipal) to monitor, prevent, minimize, and/or mitigate habitat loss or future detrimental land use changes.
	Physical barriers (highways, fences, canals, railroads)	All	2	All of 2.6.1. Improve habitat connectivity where impeded by barriers. All of 2.6.2. Prevent creation and/or minimize impacts of new barriers.
	Human disturbance	All	2,4	See actions associated with Human disturbance threat.
Reduced forage quality	All sources	All	3	All of 2.7. Enhance forage quality and availability to support viable populations of Sonoran pronghorn range-wide. 2.4. Implement environmental services, employment programs, rural development programs in priority conservation areas in Sonora, and limit and/or regulate activities and infrastructure that can threaten those areas. 2.5.8 Establish Best Management Practices (BMPs) for U.S. projects on BLM land, to minimize the impacts of projects on Sonoran pronghorn habitat quality.

Threat - stress	Threat - source	Population	Recovery Criteria	Recovery Actions (from recovery action outline)
	Invasive plant species	All	3	2.5.4. Avoid and minimize impacts on Sonoran pronghorn habitat quality from adjacent projects. 2.5.3.2 Manage invasive non-native plant species.
	Livestock grazing	Quitovac Pinacate Kofa Sauceda	3	All of 2.5.1. Limit livestock grazing where it impacts Sonoran pronghorn habitat. All of 2.5.2. Reduce impacts of livestock grazing where it will occur. 2.5.3.1. Remove feral burros, goats, cattle, and horses.
	Increased cover of creosote	All	3	No actions for this source.
	Lack of pollination of forage species	All	3	No actions for this source.
	Trails/routes (trampling/killing forage species)	Quitovac Cabeza		2.5.9. Minimize impacts of off-road racing in Sonora on Sonoran pronghorn habitat. 2.5.5. Minimize and mitigate impacts of border-related activity on Sonoran pronghorn habitat
	Altered hydrology	All	3	2.5.4. Avoid and minimize impacts on Sonoran pronghorn habitat quality from adjacent projects. 2.5.5. Minimize and mitigate impacts of border-related activity on Sonoran pronghorn habitat. 2.5.6. Reduce the impacts of mines (e.g., La Herradura) on Sonoran pronghorn habitat quality. 2.5.7. Reduce the negative impacts of agriculture on Sonoran pronghorn habitat quality. 2.5.9. Minimize impacts of off-road racing in Sonora on Sonoran pronghorn habitat.
	Erosion	All	3	2.5.4. Avoid and minimize impacts on Sonoran pronghorn habitat quality from adjacent projects. 2.5.5. Minimize and mitigate impacts of border-related activity on Sonoran pronghorn habitat. 2.5.6. Reduce the impacts of mines (e.g., La Herradura) on Sonoran pronghorn habitat quality. 2.5.7. Reduce the negative impacts of agriculture on Sonoan pronghorn habitat quality. 2.5.9. Minimize impacts of off-road racing in Sonora on Sonoran pronghorn habitat.

Threat - stress	Threat - source	Population	Recovery Criteria	Recovery Actions (from recovery action outline)
	Altered fire regimes	All	3	No actions for this source. All of 2.7. Enhance forage quality and availability to support viable populations of Sonoran pronghorn range-wide addresses the stressor.
	Extreme heat	All	3	No actions for this source. All of 2.7. Enhance forage quality and availability to support viable populations of Sonoran pronghorn range-wide addresses the stressor.
	Low annual rainfall	All	3	No actions for this source. All of 2.7. Enhance forage quality and availability to support viable populations of Sonoran pronghorn range-wide addresses the stressor.
	Increased frequency and severity of drought	All	3	No actions for this source. All of 2.7. Enhance forage quality and availability to support viable populations of Sonoran pronghorn range-wide addresses the stressor.
Altered habitat structure	All sources	All	3	2.5. Maintain and improve the quality of existing habitat (including an appropriate mix of vegetation types) range-wide. 2.4. Implement environmental services, employment programs, rural development programs in priority conservation areas in Sonora, and limit and/or regulate activities and infrastructure that can threaten those areas. 2.3.2. Work with agencies and authorities (federal, state, municipal) to monitor, prevent, minimize, and/or mitigate future detrimental land use changes. 2.5.8 Establish Best Management Practices (BMPs) for U.S. projects on BLM land, to minimize the impacts of projects on Sonoran pronghorn habitat quality.
	Altered fire regimes	All	3	No actions for this source.
	Renewable energy	Kofa	3	No actions for this source.
	Military operations	Kofa Sauceda	3	No actions for this source.

Threat - stress	Threat - source	Population	Recovery Criteria	Recovery Actions (from recovery action outline)
	Livestock grazing	Quitovac Pinacate Kofa Sauceda	3	All of 2.5.1. Limit livestock grazing where it impacts Sonoran pronghorn habitat. All of 2.5.2. Reduce impacts of livestock grazing where it will occur. 2.5.3.1. Remove feral burros, goats, cattle, and horses.
	Mining	All	3	2.5.6 Reduce the impacts of mines (e.g., La Herradura) on Sonoran pronghorn habitat quality.
	Off-highway vehicles	Quitovac	3	2.5.9. Minimize impacts of off-road racing in Sonora on Sonoran pronghorn habitat.
		All populations	3	No actions for this source
	Illegal extraction	Pinacate	3	No actions for this source.
Reduced access to water	Inadequate distribution	All	3	All of 2.8. Maintain and improve availability of and access to water (both natural and human-made) range-wide.
	Physical barriers (highways, fences, canals, railroads)	All	3	All of 2.6.1. Improve habitat connectivity where impeded by barriers. All of 2.6.2. Prevent creation and/or minimize impacts of new barriers.
	Human disturbance		3, 4	See actions for human disturbance.
Reduced availability of water	All sources	All	3	2.8. Maintain and improve availability of and access to water (both natural and human-made) range-wide.
	Low annual rainfall	All	3	2.8. Maintain and improve availability of and access to water (both natural and human-made) range-wide.
	Increased frequency and severity of drought	All	3	2.8. Maintain and improve availability of and access to water (both natural and human-made) range-wide.
	Altered runoff patterns	All	3	2.8. Maintain and improve availability of and access to water (both natural and human-made) range-wide. 2.5.1. Limit livestock grazing where it impacts Sonoran pronghorn habitat. 2.5.2. Reduce the impacts of livestock grazing where it will continue. 2.5.4. Avoid and minimize impacts on habitat quality from adjacent projects and activities. 2.5.5. Minimize and mitigate impacts of border-related activity on Sonoran pronghorn habitat. 2.5.9. Minimize impacts of off-road racing in Sonora on Sonoran pronghorn habitat.

Threat - stress	Threat - source	Population	Recovery Criteria	Recovery Actions (from recovery action outline)
	Historic drying of Gila and Sonoyta rivers	All	3	2.8. Maintain and improve availability of and access to water (both natural and human-made) range-wide.
Listing Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes				
None				
Listing Factor C: Disease or predation				
Predation	Forced use of densely vegetated areas due to increased drought/heat	All	3	No actions for this source.
	All sources	All	3	1.1.4. Reduce predation by native, feral, and domestic predators.

Disease	All sources	All	3	1.1.2.1. Vaccinate against Epizootic Hemorrhagic Disease and Blue Tongue. 1.1.2.2. Vaccinate against other diseases as vaccinations become available.
	Livestock as carriers	Quitovac Pinacate Kofa Sauceda	3	All of 2.5.1. Limit livestock grazing where it impacts Sonoran pronghorn habitat. 2.5.3.1. Remove feral burros, goats, cattle, and horses.
Lack of genetic diversity	Small population size; historic bottleneck	All	5	1.1.1. Maintain genetic diversity of Sonoran pronghorn.
Listing Factor D: Inadequacy of Existing Regulatory Mechanisms				
None			6	NA
Listing Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence				
Human disturbance	Border activities	All	4	All of 3.1. Minimize and mitigate the impact of border-related activities
	Recreation	All	4	All of 3.2. Minimize and mitigate the impact of recreational activities.
	Military activities	Cabeza Sauceda Kofa	4	All of 3.3. Minimize and mitigate the impact of military activities.
	Land management activities	All	4	All of 3.4. Minimize and mitigate the impact of public land management activities.
	Mining	Quitovac Kofa	4	All of 3.5. Minimize and mitigate the impact of mining activities.
	Ranching	Quitovac Pinacate Kofa Sauceda	4	All of 3.6. Minimize and mitigate the impact of other activities.
	Agriculture	Quitovac	4	All of 3.6. Minimize and mitigate the impact of other activities.
High mortality rates	Drowning in canals	Kofa Cabeza	3	All of 1.1.5. Reduce mortality caused by canals.
	Entanglement in fences	All	3	2.6.1.3. Remove or modify existing barriers and impediments to allow for Sonoran pronghorn passage (e.g., remove/modify fences, railroad tracks, roads, install overpasses).

	Vehicle collision	All	3	2.6.1.3. Remove or modify existing barriers and impediments to allow for Sonoran pronghorn passage (e.g., remove/modify fences, railroad tracks, roads, install overpasses).
	Thermal stress	All	3	No action for this source.
	Poaching	Quitovac	3	All of 1.1.3. Decrease poaching.
	Capture -related mortality	All	3	1.2.1. Evaluate and modify as needed methods of captive breeding, handling, transport, and transplant.
	Military activities	Cabeza Kofa Sauceda	3	3.3.1. Continue to work with the military partners in the U.S. (BMGR (MCAS Yuma and Luke Air Force Base), ARNG, YPG) to minimize the impact of military activities on Sonoran pronghorn.
Catastrophic or stochastic events	Lack of redundancy of populations	All	1	1.3. Establish new populations.
	Small population sizes	All	1	1.2. Maintain current captive breeding program.
All Listing Factors				
All	All	All	1	All of 4. Identify and address Sonoran pronghorn population monitoring needs.
			1,2,3,4,5,6	All of 5. Identify and address priority research needs.
			1,2,3,4,5,6	All of 6. Maintain existing and develop new partnerships.
			1,2,3,4,5,6	All of 7. Secure adequate funding to implement recovery actions.
			1,2,3,4,5,6	All of 8. Practice adaptive management.