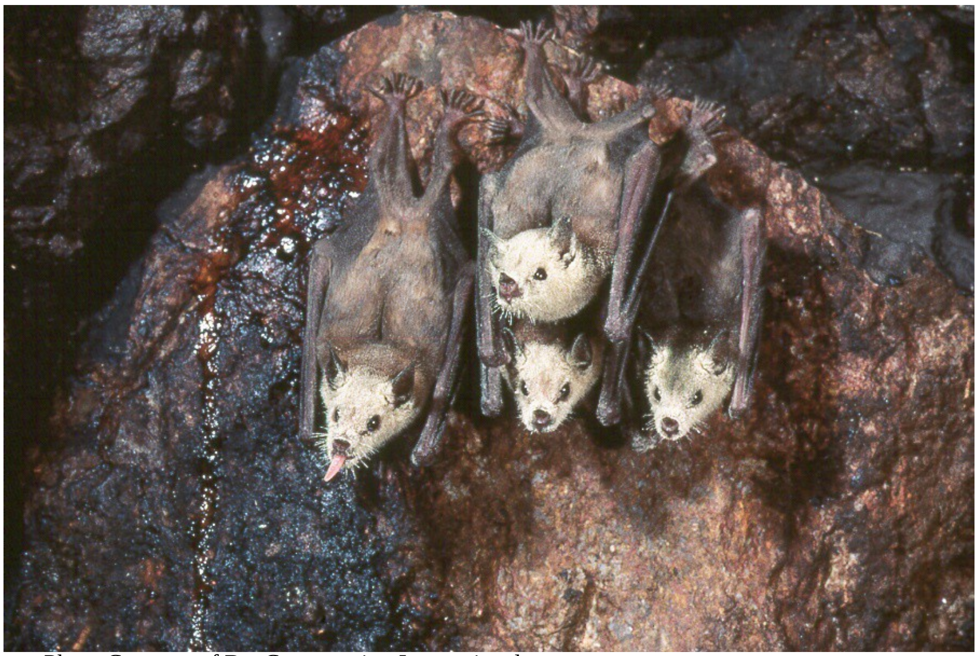
Species Status Assessment for the Lesser Long-Nosed Bat
(Leptonycteris yerbabuenae)



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Executive Summary

Background

This species status assessment (SSA) reports the results of the comprehensive status review for the lesser long-nosed bat (*Leptonycteris yerbabuenae*) by the U.S. Fish and Wildlife Service. This SSA Report provides a thorough account of the species' overall viability and, therefore, extinction risk. The lesser long-nosed bat is a medium-sized migratory bat that spends the summer in Arizona and New Mexico in the United States and then migrates south into central and southern Mexico for the winter months. The lesser long-nosed bat is a nectar, pollen, and fruit eating bat that is dependent on sources of flowering plants and a "nectar trail" that seasonally connects these foraging resources to allow migration between mating and wintering areas in Mexico and birthing areas in northern Mexico and the United States.

To evaluate the biological status of the lesser long-nosed bat both currently and into the future, we assessed a range of conditions to allow us to consider the species' resiliency, redundancy, and representation (the 3 Rs). The lesser long-nosed bat is currently considered a single population, but it is characterized by subpopulations. This species needs multiple resilient subpopulations distributed across its range to maintain its persistence into the future and avoid extinction.

Species Biology and Needs

The lesser long-nosed bat is a migratory bat characterized by a resident subpopulation that remains year round in central and southern Mexico to mate and give birth, and a migratory subpopulation that winters and mates in central and southern Mexico, but that migrates north in the spring to give birth in northern Mexico and the southwestern United States (Arizona). This migratory subpopulation then obtains the necessary resources (in Arizona and New Mexico in the United States) to be able to migrate south in the fall back to central and southern Mexico. The primary life history needs of this species include appropriate and adequately distributed roosting sites; adequate forage resources for life history events such as mating and birthing; and adequate roosting and forage resources in an appropriate configuration (a "nectar trail") to complete migration between central and southern Mexico and northern Mexico and the United States.

Risk Factors

A number of factors or activities result in threats and stressors to the lesser long-nosed bat population. These risk factors affect all aspects of the lesser long-nosed bat's life history, including the presence of adequate roost sites, sufficient forage resources distributed appropriately across the range of the lesser long-nosed bat, and habitat connectivity to support annual migration activities. Disease does not currently appear to be a significant risk factor for the lesser long-nosed bat. However, emerging disease issues, such as those associated with white-nose syndrome, may become more significant, although current opinion is that white-nose syndrome will not affect this non-hibernating species. Additionally, climate change has the potential to exacerbate all of the known risk factors affecting the lesser long-nosed bat. Finally, bats are subject to a range of human biases and perspectives; many of these are negative and affect our ability to protect and conserve bats. Human attitudes towards bats have improved in recent years, but there is continuing outreach and education to be done.

Roost threats - The primary threat to this species comes in the form of roost site disturbance or loss. The colonial roosting behavior of this species, where high percentages of the population can congregate at a limited number of roost sites, increases the likelihood of significant declines or extinction due to impacts at roost sites. Lesser long-nosed bats remain vulnerable because they are so highly aggregated. Specific activities that can affect roosting activities are summarized below.

Border activities – One of the most significant threats to known lesser long-nosed bat roost sites are impacts resulting from use and occupancy of these roost sites by individuals involved in illegal border crossings, both from individuals crossing to look for work and the trafficking of illegal substances. Mines and caves which provide roosts for lesser long-nosed bats also provide shade, protection, and sometimes water, for border crossers. The types of impacts that result from illegal border activities includes disturbance from human occupancy, lighting fires, direct mortality, accumulation of trash and other harmful materials, alteration of temperature and humidity, destruction of the roost itself, and the inability to carry out conservation and research activities.

Recreation – Caves and mines continue to attract recreational users interested in exploring these features. This threat has probably not increased since the listing, but continues to be an issue. Managing recreational use of roost sites may be a substantial impact because of safety and liability concerns that may lead to the closing of the roost site (see issue below).

Vandalism – The deliberate destruction, damage, or defacing of caves and mines for whatever reason is a threat to lesser long-nosed bat roosts. This does not appear to be as big of a threat in the United States, but vandalism has been identified as perhaps the single most important threat to the lesser long-nosed bat in Mexico (Medellín 2005, p. 4) and has also been identified as an issue in the United States (USFWS 1988, p. 38459). However, significant changes in the public perception of bats are occurring. Educational efforts are beginning to make a difference.

Fire – Catastrophic wildfire may result in impacts to roost sites. The fire itself can result in short-term impacts from smoke and heat. More lasting impacts can result if the microclimate of the roost is affected by the impact of the fire (removal of vegetation, change in air currents, alteration of hydrology, etc.). In 2005, the Florida Fire in the Santa Rita Mountains, south of Tucson, burned in areas affecting late summer roost sites for the lesser long-nosed bat. Post-fire monitoring did not occur, but smoke and suppression efforts (fire retardant and water drops, helicopters, etc.) could have potentially affected these roost sites (USFS pers. comm.). The ongoing drought and past fire suppression efforts make fire a continuing threat to roost sites.

Vampire Bat Control – Vampire bat control is implemented in portions of the lesser long-nosed bat range in Mexico. This control is necessary because of potential impacts to humans and livestock, including the transmission of rabies. Such control can result in the indiscriminate killing of non-target bats, including lesser long-nosed bats (Johnson et al. 2014; p. 1920 – 1922).

Ongoing educational efforts have improved the identification of bat species in targeted vampire bat control and improved the understanding of the general public and agricultural operators with regard to methodology.

Mine closures – Many public agencies with land management responsibilities must consider the liability of caves and mines occurring on the lands for which they are responsible. If lesser long-nosed bat roosts in mines or caves are deemed a public safety threat, the agency may take action to permanently close the roost site. This obvious direct effect to a roost site would be significant. Most land management agencies (FS, BLM, NPS, etc.) have an ongoing program to close old mine sites. Pima County, in southeastern Arizona, is implementing mine closures on lands that they have acquired for conservation purposes. A positive aspect of this mine closure process is that most agencies and landowners now understand the value of these features to bats and other wildlife. Typically, prior to closure, surveys and monitoring of these sites occurs to identify use by wildlife. Often, if bats are documented using the features, bat-friendly closure methods will be used, although current information leads us to believe that bat gates are not accepted as well by lesser long-nosed bats as they are by insectivorous bats.

Forage Availability – Lesser long-nosed bats have the ability to forage over long distances to obtain resources. In fact, long commuting flights are a particularly striking aspect of the foraging behavior of lesser long-nosed bats. These long commuting flights are a likely a consequence of the gregarious roosting behavior of this species and the need for these relatively large concentrations of bats to obtain adequate forage resources from the available forage (Horner et al. 1998, p. 582 - 584). They will often bypass foraging sites close to their day roosts and utilize forage resources long distances from their roosts. While we do not completely understand why they do this, it emphasizes the need to protect forage resources not only in proximity to roosts, but also at relatively long distances (>40 miles) from known roosts. Impacts to forage availability include drought, invasive plant species, fire, grazing, and urban development.

Fire – In 2005, it became evident that fire is an important factor related to potential forage availability for the lesser long-nosed bat. As a result of ongoing drought and years of fire suppression, two catastrophic wildfires (Florida and Cave Creek Complex fires) and a number of smaller ones affected potential foraging habitat for the lesser long-nosed bat. While the effects of fire on agaves and saguaros have been studied to some extent, the long-term effects of fire on forage availability are not completely understood.

Grazing – Livestock grazing can affect forage resources such as agaves and saguaros. Cattle can preclude flower development in agaves by grazing the emerging flower stalk, ultimately reducing forage abundance for the lesser long-nosed bat. Soil compaction and vegetation effects from livestock grazing can affect the germination and survival of saguaro seedlings. However, current observations indicated that, while livestock grazing can result in observable effects in some local areas, the overall effects of livestock grazing on lesser long-nosed bat forage resources has not resulted in reduced occupancy or numbers of roosting lesser long-nosed bats.

Non-native invasives – Non-native, invasive plant species such as buffelgrass, Lehmann's lovegrass, red brome, and Sahara mustard have become established and are increasing in vegetation communities that provide important lesser long-nosed bat foraging habitat. Of primary concern is that the presence of these species significantly changes the fire regime. These non-native species are fire adapted, and the fuels they provide increase the occurrence and intensity of fire within the vegetation community. The Sonoran Desert is not a fire adapted community, and the columnar cacti upon which the lesser long-nosed bat depends for food resources are not fire adapted. The occurrence of fire in the Sonoran Desert community results in the loss of these non-fire adapted species. Microclimates in areas where these non-native plant species occur are not suitable for the germination and establishment of columnar cacti. The issue of non-native, invasive plants is significant in both the United States and Mexico.

Development –Lesser long-nosed bats are affected directly by development which removes important foraging habitat, but also indirectly as growing numbers of people increase the potential for roost disturbance. The impacts of development to lesser long-nosed bat habitat are of great concern because they tend to be permanent, long-term impacts, as opposed to the often temporary, shorter-term impacts from fire, grazing, and agave harvesting. Lesser long-nosed bats are able to reduce the impacts of temporary impacts by moving to alternative sites in the short-term. The permanent removal of habitat and long-term increased human presence on the landscape are significant and problematic threats to lesser long-nosed bat populations. Urban development and population growth were not identified as threats in the original listing or in the recovery plan. However, this threat is real and is increasing in significance. The presence of hummingbird feeders used by foraging lesser long-nosed bats is a potential effect associated with urban development. It is currently unclear if effects are positive (additional food resource) or negative (nutritional deficiencies, late migration). Studies are currently underway investigating the potential effects of hummingbird feeders on lesser long-nosed bats (Wolf and Dalton 2005, Wolf 2006, Fleming 2014, Town of Marana [http:www.maranaaz.gov/bats]). Development and urbanization result in an increased demand for cheap and clean energy. With the development of renewable energy sources, such as wind energy, additional lesser long-nosed bat mortality factors are introduced into the landscape. Mortality of bats resulting from wind turbines is well documented (O'Shea et al. 2016; p. 1 – 5), including lesser long-nosed bats (Kenney 2016, p.1; Fink 2015, p.1).

Agave Harvesting – It has been suggested that lesser long-nosed bats, as important pollinators of agave, are affected by the harvesting of agave for the production of tequila. Arita and Wilson (1987, p. 3 - 4) indicated that this bat-plant relationship is so strong that the disappearance of one would threaten the survival of the other. However, it is more likely that the relationship between agaves and lesser long-nosed bats is "a loose association of less closely evolved organisms in a multiple-species pollination syndrome where the effects of one species' decline upon the other organism may be more subtle and complex than those of the "storybook" mutualisms that have become cliché (Nabhan and Fleming 1993, p. 457)." While some "bootleg" harvest of agaves is likely occurring in some local communities, outreach and education of major tequila producers is occurring such that efforts are being made to minimize the impacts to lesser long-nosed bats.

Disease – *White-nose Syndrome* – White-nose syndrome is a disease affecting hibernating bats caused by the pathogenic fungus *Pseudogymnoascus destructans* (Lorch et al 2011, p. 376). The fungus invades skin tissues while bats are hibernating causing skin lesions and disrupting natural torpor cycles, leading to mortality during hibernation (Meteyer et al. 2009, entire; Reeder et al. 2012; Warnecke et al. 2012; Langwig et al. 2012). Because lesser long-nosed bats do not hibernate, it is not anticipated that white-nose syndrome will be a risk factor for lesser long-nosed bats.

There is no evidence that rabies is a significant mortality factor in lesser long-nosed bats. While bats are vectors for rabies, a relatively small percentage of bats are actually carriers of the rabies virus (Johnson et al. 2014; p. 1920; Klug et al. 2011; p. 71 – 73). Control of bat species, such as vampire bats, that are known vectors of rabies potentially affecting both humans and livestock may result in the indiscriminate killing of lesser long-nosed bats.

Climate Change – The effects of climate change have the potential to be a significant issue for the lesser long-nosed bat. Shifting distributions and changes in flowering/fruiting phenology of forage species may affect the timing and extent of forage availability for the lesser long-nosed bat. While there is much uncertainty related to the future effects of climate change, there is already evidence that climate change is affecting the ecosystems upon which the lesser long-nosed bat depends. The prediction of what the effects of climate change will be in the future is dependent on scientific modeling efforts and, while models are only as good as the information upon which they are built, they do represent the best available information upon which to base our analysis.

Perceptions of Bats by Humans – Efforts to conserve bats are complicated by human impressions and perceptions of them. Historically, although bats in some cultures were perceived as strong positive symbols, generally, bats have been viewed in a negative light and are symbols of darkness and evil. Conversely, an increased understanding of the roles of bats in ecosystems has led to a more positive perception of bats as consumers of insect pests, pollinators, and providers of other ecosystem benefits. In fact, in some areas, people are taking measures to actually attract bats in recognition of their important roles in the environment.

<u>Current Conditions</u>

For the last twenty years following the completion of the lesser long-nosed bat Recovery Plan, there has been a steadily increasing effort related to the conservation of this species. Better methods of monitoring have been developed. The number of known roosts has increased throughout its range. Protection measures have been implemented at a number of roosts in both the U.S. and Mexico. Increased public and academic interest and available funding has resulted in additional research leading to a better understanding of the life history of the lesser long-nosed bat. Certain perceived historical threats (livestock grazing and fire) have been shown to not be as much of an impact on the viability of this species as previously thought. Other threats have been reduced (collateral damage from vampire control and human disturbance at roosts). However, threats to this species still remain in the form of roost disturbance, particularly in the border region between the U.S. and Mexico; habitat loss due to various land uses; mortality associated with wind turbines; and, to an unknown extent, climate change.

The conservation status in Mexico has been determined to be secure enough to be removed from their Endangered Species list. While the extent of the lesser long-nosed bat's distribution is not nearly as great in the U.S. as it is in Mexico, we have determined that, for many of the same factors that Mexico considered to delist this species, this also represents the current condition in the U.S. Much of the range of this species in the U.S. is on federally-managed lands; outreach and education, particularly with regard to pollinator conservation, has increased and human attitudes are more positive now than in the past; and the lesser long-nosed bat has demonstrated adaptability to adverse environmental conditions within the portion of its range that is in the U.S.

With regard to the 3 R's, we have determined that high resiliency, high redundancy, and high representation characterize the current condition of the lesser long-nosed bat population (See Table ES-1).

Future Conditions and Viability

By its very nature, any status assessment is forward-looking in its evaluation of the risks faced by a species, and future projections will always be dominated by uncertainties which increase as we project farther and farther into the future. This analysis of the lesser long-nosed bat is no exception. In spite of these uncertainties, we are required to make decisions about the species with the best information currently available. We have attempted to explain and highlight many of the key assumptions as part of the analytical process documented in this SSA report. We recognize the limitations in available information and we handled them through expert elicitation and through the application of scenario planning.

Future Scenarios – The viability of the lesser long-nosed bat depends on the future availability of appropriate roost sites, particularly mating and maternity roosts, and the availability of forage resources across its range in areas occupied seasonally by the lesser long-nosed bat, including migration corridors. Because we have uncertainty regarding how and when roost site conservation may be implemented or maintained, and also what the effects of climate change will be on the range-wide availability of forage resources, we have forecasted what the effects to the lesser long-nosed bat may be in terms of population resiliency, and species redundancy and representation under three plausible future scenarios over two reasonable time frames: 15 years and 50 years (See Table ES-1). We chose the 15-year timeframe because it is an appropriate timeframe over which to assess the progress of lesser long-nosed bat conservation efforts. Fifteen years is based on the history of conservation implementation in the past. Past conservation efforts such as identifying and monitoring roost sites; completing the processes for identifying, permitting, implementing, and monitoring roost protection measures; conducting education and outreach and seeing changes in public perceptions; and implementing regulatory change can often take up to 15 years to determine the impacts on conservation. We selected the 50-year timeframe because it falls within the range of available climate change prediction models at a level where there is less uncertainty regarding the models. The following three general scenarios are included in our analysis:

(1) Best Case – The majority of known roost sites are protected. Forage resources are maintained or enhanced, including areas along the "nectar trail". Migration pathways are protected throughout the species' range and over a range conditions. White-nose syndrome is not a concern for this species. Technology and understanding allows for the elimination of mortality at wind turbines. Attitudes towards bat conservation are positive and conservation actions are being implemented across the range of this species. We have determined that it is somewhat likely that the Best Case Scenario will occur over both time frames. Under this scenario and over both time frames, we have determined that resiliency, redundancy, and representation will all remain high.

(2) Moderate Case – More than 50 percent of known roosts remain unprotected. Some areas of forage resources are reduced or become unavailable or out of sync with migration patterns as a result of climate change and changing land uses. Tropical dry forests are more heavily impacted than northern habitats. Some migration corridors are lost or compromised, but some remain intact and in protected status. White-nose syndrome does not affect the species, but spreads into the distributional range of the lesser long-nosed bat such that restrictions are placed on research and monitoring. Mortality at wind turbines occurs, but is reduced. Attitudes regarding the conservation of bats remain mixed and conservation measures are being implemented in some areas, but struggle to get support in other areas. We have determined that it is moderately likely that the Moderate Case Scenario will occur over both time frames. Under this scenario and over both time frames we have determined that resiliency, redundancy, and representation will all remain high.

(3) Worst Case – Roost protection is lost at some roosts or is not being implemented adequately. Available forage resources are lost or reduced in all areas of the range, including those necessary to support migration, due to climate change and changing land uses. Migration pathways are lost or compromised. White-nose syndrome occurs within the distributional range of the lesser long-nosed bat and affects the species. Mortality at wind turbines is not addressed. Attitudes towards bat conservation are generally negative and conservation efforts are minimal. We have determined that it is unlikely that the Worst Case Scenario will occur over both time frames. Under this scenario, at the 15-year time frame, we have determined that resiliency, redundancy, and representation will be moderate. At the 50-year time frame, we have determined that resiliency, redundancy, and representation will be low.

Table ES-1. Summary of the current viability of the lesser long-nosed bat population and the predicted future viability of the population under the described future scenarios.

3 Rs	Needs	Current Condition	Future Condition (Viability)
Resiliency: Population segments able to withstand stochastic events	• Multiple roosts of each type distributed across the range (maternity, mating, migration, transition), including alternate roost sites • Diversity of forage resources occurring at the appropriate times for life history events • Intact migratory pathways	• Multiple roosts are currently found in both resident and migratory segments of the population. • Multiple mating sites are known; multiple maternity sites are known; and transition roosts are located in areas used by both the resident and migratory segments of the population. Adequate roost sites exist to support roost switching to use seasonally and annually ephemeral forage resources. • A number of roost sites of each type (maternity, mating, transition) are protected in both the U.S. and Mexico. • Currently, forage and roosting resources are available in an adequate number and distribution to support residence and migration throughout the range.	• **Best Case –** We anticipate that the resiliency of the lesser long-nosed bat population will remain high and improve over the current condition at both time frames. • **Moderate Case –** We anticipate that the resiliency of the lesser long-nosed bat population will remain high and similar to the current condition over both time frames. • **Worst Case –** We anticipate that the resiliency of the lesser long-nosed bat population will decrease to moderate within the 15-year time frame and to low within the 50-year time frame.
Redundancy: Number and distribution of population segments to withstand catastrophic events	• Multiple roost sites within each population segment that provide, as appropriate, maternity, mating, and transition roosts in proximity to available forage resources. • Multiple potential migration pathways that provide connectivity among population segments, including resident and migratory population segments and that support adequate forage	• Multiple maternity roosts are known in both resident and migratory segments of the population. • Multiple mating roosts are known in the areas of Mexico where mating for both the resident and migratory segments of the population occur. • Multiple transition roosts occur in both the resident and migratory segments of the population in a distribution that allows this species to use available forage resources. • Currently, migration pathways are currently intact along both the Pacific Coast and Sierra Madre hypothesized migration pathways. Lesser long-nose	• **Best Case –** We anticipate that redundancy within the lesser long-nosed bat population will remain high and may improve slightly over both time frames. • **Moderate Case –** We anticipate that redundancy within the lesser long-nosed bat population will remain high and similar to the current condition over both time frames. • **Worst Case -** We anticipate that redundancy within the lesser long-nosed bat population will ecrease

	resources.	bats have shown the ability to adapt to historical fluctuations in the availability of forage across its range.	to moderate within the 15-year time frame and to low within the 50-year time frame.
Representation: Genetic and ecological diversity to maintain adaptive potential	• Genetic representation is maintained across the range and across population segments. • Ecological diversity is maintained across the range, including adequate roosts and forage resources in both resident and migratory segments of the population.	• The best available information indicates that the lesser long-nosed bat is currently a single population. Genetic variability occurs, but not to the extent that different populations can be identified. Current genetic diversity is likely to be maintained due to the large range of this species and the intermixing of both the resident and migratory population segments for reproductive activities. • Currently, this species' large range is characterized by diversity in vegetation communities, topography and climate. This diversity allows this species to carry out its life history activities that requires seasonal and annual changes in activities and behavior.	• **Best Case –** We anticipate that representation within the lesser long-nosed bat population will remain high and similar to the current condition over both time frames. • **Moderate Case –** We anticipate that representation within the lesser long-nosed bat population will remain high and similar to the current condition over both time frames. • **Worst Case -** We anticipate that representation within the lesser long-nosed bat population will decrease to moderate within the 15-year time frame and to low within the 50-year time frame.

TABLE OF CONTENTS

Executive Summary iii

CHAPTER 1 – INTRODUCTION. 1

CHAPTER 2 – LIFE HISTORY AND RESOURCE NEEDS 6

CHAPTER 3 – POPULATION DYNAMICS 25

CHAPTER 4 – INFLUENCES ON VIABILITY 28

CHAPTER 5 – CURRENT CONDITION AND FUTURE SCENARIOS 50

CHAPTER 6 – SYNTHESIS 58

LITERATURE CITED 70

CHAPTER 1. INTRODUCTION

The lesser long-nosed bat (*Leptonycteris yerbabuenae)* is one of three nectar-feeding bats in the United States (U.S.); the others include the Mexican long-nosed bat (*Leptonycteris nivalis*) and the Mexican long-tongued bat (*Choeronycteris mexicana*). The lesser long-nosed bat is a migratory pollinator and seed disperser that provides important ecosystem services in arid forest and grassland systems throughout its range in the U.S. and Mexico, contributing to healthy soils, diverse vegetation communities, and sustainable economic benefits for communities. The range of the lesser long-nosed bat extends from the southwestern U.S. southward through Mexico (Figures 1 and 2).

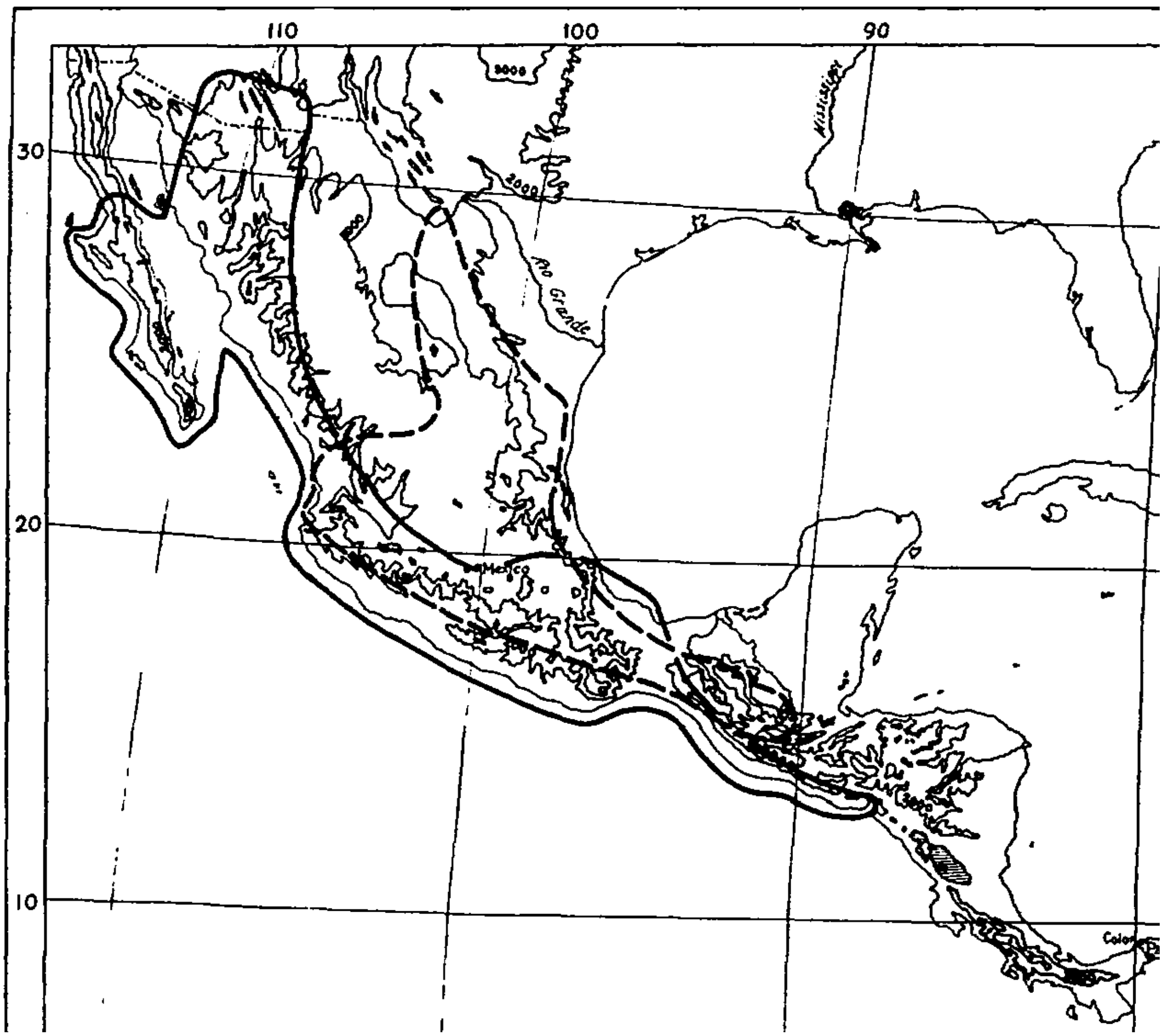
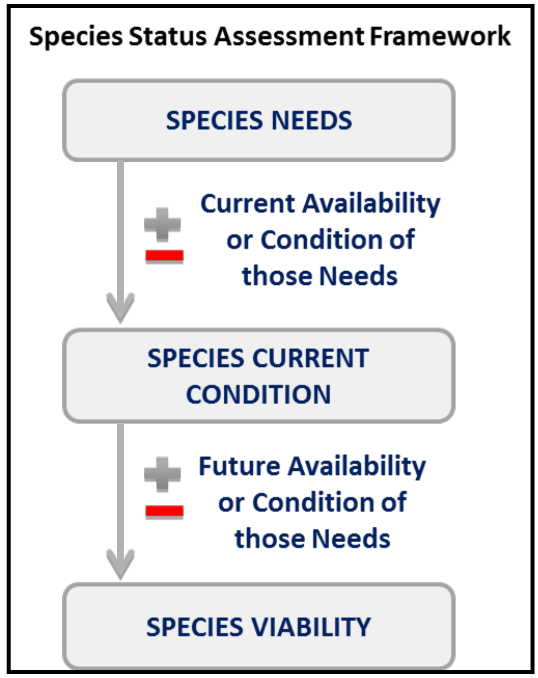


Figure 1. General distribution of *Leptonycteris yerbabuenae* (solid line) (from Koopman 1981)

Figure 2. Distribution of *Leptonycteris yerbabuenae* in Mexico (adapted from Medellín et al. 2008, Hall 1981, and Ceballos and Olive 2005)

The lesser long-nosed bat is currently listed as endangered under the U.S. Endangered Species Act of 1973 (16 U.S.C. 1531-1544), as amended (Act) (53 FR 38456, September 30, 1988). No critical habitat under the Act has been designated for this species. A U.S. recovery plan was completed for the lesser long-nosed bat in 1997 (USFWS 1997; entire) and a recovery priority number of 8 was assigned. This recovery priority number means that the lesser long-nosed bat is considered to have a moderate degree of threat and a high recovery potential. Because the lesser long-nosed bat is a colonial roosting species known to occur at a limited number of roosts across its range in Mexico and the U.S. (Arizona and New Mexico), impacts at roost locations could have a significant impact on the population, particularly if the impacts occur at maternity roosts. However, because some of the roost locations are on "protected" lands in both the U.S. and Mexico, the degree of threat was determined to be moderate. The primary recovery actions outlined in the recovery plan were to monitor and protect known roost sites and foraging habitats. Because both of these actions could be accomplished through management within identifiable areas, the recovery potential for the lesser long-nosed bat was determined to be high. The U.S. Fish and Wildlife Service (USFWS) completed a 5-year review of the status of the lesser long-nosed bat in 2007. This review recommended downlisting the bat from endangered to threatened status under the Act (USFWS 2007, entire). In Mexico, the lesser long-nosed bat was recently removed from that nation's equivalent of the endangered species list (SEMARNAT 2015, entire; Medellín and Torres 2013, entire).



In an effort to make species conservation and recovery more effective and efficient, the USFWS recently developed a Species Status Assessment (SSA) framework (USFWS 2014, entire) that is intended to support an in-depth review of a species' biology and threats, an evaluation of its biological status, and an assessment of the resources and conditions needed to maintain long-term viability. In this context, viability is not a specific state, but rather a continuous measure of the likelihood that the species will sustain populations over time. This framework analysis is presented as the SSA Report. The intent is for the SSA Report to be easily updated as new information becomes available and to support all functions of the Endangered Species Program from Candidate Assessment to Listing to Consultations and Recovery. As such, the SSA Report will be a living document upon which other documents, such as listing rules, recovery plans, 5-year reviews, section 10 documents, agreements, and biological opinions will be based.

Importantly, the SSA Report does not result in a decision by the USFWS on whether this species' legal status under the Act should change. Instead, this SSA Report provides a review of the available information strictly related to the biological status of the lesser long-nosed bat. Decisions related to listing status or other actions implementing the USFWS's authorities and policies will be made by the USFWS after reviewing this document and all relevant laws, regulations, and policies. The results of any proposed decisions will be announced in the *Federal Register* or otherwise be made available to the public through the appropriate processes.

Using the SSA framework, we consider what the species needs to maintain viability by characterizing the status of the species in terms of its resiliency, redundancy, and representation (Wolf et al. 2015; entire).

• **Resilience** describes the ability of populations to withstand stochastic events (arising from random factors). We can measure resiliency based on metrics of population health; for example, birth versus death rates and population size. Highly resilient populations are better able to withstand disturbances such as random fluctuations in birth rates (demographic stochasticity), variations in rainfall (environmental stochasticity), or the effects of anthropogenic activities.

• **Redundancy** is having a sufficient number of populations (or, in the case of the lesser long-nosed bat, subpopulations) for the species to withstand catastrophic events. A catastrophic event is defined here as a rare destructive event or episode involving many populations and occurring suddenly. Measured by the number of populations, redundancy is about spreading the risk and can be measured through the duplication and broad distribution of resilient populations across the range of the species. The more resilient populations the species has, distributed over a larger area, the better chances that the species can withstand or bounce back from catastrophic events.

• **Representation** is having the breadth of genetic makeup of the species to allow for potential future adaptation to changing environmental conditions. Representation can be measured through the genetic diversity within and among populations and the ecological diversity (also called environmental variation or diversity) of populations across the species' range. Theoretically, the more representation, or diversity, the species has, the higher its potential for adapting to changes (natural or human caused) in its environment. In the absence of species-specific genetic and ecological diversity information, we evaluate representation based on the extent and variability of habitat characteristics across the geographical range.

To evaluate the biological status of the lesser long-nosed bat, both currently and into the future, we assessed a range of conditions to allow us to consider the species' resiliency, redundancy, and representation. This SSA Report provides a thorough assessment of biology and natural history and assesses demographic risks, stressors, and limiting factors in the context of determining the viability for the species into the future.

The format for this SSA Report includes: (1) an evaluation of the life history of the lesser long-nosed bat and resource needs of individuals and populations (Chapter 2); (2) a discussion of the lesser long-nosed bat's population dynamics for determining the distribution of resilient, redundant, and representative populations across its range and that are needed for species' viability (Chapter 3); (3) a review of the likely causes of the current and future status of the species and determining which of these risk factors affect the species' viability and to what degree (Chapter 4); and (4) a description of the current condition of populations and the evaluation of a best-case and a worst-case scenario in order to estimate future viability in terms of resiliency, redundancy, and representation (Chapter 5). A synthesis of the status of the lesser long-nosed bat is included in Chapter 6. This document is a compilation of the best available scientific and commercial information and a description of past, present, and likely future risk factors for the lesser long-nosed bat.

Information used in developing this SSA Report is the result of an extensive literature search, a review of existing files and internal USFWS documents related to this species (biological opinions, listing documents, recovery documents, etc.), a review of recent research and monitoring efforts, and expert elicitation of information related to the lesser long-nosed bat from a series of meetings and interviews.

We acknowledge the input and expertise of the following individuals who have contributed to the completion of this SSA Report:

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CHAPTER 2. LIFE HISTORY AND RESOURCE NEEDS

In this chapter, we provide basic biological and life history information about the lesser long-nosed bat, including taxonomic history and a description of its life history elements. We then outline the resource needs of individuals and the population of lesser long-nosed bats.

Taxonomy and Phylogeny – In the western hemisphere, certain members of one bat family, *Phyllostomidae*, within the generally insectivorous *Yangochiroptera* (*Microchiroptera*), have become adapted to nectar feeding (Koopman 1981; p.352). This includes adaptations to such diverse morphology as skulls, teeth, tongues, throat muscles, and stomach linings (Koopman 1981; p. 353 - 356) (Figure 1). The lesser long-nosed bat is identified as a member of the *Phyllostomidae* family by its nose leaf (AGFD 2011; p. 2). Within this family, the genus *Leptonycteris* is probably better adapted to semiarid conditions than most neotropical nectar-feeders. As a result, its distribution actually seems to avoid the wet tropics favored by most phyllostomid bats (Koopman 1981; p.359).

Figure 3. Adult lesser long-nosed bat showing elongated rostrum and nose leaf (D. Buecher photo)

The lesser long-nosed bat has a relatively complicated taxonomic history (Carstens et al. 2002; p. 23). It was formally separated from the greater (Mexican) long-nosed bat (*Leptonycteris nivalis*)* as a distinct species (*L. sanborni*) by Hoffmeister (1957) and the species was originally listed in the U.S. under the Act as *L. sanborni* (USFWS 1988, entire). Work published by Arita and Humphrey (1988, entire) and Wilkinson and Fleming (1996; entire) supported classification as *L. curasoae*. These works further defined two subspecies, *L. c. curasoae* (found in the southern portion of the range) and *L. c. yerbabuenae* (found in the northern portion of the range, including the U.S.). More recently, a synthesis of the currently available information related to this species resulted in the raising of *L. c. yerbabuenae* to specific status as *Leptonycteris yerbabuenae* (Cole and Wilson 2006, p. 1). Additionally, Wilson and Reeder's (2005, accessed online 10/20/16) "Mammal Species of the World (Third Edition), an accepted standard for mammalian taxonomy, also indicates that *L. yerbabuenae* is a species distinct from *L. curasoae*. The distribution of *L. curasoae* is limited to South America. Currently, the most accepted and currently used classification for the lesser long-nosed bat is *L. yerbabuenae*, however, the

* The ranges of *L. nivalis* and *L. yerbabuenae* overlap in some areas of both the U.S. and Mexico. *L. nivalis* is similar in appearance to *L. yerbabuenae* but can be differentiated by its slightly larger size and longer 3rd finger.

USFWS continues to classify the listed entity as *Leptonycteris curasoae yerbabuenae*. We recommend, as part of this status review, that the USFWS recognize and change the taxonomic nomenclature for the lesser long-nosed bat to be consistent with the most recent classification of this species, *L. yerbabuenae*.

The currently accepted classification is:

Phylum:	Chordata
Class:	Mammalia
Order:	Chiroptera
Suborder:	Microchiroptera
Family:	Phyllostomidae
Subfamily:	Glossophaginae
Species:	*Leptonycteris yerbabuenae*

Currently, the distribution of the lesser long-nosed bat extends from southern Mexico into the southwestern U.S. In Mexico, the distribution of the lesser long-nosed bat covers approximately 40 percent of the country when considering resident areas, migration pathways, and seasonally-occupied roosts within the range of this subspecies. Arita and Humphrey (1988) reported 269 historical and currently occupied locations in Mexico. Arita (1991) mapped well over 100 lesser long-nosed bat collection sites in Mexico. Within both the U.S. and Mexico, the current distribution of the lesser long-nosed bat has not decreased or changed substantially from that described in the literature. It is important to note, however, that, as discussed in this SSA report, any give area within the range of the lesser long-nosed bat may be used in an ephemeral manner dictated by the availability of resources that can change on an annual and seasonal basis. Roost switching occurs in response to changing resources and areas that may be used during one year or season may not be used in subsequent years until resources are again adequate to support occupancy of the area. This affects if and how maternity and mating roosts, migration pathways, and transition roosts are all used during any given year or season. However, while the distribution of the lesser long-nosed bat within its range may be fluid, the overall distribution of this species has remained similar over time.

The lesser long-nosed bat is a medium-sized bat (total length of 2.95 – 3.35 inches (in.) [7.5 – 8.5 centimeters (cm)]; forearm 2.0 – 2.2 in. [5.1 – 5.6 cm]; wingspan 14 – 16 in. [36 – 40 cm]; and weight between 0.53 and 0.99 ounces [15 – 25 grams]), is grayish to reddish brown and has an elongated snout. This bat has a nose-leaf, no tail, and an interfemoral membrane that is reduced to a narrow band along each hind leg. This species has large eyes and reduced ears compared to other bats in Arizona (AGFD 2011; p. 1 - 2). It is easily confused with the Mexican long-tongued bat, which has a visible tail enclosed in the interfemoral membrane and a more elongated rostrum. Structural adaptations of the mouth of the lesser long-nosed bat serve to procure nectar, their primary food source. The tongue is long and tipped with brush-like papillae that facilitate nectar lapping and the teeth are modified, having lost the cutting and crushing cusps essential to successfully forage on insects (AGFD 2011; p.3; Koopman 1981; p. 353 - 356).

Life History – Since the listing of the lesser long-nosed bat in 1988, a number of groups, agencies, and universities have provided funding for a variety of lesser long-nosed bat research projects. Independent research has also occurred. The lesser long-nosed bat recovery plan has been used as a general guide to direct this research and, while much remains to be done, the recovery plan has guided research in the areas of roost surveys and monitoring, forage availability and management, impacts to roosts, migration patterns, and lesser long-nosed bat natural history. Because of the occurrence of both resident and migratory subpopulations within the lesser long-nosed bat population, it is important for all of the necessary habitat elements to be appropriately distributed across the range of this species such that roost sites, forage resources, and migration pathways are in the appropriate locations during the appropriate season.

In 2002, a *Leptonycteris curasoae* Recovery Cooperative (LcRC) was formed. Members include representatives of the Arizona Game and Fish Department, USFWS, Bat Conservation International, the Arizona Sonora Desert Museum, various land management agencies, and members of the bat research community in Arizona, New Mexico, and Mexico to encourage implementation of the 1997 recovery plan. This group has met or coordinated as needed to review recovery progress, discuss research proposals, collaborate on simultaneous roost count efforts, and develop a standardized roost count protocol.

Lesser long-nosed bat research is also ongoing in Mexico. This research is accomplishing some of the recovery actions outlined in the recovery plan, primarily those related to roost monitoring and education. A bat conservation program, the Program for the Conservation of Migratory Bats in Mexico was formed in 1994 (Walker 1995, p. 1 – 6) and has conservation of nectar-feeding bats, including the lesser long-nosed bat, as an objective. While much progress has been made, continued efforts need to be made to coordinate and accomplish recovery actions in Mexico, where the majority of this species' range is located.

Considerable progress has been made in understanding the life history and recovery needs of this species. Funding from a variety of sources over the past five years has allowed a number of research and monitoring projects to be completed that have helped to fill information gaps related to the lesser long-nosed bat. Our understanding of the life history of the lesser long-nosed bat is considerably advanced beyond what was known at the time of listing. However, as with most species, the more information we gather on a species, the more questions arise. There are still many questions to be answered with regard to the life history of the lesser long-nosed bat and many aspects of its ecology that we do not completely understand. The following is a summary of the general life history activities of the lesser long-nosed bat based on the best available information and expert input.

***Roosting* –** The formation of the LcRC has created a forum for improved availability and analysis of lesser long-nosed bat roost monitoring data. Specifically, an action was identified to create a centralized data repository that will improve the completeness and availability of roost monitoring data for population analysis. In addition, roost monitoring protocol has been improved through the use of infrared video monitoring. Lesser long-nosed bat roost exits are recorded using infrared technology. These recordings can then be reviewed in the lab, using slow motion, to obtain a more accurate count and improved species identification. There is some ongoing debate as to the cost effectiveness of this method because of the increased hours needed to complete the count and the need for special equipment. The issue of data comparability has been raised when not all monitoring efforts can employ the use of infrared recordings. The question has also been raised with regard to needing such an accurate count when, in fact, all counts are an index of abundance rather than a complete count, even when using infrared recording technology. Regardless, infrared recording has improved the accuracy of roost exit counts. Live counts are often not very accurate and with the advent of digital videography, the ease and cost involved for recording exit and return flights at roost is improving.

Significant efforts have been made to implement a regular schedule of monitoring at the known roost sites in Arizona (Figure 4). The formation of the LcRC has led to the implementation of annual simultaneous maternity and late summer roost surveys. Efforts have been made to improve monitoring protocols. All of the roost sites identified in the recovery plan have had some degree of monitoring over the past 15 years, including roosts in Mexico. As indicated in comments provided by Dr. Rodrigo Medellín, as part of the 5-year Review, a number of roosts in Mexico have been monitored over the past six years (Medellín 2005); this monitoring has continued to the present time (Medellín and Torres 2013, p. 11 - 13).

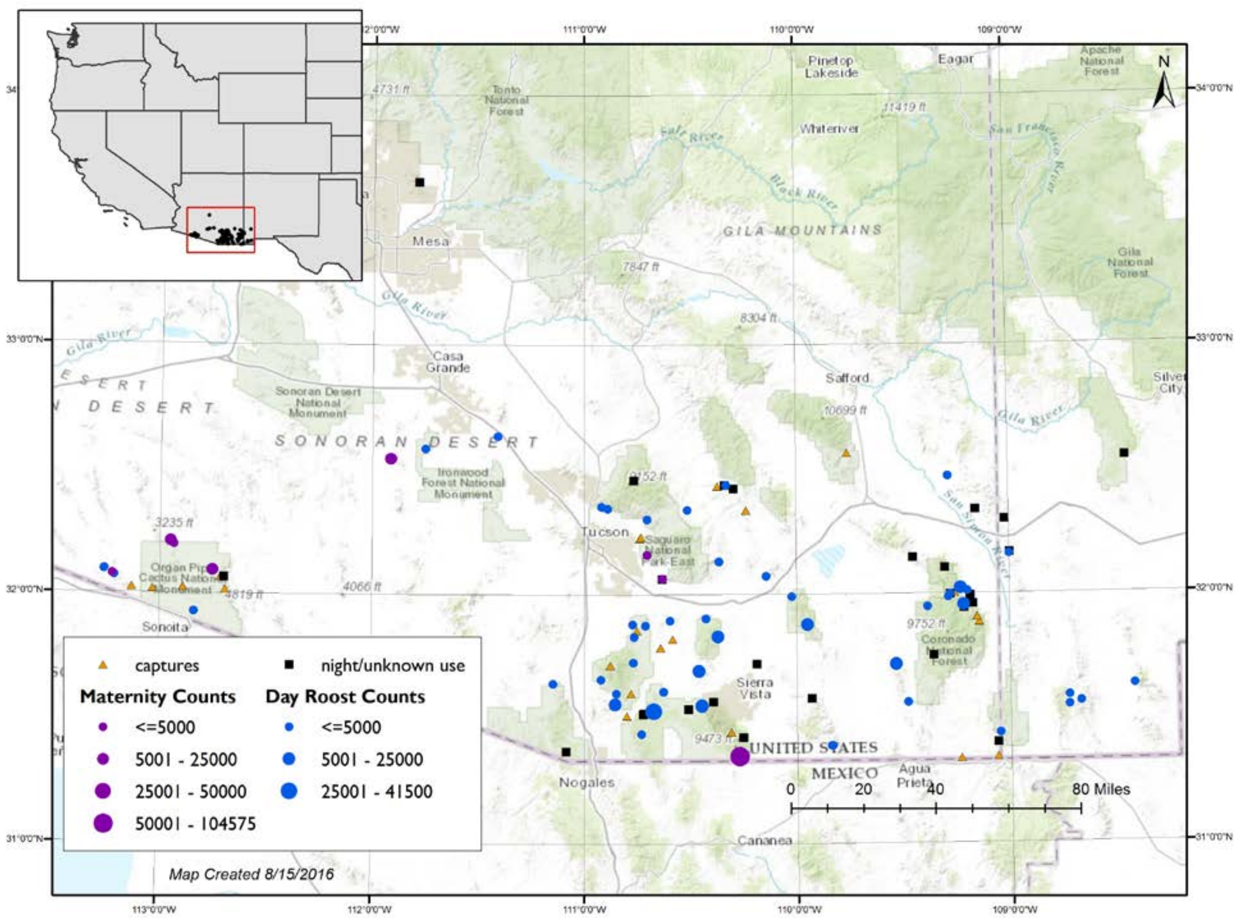

Figure 4. Approximate distribution of the lesser long-nosed bat roosts in Arizona (Map courtesy of BCI)

Individuals who provided input to this SSA Report generally indicated that they felt that the number of lesser long-nosed bats at most of the roost sites in both the U.S. and Mexico is stable or increasing. Specifically, Dr. Medellín indicated that the roosts they are monitoring in Mexico show stable or increasing numbers and had a conservation status adequate to remove the lesser long-nosed bat from the Mexican equivalent of the Endangered Species List (Medellín and Torres 2013, entire).

The lesser long-nosed bat is a colonial roosting species that will form colonies numbering from around 100 individuals to colonies that exceed 100,000 individuals (Hayward and Cockrum 1971; Fleming et al. 2003, p. 64 - 65). Lesser long-nosed bats spend well over one-half of their lives in a day roost, leaving it only to forage at night. While in the day roost, bats rest, digest food, interact socially, avoid extreme environmental conditions, reduce exposure to predators, mate, and care for their young (Arroyo-Cabrales et al. 2008, p. 3). Fleming et al. (1998, p. 153 – 154) described lesser long-nosed bat roosting behaviors, including time/activity budgets, for a maternity roost in Arizona. This study indicated that lesser long-nosed bats do not spend much time sleeping or resting while in the roost, nor is there any evidence of cooperative care or significant social interaction within a maternity roost. They conclude that, because of the lesser long-nosed bat's long-distance migratory behavior and the fluid composition of its colonies, it seems unlikely that cooperative behavior could evolve in the lesser long-nosed bat on the basis of long-term social cohesion alone (Fleming et al. 1998, p. 154).

The following is a comparison of lesser long-nosed bat numbers at Arizona roosts identified in the recovery plan:

Roost	Recovery Plan Numbers[1]	Current Numbers[2]
Copper Mountain	~ 20,000	~ 50,500 (+ 152%)
Blue Bird	~ 3,000	~ 5,708 (+ 90 %) [3]
Old Mammon	~ 3,600	~ 10,700 (+ 197 %)
Patagonia Bat Cave	~ 50,000	~ 34,340[4] (- 32 %)
State of Texas	~ 20,000	~ 4,822 (- 76 %)
Hilltop	~ 300	~ 0 (- 100%)
Total	~96,900	~106,070

[1] Highest number in recovery plan
[2] Highest numbers 2010 – 2015
[3] Blue Bird was abandoned in 2002, 2003, and 2005 due to illegal border activities.
[4] It should be noted that there were at least two years during this period when the number of lesser long-nosed bats was 40 – 50 showing how variable these roost counts can be over time.

The numbers above must be considered with some caution. These counts do not represent the total number of lesser long-nosed bats in Arizona because counts include a combination of maternity roosts and late summer roosts. Bats found in maternity roosts early in the year could occupy late summer roosts, resulting in double counting. The number of lesser long-nosed bats at any given roost fluctuates considerably each year and among years. For consistency, only the highest count at each roost was used. However, multiple counts at each roost each year are not conducted so this does not necessarily give an accurate picture of lesser long-nosed bat use at these roosts throughout the year or among years. For example, although the Hilltop roost has not had any lesser long-nosed bats for the past several years, other roosts in proximity have increased their numbers, so it is unlikely that the abandonment of this particular roost is meaningful when considering all known roosts in the area. Additionally, the decrease in the numbers of bats at the State of Texas roost may be attributed to the installation of a gate structure. Although still occupied every year, the numbers of lesser long-nosed bats that are still using this roost remain at a reduced level and a study is underway to see if gate design is affecting numbers at this roost site. Other discrepancies in the numbers between those used in the recovery plan and current numbers can likely be attributed to differences in methods and protocols for counting exit flights.

In addition, researchers indicate increasing and stable populations at roost sites not included for monitoring in the recovery plan. Of particular note are roost sites on Fort Huachuca in the Huachuca Mountains of Arizona. Monitoring over the past 24 years indicates steady increases in the numbers of lesser long-nosed bats at these roosts. In addition, two roost sites that had been abandoned have been reoccupied (Sidner 2005; Buecher 2016; p. 17). Additionally, a number of new roost sites at various locations in Arizona have been discovered (see Figure 4).

Past and current experiences related to lesser long-nosed bat roost monitoring continue to indicate that developing a definitive population estimate for this species is difficult. Many factors must be considered when interpreting roost monitoring data; therefore, the recovery plan criterion related to the numbers of lesser long-nosed bats in designated roosts is difficult to assess. While most agency and research personnel feel lesser long-nosed bat roost numbers are stable or increasing, the available data are inconclusive at the scale of the individual roost. The available data make it hard to say if there has been a ± 10% change in the numbers at certain roosts. It is unclear if this recovery criterion has been met.

We have considerably better data with regard to roost locations of the lesser long-nosed bat compared to the information available at the time of listing and completion of the recovery plan. Efforts over the past five years, especially the use of radio telemetry, have nearly doubled the number of known lesser long-nosed bat roosts in the U.S. Efforts by a number of agencies, the University of Arizona, and independent researchers since the last status update (the 5-year Review in 2007) have all contributed to an increase in the number of known lesser long-nosed bat roosts and our understanding of this species' life history.

To date, some efforts to protect roosts have been implemented. Generally, roosts on Federal lands benefit from monitoring by agency personnel and a law enforcement presence. Some of these roosts are probably exposed to fewer potential impacts than they otherwise would be. Agency land-use plans and general management plans contain objectives to protect cave resources and restrict access to abandoned mines, both of which can be enforced by law enforcement officers. In addition, guidelines in these plans for grazing, recreation, off-road use, fire, etc. will continue to prevent or minimize impacts to lesser long-nosed bat forage resources (USFS 2005, entire; BLM 1991, entire; DOD 2001, entire). However, resource and personnel limitations, as well as safety concerns, can sometimes limit how effective these protections are. Two efforts to physically protect roosts through the use of gates or barriers have been implemented (Bluebird and State of Texas). The experimental fence at the Bluebird Mine worked initially, but it has been subsequently vandalized resulting in roost abandonment. The gate was repaired and there have been no subsequent breeches and the bats have recolonized the site. Gating at the State of Texas mine has had some success (the site is protected, but bat numbers have declined), but we still do not know how lesser long-nosed bats will adapt to gates over time or if gates will prove to be a viable option for lesser long-nosed bat roost protection, especially at roosts containing the largest numbers of bats.

Using funding from the Department of Homeland Security and U.S. Customs and Border Protection, significant information regarding the identification and protection of lesser long-nosed bat roosts has been gathered over the past five years. Two studies were specifically implemented to find previously unknown lesser long-nosed bat roosts (AMEC 2015, entire; HEG 2015, entire). Another study assessed known lesser long-nosed bat roosts for threats and developed recommendations for roost protection measures. Additionally, they gathered baseline information on lesser long-nosed bat exit and return behavior to help us better assess the effects of gating (AGFD 2013a, b, and c, entire). Finally, the U.S. Forest Service implemented the recommended roost site protection measures at three roost sites per the recommendations from the AGFD threats assessment project (USFS 2015a, entire). Monitoring, including the use of telemetry, associated with specific border projects has led to the discovery and subsequent monitoring of additional lesser long-nosed bat roost sites (CBP 2012, entire; Lowery and Diamond, 2013, entire).

The Arizona Game and Fish Department is nearing completion of a modeling project in both Arizona and northern Mexico, focusing on roost site variables. The intent is to allow us to better identify potential roost sites in order to more effectively and efficiently allocate research and monitoring resources.

A number of research and monitoring efforts have been completed or are ongoing related to the abundance of the lesser long-nosed bat in Arizona and New Mexico. Maternity roost counts indicate more lesser long-nosed bats than at the time of listing (Table 2). Some late summer roost site counts have shown a decrease in numbers. However, subsequent to listing, new late summer roost sites have been documented in both Arizona and New Mexico and may indicate a change in use patterns rather than an actual decrease in numbers. Ongoing efforts seem to indicate that the lesser long-nosed bat is more abundant in Arizona and New Mexico than indicated in the final listing rule.

Fort Huachuca, a military base in the Huachuca Mountains of southeastern Arizona, has monitored lesser long-nosed bat colonies on the installation since 1990 (Sidner 1990a, 1990b, 2005; Buecher 2016; entire). In 1990, cave gates that had caused bats to abandon the sites were removed from two natural caves that were historically used by lesser long-nosed bats. Although it took years for the nectar bats to rediscover the main cave roost, numbers of lesser long-nosed bats in this post-maternity roost have steadily increased from no bats (1990 – 1994) to approximately 17,213 in 2015 (Buecher 2016; p. 11 - 16). The second Fort cave roost had extensive evidence of nectar bat use (thick desiccated deposits of nectar bat fecal material), however, once the gate was removed it took over 18 years to be rediscovered by lesser long-nosed bats (with approximately 8,000 in August 2014 (Buecher 2016; p. 17)).

Organ Pipe Cactus National Monument personnel have also conducted annual monitoring at the largest lesser long-nosed bat maternity roost in the U.S. They have conducted monitoring of this roost since 1989. Lesser long-nosed bat numbers have increased from an average of approximately 12,000 from 1989 – 1997 to around 25,000 in 2005 (Billings 2005, p. 6). Since 2010, the average has been around 40,000 (NPS 2016, p. 6 - 8). Monitoring at nearby Cabeza Prieta National Wildlife Refuge of a much smaller maternity roost has shown stable numbers, but has also experienced abandonment in three out of five years in the early 2000's, resulting in the potential loss of the annual reproduction of approximately 4,000 lesser long-nosed bats.

The Arizona Game and Fish Department, in conjunction with the LcRC, has coordinated an annual, simultaneous roost count for selected maternity roosts and late summer roosts throughout Arizona. The results of these counts, summarizing data since 2010 and subsequent to the last summary during the 5-year review (USFWS 2007, p. 5, 11), are presented below (AGFD 2016, entire). For the August counts, volunteer participation has dropped over the past few years. Consequently, not every roost was counted every year. For this summary, we took the average count (high count was used if there were multiple counts during the year) for the period from 2010 to 2015 for ten of the most regularly monitored transient roosts in southern Arizona. As discussed previously in this SSA Report, these counts are useful primarily as an index of occupancy and abundance, rather than an actual estimate of the population. The numbers below are useful in helping us understand the scale of occupancy, but do not represent a population estimate:

Table 1. Average August Simultaneous Roost Census for Select Roosts in Arizona (2010 – 2015)

Roost	**Average Count**
Bluebird	3,856
Copper Mtn.	28,089
Helena	6,380
Montezuma	4,021
Mustang	9,488
Tungsten	2,576
Pyeatt (Upper)	4,819
Pyeatt (Lower)	11,936
State of Texas	3,679
Cottonwood	5,100
Total	**79,944**

Table 2. Maternity Site June Roost Census - Arizona (2010 - 2015); Number of Roosts = 3

	2015	**2014**	**2013**	**2012**	**2011**	**2010**
Annual Total	61,217 (no count from Bluebird)	40,236 (no count from Bluebird)	56,305	45,924 (no count from Old Mammon)	58,670	52,251

Less is known about lesser long-nosed bat numbers and roosts in New Mexico (Figure 5). One roost site is known from the Peloncillo Mountains on the Arizona/New Mexico border. Additionally, work done by Hoyt *et al.* (1994, entire) in the mid-1990s located at least two roosts in the Animas Mountains of Hidalgo County, New Mexico. Dr. Mike Bogan, also with UNM, reported an August 2005 roost count total of 6,200 – 6,500 lesser long-nosed bats at multiple roost sites (Bogan 2005).

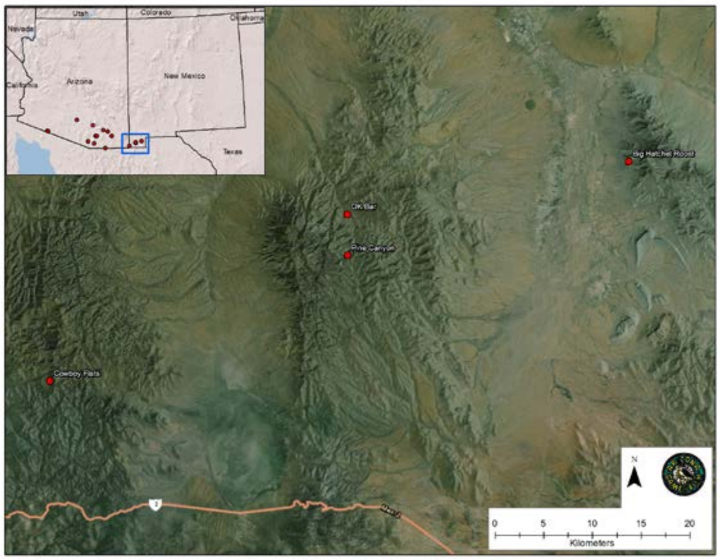

Figure 5. Map of approximate lesser long-nosed bat roosts in New Mexico (Map courtesy of the Arizona Game and Fish Department)

With regard to laws or regulations that may provide some protection of lesser long-nosed bat roosts, there is one Federal Act and one State Statute in the U.S. that provide some measure of protection at cave roosts, subject to enforcement capability. The Federal Cave Protection Act of 1988 prohibits persons from activities that "destroy, disturb, deface, mar, alter, remove, or harm any significant cave or alters free movement of any animal or plant life into or out of any significant cave located on Federal lands, or enters a significant cave with the intent of committing any act described …" Arizona Revised Statute 13-3702 makes it a class 2 misdemeanor to "deface or damage petroglyphs, pictographs, caves, or caverns." Activities covered under ARS 13-3702 include "kill, harm, or disturb plant or animal life found in any cave or cavern, except for safety reasons."

In Mexico, 13 roost sites have been monitored on a regular basis and were used in determining that the lesser long-nosed bat no longer needed listing under the Mexican endangered species list (Medellín and Torres 2013; entire) (Figure 6). Additionally, Frick (2016; entire) provides information on nine additional roosts located on the Baja Peninsula. These nine roost sites include five maternity sites and two mating sites. Two maternity roosts in mines in Baja California Sur were destroyed in the past 5 years – one intentionally bulldozed as part of mining operations and the other collapsed in an earthquake. Other roost sites are known from mainland Mexico, but are not monitored or studied on a regular basis (Penalba et al. 2006, p. 3030 – 3032).

A few of the known roost sites in Mexico and two in the U.S. are roosts that are shared with the closely related, endangered Mexican long-nosed bat (*Leptonycteris nivalis*), which currently remains listed in both the U.S. and Mexico. Conservation measures at these shared roost sites for either of these species results in concurrent conservation for the other species (Arita 1991, p. 711 - 712).

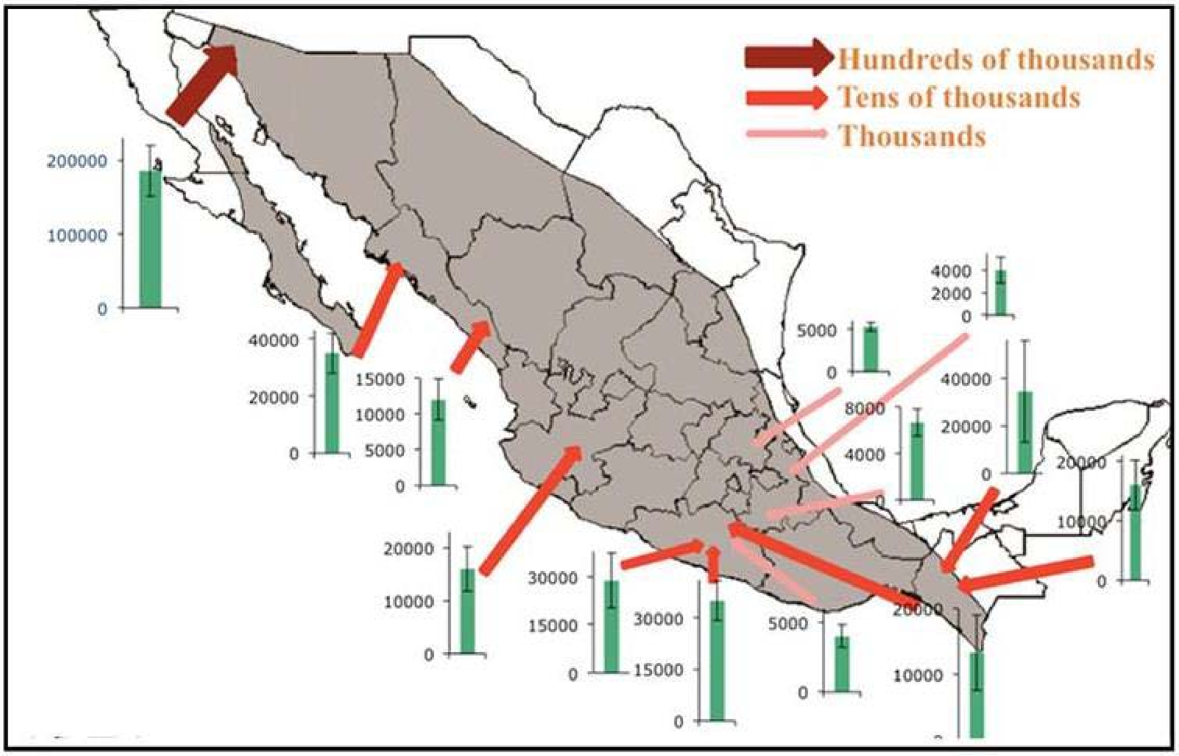

Figure 6. Map of the major lesser long-nosed bat roosts in Mexico and their estimated numbers from Medellín and Torres 2013. Shaded area is the approximate range of the lesser long-nosed bat in Mexico .

Foraging – Telemetry technology is contributing to our increased understanding of seasonal lesser long-nosed bat movements within Arizona and understanding lesser long-nosed bat foraging behavior. We know more about suitable foraging habitat, and have made progress in clarifying the role of the lesser long-nosed bat in pollination and seed dispersal (Rojas-Martinez et al. 2015, p. 87 – 88). The use of the developing technology of GPS trackers at roosts in Mexico has provided additional documentation of long-distance foraging commutes by this species. We also know that the impacts of livestock grazing and prescribed fire activities are probably not as great as once thought, though we remain cautious because these impacts could be compounded by increasing development, urbanization, and other land conversion activities, as well as climate change.

One of the primary issues related to listing and discussed in the recovery plan had to do with the mutualistic relationship between lesser long-nosed bats and their forage species, columnar cacti and agaves. It has been suggested that a decline in the lesser long-nosed bat or a decline in the forage species could result in a subsequent decline of the other member of the mutualistic pair. There is no question that lesser long-nosed bats have specific adaptations that allow them the exploit nectar, pollen, and fruits as food resources and that certain plants have adaptations that attract and reward lesser long-nosed bats for their visits (Howell 1974, Howell and Hodgkin 1976). Considerable work has been done since the listing to better understand this relationship.

As a result of their diet, lesser long-nosed bat guano is very different than the guano of insectivorous bats. Lesser long-nosed bat guano consists of splatters of thin yellow material found on the floors and walls of their roosts. The yellow color comes from the pollen which the bats ingest while consuming nectar or while grooming. The color of the splatter changes to a reddish or purple color when the bats are consuming fruits from columnar cacti (Figure 7).

Figure 7. . Lesser long-nosed bat guano consisting of yellowish splatter (left) and both red and yellow fecal material (right).

Barnitz (2002, p. 8) indicated that a summary of available literature shows that lesser long-nosed bat are probably dependent on agaves as food source from mid- to late summer. Conversely, some agaves are not solely dependent on lesser long-nosed bat for pollination and reproduction, but they may benefit from lesser long-nosed bat through long-distance pollination. Pollen exchange over long distances may be especially important for species such as agaves that have clumped distributions. The mutualistic relationship appears to be skewed heavily to the side of the lesser long-nosed bat (Barnitz 2002, p. 8). However, further south in more tropical communities, a stronger mutualistic relationship occurs between lesser long-nosed bats and their forage species (Molina-Freaner and Eguiarte 2003, Nassar et al. 2003). Mexico has over 100 species of agaves, with some being more dependent on bats than others for pollination. For example, *Agave macroacantha* relies heavily on nectar feeding bats (Arizaga et al. 2000). The relationship of lesser long-nosed bats to their forage species needs to consider the entire range of the bat, not just the portion in the U.S.

Howell (1979) and Ober et al. (2005, p. 1619 - 1620) suggest that bats remember the location of foraging areas and plants within a population. Lesser long-nosed bat flock foraging behavior decreases overall energy costs of feeding by minimizing the time spent searching for food. Group memory reduces the potential for visiting agave flowers that have been emptied on previous nights, and increases the potential of visiting agave flowers having a large amount of nectar from more than one night of accumulation. Ober et al. (2005, p. 1619) reported that lesser long-nosed bats returned to agave foraging areas on consecutive nights and observed that changes in core use areas tended to be the result of the conclusion of nectar production in the original area. Lesser long-nosed bat visitation rates to individual agave plants increased as the number of flowering umbels per plant increased and was higher at plants where blooming had progressed to the mid-inflorescence and decreased again as blooming moved to the top of plants (more flowers are in the middle umbels) (Figure 8). Peak visitation occurred at 2100 h, which is when nectar production is the highest. Thus, foraging areas that experience regular and ongoing use, based on nectar and pollen production, may be of particular importance to lesser long-nosed bats. Ober et al. (2000) calculated that a population of 100,000 bats would need an average density of 0.16 flowering plants/ha over a 3771 km^2 foraging area surrounding a roost. However, density over a broad area is probably less of a determinant than arrangement of food plant populations and density of flowering plants within those populations.

Figure 8. View of a flowering agave from Fort Huachuca showing the greatest number of flower panicles about midway up the stalk (D. Buecher photo).

Ober et al. (2005, p. 1620) presents evidence that lesser long-nosed bats select areas with both high resource abundance and evidence of high resource abundance in previous years (old floral stalks), suggesting site fidelity to agave stands. The seasonal dietary specialization of lesser long-nosed bats implies that a reduction in or further fragmentation of agave populations could have serious effects on bat behavior, forcing them to commute farther, roost in suboptimal roosts, or compete with one another for food at remaining plants. These effects would be especially evident during years of low flower production, when energy expended by bats is appreciably higher.

Similar relationships exist between lesser long-nosed bats and columnar cacti (McGregor et al. 1962). Valiente-Banuet et al. (1996) found that most Mexican species of columnar cacti show a chiropterophilic pollination syndrome and flower synchronously from March to May. Bats, including the lesser long-nosed bat, were the only pollinator of *Neobuxbaumia tetetzo*, the most abundant and dominant columnar cactus in the Tehuacan Valley. Contrary to findings for multiple pollinators of columnar cacti in extratropical deserts of North America, the relationship between *N. tetetzo* and nectar-feeding bats was strong and tightly coupled in Mexico. Petit (1997) concluded that the interdependence of bats and cacti on Curacao is suggestive of coevolution, and that columnar cacti are critical for the survival and persistence of nectar-feeding bats in Curacao. Studies by Fleming (2000) showed that lesser long-nosed bats accounted for nearly 90% of the fruit set in cardon (*Pachycerius pringlei*), 45% of fruit set in saguaros (*Carnegiea gigantea*), and 30% in the organ pipe cactus (*Stenocereus thurberi*). Cactaceae may account for 90–100% of diet, particularly in northwestern sites. Penalba et al. 2006, p. 3031 – 3032) indicated that columnar cacti and, secondarily, *Agave* constituted the basic diet of both *Leptonycteris curasoae* and *Choeronycteris mexicana* in their study area. They also indicated that their samples did not reveal major diet differences from north to south, suggesting that the basic diet is about the same all over Sonora. The only conspicuous difference concerns Bombacaceae, which shows a southeast-northwest abundance gradient (Penalba et al. 2006, p. 3032). Flowers of Bombacaceae are visited and consumed by bats, particularly in central, eastern and southeastern Sonora, where they currently grow. Bombacaceae are reported as being one of the most important components of the diet of L. curasoae in southern Mexico (Penalba et al. 2006, p. 3032; Stoner et al. 2003), where they are abundant in tropical deciduous forest.

Howell and Roth (1981) presented data suggesting a 30% - 90% decline in the fecundity of three agave species from 1930 to 1976 in areas where lesser long-nosed bats had declined. Fleming (2000) showed that limitations in lesser long-nosed bat pollination reduced fruit set in cardon and organ pipe cacti. Such apparent declines in fruit set of bat-pollinated plants may not immediately affect the population structure of long-lived cactus and agave species, for which recruitment occurs only a few years per century from less than one in ten thousand seeds produced. But, it is clear that local (and possibly temporary) reductions in the abundance of nectar-feeding bats can strongly affect seed set in co-evolved plants. While these plants may not be completely dependent on lesser long-nosed bats for pollination and seed set, lesser long-nosed bats contribute significantly to the reproductive success of these species.

Lesser long-nosed bats probably employ different feeding strategies according to forage plant and nectar availability. Changes in nectar availability from year to year can have a large impact on energy expenditure. The common theme of foraging areas is the presence of a high concentration of nectar arranged in a way that minimizes time in inefficient flight. The juxtaposition (or lack thereof) of suitable night roost habitat with areas of high nectar availability is important in relation to energy expenditure, and may further define foraging areas (Barnitz 2002). Sahley et al. (1993) discuss the mechanics of traveling and foraging flight in lesser long-nosed bats and the adaptations of this species to their foraging environment.

Moreno-Valdez et al. (2004) found that the abundance of *Leptonycteris nivalis* (a species closely related to the lesser long-nosed bat) at a major roost in Mexico was correlated with the frequency of blooming agave and ambient air temperature. They suggest that the conservation of this federally-protected bat will require the maintenance of relatively large areas of wild agave. Recent research suggests that nectar availability is not likely to be a limiting resource rangewide, but that there may be areas or years where nectar availability affects lesser long-nosed bat numbers and distribution (Billings 2005, p. 3 – 4; Howell 2005, Slauson and Dalton 1998)

Bats play several major ecological roles in many ecosystems. Specifically, lesser long-nosed bats are important mobile links as pollinators which contribute to the reproductive success of many plant species. Their decline could likely cause significant alterations in the ecological functioning of various ecosystems (Medellín 2003). Through seed dispersal, bats have established a mutualistic interaction with many plant species. Seed-dispersal rate by bats is comparable to or higher than that by birds (Medellín 2003). Godinez-Alvarez and Valiente-Banuet (2000) and Rojas-Martinez et al. (2012, p. 375 – 377) found that lesser long-nosed bats were important seed dispersers of columnar cacti in the Tehuacan Valley of Mexico. The seeds of 21 different cactus species were collected from lesser long-nosed bat guano. This diversity of seeds suggests that cactus fruits are a common food for this nectar feeding bat in central Mexico (Rojas-Martinez et al. 2012, p. 375). Lesser long-nosed bats removed the ripe fruits, carried them to a feeding roost, and dropped seeds under the roost as they fed on the fruits. In addition to dispersing the seeds, lesser long-nosed bats deposit the seeds in a microclimate (under the canopy of trees and shrubs used as feeding roosts) that is more favorable for germination (Godinez-Alvarez and Valiente-Banuet 2000; Rojas-Martinez et al. 2015, p. 87 – 88; Rojas-Martinez et al. 2012, p. 376).

Other studies emphasizing the relationship between lesser long-nosed bats and their forage species include Nabhan and Fleming 1993, Fleming and Sosa 1994, Howell 1994, Petit and Pors 1996, Slauson 1999, Fleming 2000, Slauson 2000, Stoner et al. 2003, Nassar et al. 2003, Molina-Freaner and Eguiarte 2003, Fehmi et al. 2004, Moreno-Valdez et al. 2004, Ober and Steidl 2004, Quesada et al. 2004, and Scott 2004.

One interesting aspect of the foraging behavior of lesser long-nosed bats is the fact that they readily find and use hummingbird feeders as a forage resource (Buecher and Sidner 2013, Wolf 2006, Town of Marana [http:www.maranaaz.gov/bats]) (Figure 9). Some hypothesize that the year-round presence of hummingbird feeders in southern Arizona and New Mexico support lesser long-nosed bats staying later in the year in these areas, perhaps even year-round. It is possible that this extra availability of forage resources may be one factor that has led to the lesser long-nosed bat's increased stability and progress towards recovery. The increase and permanent presence of hummingbird feeders at homes in southern Arizona and New Mexico may supply a consistent forage resource for these nectar-feeding bats that allows them to use and remain in areas when natural forage resources are absent or reduced (R. Sharp, pers. comm. to R. Medellín). Alternatively, the long-term effects of staying longer before migrating southward and the questionable nutritional value of the sugar water in the hummingbird feeders are unknown and could actually be detrimental. More study related to these issues is needed.

In 2006, in southern Arizona, there was a significant failure of blooming agaves. As a result, many members of the public reported that bats were using their hummingbird feeders that year. The USFWS and the AGFD had seen how a study initiated by Wolf in 2004 was able to use the public as citizen scientists to track the use of hummingbird feeders by lesser long-nosed bats (Wolf 2006) and initiated an expansion of Wolf's efforts to use citizen hummingbird feeder

Figure 9. Lesser long-nosed bat feeding at a hummingbird feeder (Photo courtesy of Meg Benhase)

monitors as an effective tool for tracking aspects of the lesser long-nosed bat's life history such as arrival and departure dates, demographic data, relative abundance, and behavioral patterns. The USFWS, AGFD, and the Town of Marana initiated this citizen scientist feeder watch program in 2007 and, over the past approximately 10 years, the volunteer network of feeder watchers has grown to over 100 individuals monitoring their hummingbird feeders across southern Arizona. This has resulted in a tremendous amount of data and some very interesting results. As this study has progressed, it has generated a number of additional questions for study. For example, as seen in Figure 10 below, the area where lesser long-nosed bats have been documented in Tucson has expanded. Does this mean there are there more bats or more hummingbird feeders? It appears that finding and using hummingbird feeders as a forage resource is not a learned behavior. Approximately 90 percent of bats captured at hummingbird feeders are young of the year or juveniles, not adults (Fleming 2014; USFWS unpublished data). Therefore, adults do not appear to be teaching their offspring where to forage at hummingbird feeders, but this does not preclude this being a learned behavior, however, more study is needed to understand how this learning process occurs.

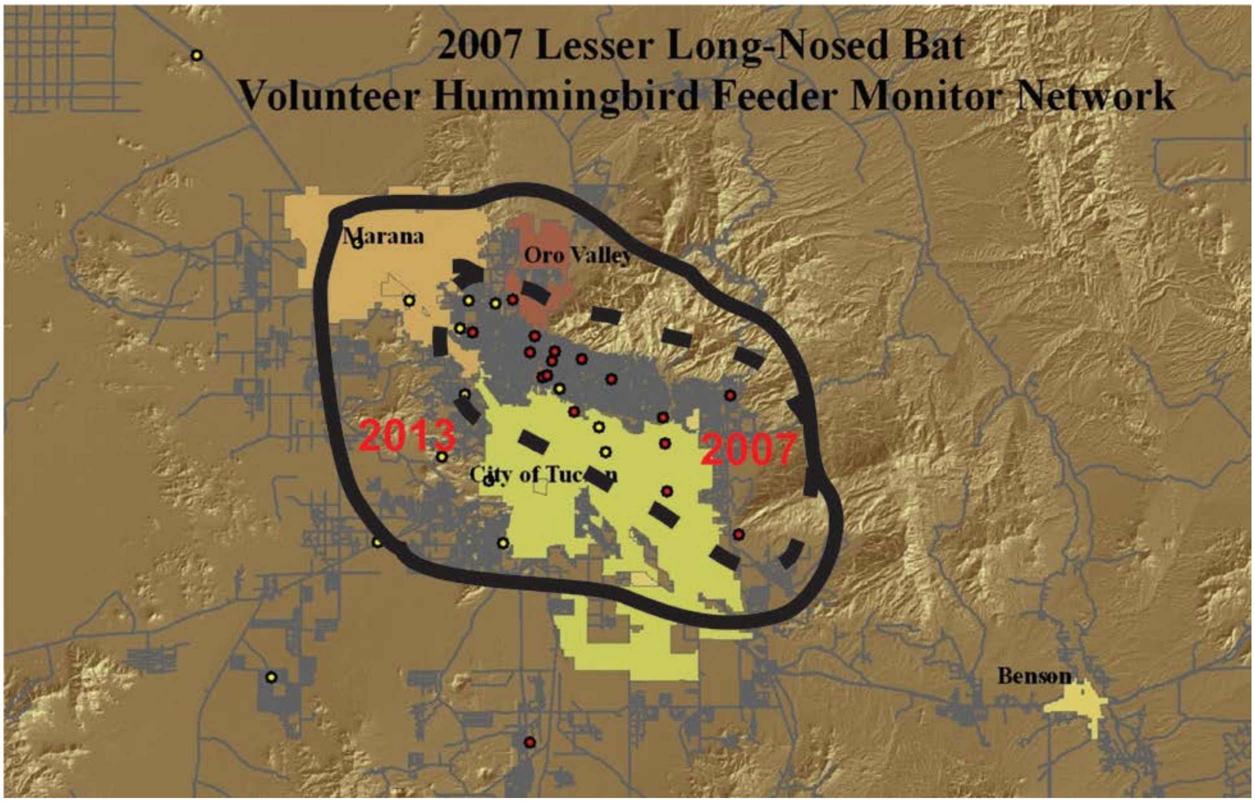

Figure 10. Map showing expansion of area used by lesser long-nosed bats visiting humminbird feeders in Tucson – 2007 (red dots) to 2013 (yellow dots). (Map courtesy of Ted Fleming)

As more information is obtained through the hummingbird feeder watch project, additional questions for future research have been formulated. The following briefly summarizes some of the results of this informative citizen scientist hummingbird feeder monitoring project:

- The lesser long-nosed bat is a common seasonal visitor to hummingbird feeders in Tucson and other locations in southern Arizona.
- These bats visit feeders between mid-August and mid-October.
- Large numbers of bats (>20) can visit particular sites.
- Most of these visitors are non-adults, and the sex ratio is strongly female-biased.
- These bats commute long distances from day roosts and have large feeding areas.
- The use of hummingbird feeders by Leptonycteris bats in Tucson has expanded between 2007 and 2014 (Fleming 2014, entire).

Reproduction **–** Female lesser long-nosed bats give birth to one young per year, with the time of mating and parturition varying geographically (Ceballos et al. 1997). The sex ratio at birth is 1:1 (Hayward and Cockrum 1971). There appear to be two reproductive patterns followed by this species: northern spring births and southern winter births. In both, males and females breed only once per year (Rincón-Vargas et al. 2013, p. 493 – 494).

Lactation lasts four to eight weeks (Cole and Wilson 2006, p. 3), and young are volant after about one month and begin venturing out of the maternity roosts at about two to three weeks later (Cole and Wilson 2006, p. 3).

Males are reproductively active in late fall on San Andres Island, Jalisco (Rincón-Vargas et al. 2013, p. 493 – 494; Ceballos et al. 1997, p. 1226 - 1227), but further south at Las Grutas, Michoacan, peak male reproductive activity occurs in June (Fleming and Nassar 2002). Mating takes place in central Mexico in November-December (northern birth pattern) or May-June (southern birth pattern). In both instances, birth and nursing occur during peaks in flower and fruit availability in the Sonoran desert (spring births) or in tropical dry forests (winter births).

It was previously hypothesized that the lesser long-nosed bat was a year-round resident in southern Baja California (Fleming and Nassar 2002). However, recent work by Frick shows that the majority of maternity colonies throughout the peninsula are abandoned in mid-winter (Frick, unpublished data). There are a few individuals (primarily males) present year round in one monitored site in the southern peninsula (Frick, pers. comm.). Timing of reproduction varies on the Baja peninsula, with maternity sites in the mid-peninsula having a synchronized early April birthing pulse that corresponds to flowering of cardon cactus (*Pachycereus pringlei*), the primary food resource in this region (Frick et al. 2013, p. 137), and maternity sites in the southern peninsula that have winter-blooming agaves and a winter blooming columnar cacti (*Pachycereus pectin-aboriginum*) with female lesser long-nosed bats giving birth between February and April (Frick, unpublished data). Additional information related to the specific internal and external indicators of male lesser long-nosed bat reproduction status is discussed in Rincón-Vargas et al. (2013, entire). Of particular interest in this study is the description of the formation of a dorsal patch in reproductive males (Rincón-Vargas et al. 2013, p. 489) and a single period of spermatogenesis (Rincón-Vargas et al. 2013, p. 493).

For additional information related to the population dynamics of the different birthing and migration patterns of the lesser long-nosed bat, see Chapter 3 – Population Dynamics.

Migration **–** Migration is a key aspect of the life history of one segment of the lesser long-nosed bat population. The northern population segment of *L. yerbabuenae* is migratory (Arroyo-Cabrales et al. 2008, p. 3). Each year, at the beginning of the spring, this segment of the population (almost exclusively females) migrates from the tropical and subtropical areas of Mexico in the north region of the country to the Sonoran desert of the southwestern U.S. and northwestern Mexico (Hayward and Cockrum 1971; Fleming et al. 1993). Records document that lesser long-nosed bats, specifically pregnant females, arrive in northern Sonora and southwestern Arizona in early April to give birth. These maternity roosts are occupied until the middle or end of September. In New Mexico, lesser long-nosed bats arrive later, in mid-July to early August, and then migrate south at the beginning of September into October (Cockrum and Petryszyn 1991). Although it was originally thought that migration occurred from two independent migratory routes (Wilkinson and Fleming 1996; p. 335 - 338), recent genetic studies (Ramirez 2011; entire) show that there is likely just a single population of lesser long-nosed bats and that migration movements may just be along a single looping migration pathway. This circular migration pattern supports the bats in the spring moving from the tropical dry forest of the Pacific toward the Sonoran desert to give birth and then to southern Arizona and New

Mexico, where they spend the late summer (see Chapter 3 for additional discussion related to hypothesized migration pathways). Conversely, in the autumn (September and October), bats begin their return south into Mexico, primarily along the Sierra Madre Occidental, although some individuals use migration pathways through the tropical dry forest. Such migration pathways characterize a diffuse migration (Téllez 2001). It has been suggested that the migration routes that lesser long-nosed bats follow are influenced by the "nectar trail" of CAM (crassulacean acid metabolism) plants (succulents and cacti) that are present in northern Mexico and the southwestern U.S. and that continue to the south with the agaves (Fleming et al. 1993). The winter is spent in the tropical dry forest of the Pacific, from Chiapas to the states of Jalisco and Sinaloa (Medellín, pers. obs. and Rojas-Martínez et al. 1999).

Table 3 summarizes the basic life history needs of the lesser long-nosed bat.

Need	Description	References
Roosts	• Day Roosts – caves, mines, crevices with appropriate temperatures and humidity; reduced access to predators; free of the disease-causing organisms (fungus that causes white-nose syndrome, etc.); limited human disturbance; structural integrity maintained; diversity of locations to provide for maternity, mating, migration, and transition roost sites. • Night Roosts – protected area in caves, mines, crevices, vegetation, and structures such as buildings and bridges; limited human disturbance; protection from predators; in proximity to forage resources and day roosts.	Cole and Wilson 2006, Medellín and Torres 2013, Hoyt et al. 1994, AGFD 2016, Bogan 2005, Buecher 2016, AGFD 2013, NPS 2016, USFWS 2007, Fleming et al. 1998, Frick 2016.
Forage	• Resident Areas – sufficient stands of columnar cacti, agaves, and flowering tree species in proximity to maternity, mating, and transition roosts. • Migration Pathways – columnar cacti, agaves, and flowering tree species distributed across the range of the species and along migration pathways forming a “nectar trail” with blooming and fruiting phenologies that support the seasonal migrations of the lesser long-nosed bat.	Cole and Wilson 2006, Godinez-Alvarez and Valiente-Banuet 2000, Horner et al. 1998, Valiente-Banuet et al. 1996, Rojas-Martinez et al. 2012, Medellín and Torres 2013, USFWS 2007, Stoner et al. 2003, Nassar et al. 2003, Molina-Freaner and Eguiarte 2003, Fehmi et al. 2004, Moreno-Valdez et al. 2004, Ober and Steidl 2004, Quesada et al. 2004, Arita and Santos-Del-Prado 1999, and Scott 2004

Migration Pathways	• Location – intact habitat that provides cover, forage, and roosts to support the hypothesized migration pathways along the Pacific Coast and the Sierra Madre connecting areas from south and south central Mexico to the southwestern U.S. These pathways should be free of impediments or threats such as wind turbines, large urban areas, etc. • Forage – migration pathways containing a diversity of forage resources that provide seasonally available forage to support annual migration movements. • Roosts – caves, mines, and crevices to provide day and night roosts characterized by limited predation and human disturbance and that provide cover and protection during annual migration movements.	Wilkinson and Fleming 1996; Cole and Wilson 2006, Rojas-Martinez et al. 1999, Krebbs 2005b, Medellín and Torres 2013, USFWS 2007, Hayward and Cockrum 1971, Fleming et al. 1993, Cockrum 1991, Téllez 2001,

CHAPTER 3. POPULATION DYNAMICS

Many questions remain unanswered with regard to the population dynamics of the lesser long-nosed bat. However, recent work does enlighten us with regard to how the lesser long-nosed bat population functions.

Wilkinson and Fleming (1996) suggest that there are two migration routes used by lesser long-nosed bats as they move northward from Mexico: 1) a Pacific coastal route ranging from at least Guerrero in the south to Arizona and 2) a Sierra Madrean inland route, possibly ranging as far south as Chiapas to Arizona (Figure 11). Lesser long-nosed bats in southwestern Arizona show genetic affinities with bats from Pacific coastal sites. Lesser long-nosed bats roosting in southeastern Arizona show genetic affinities with Mexican bats from inland sites. Under this hypothesis, lesser long-nosed bats move north and south along two distinct paths, one to southwestern Arizona, and another to southeastern Arizona and southwestern New Mexico.

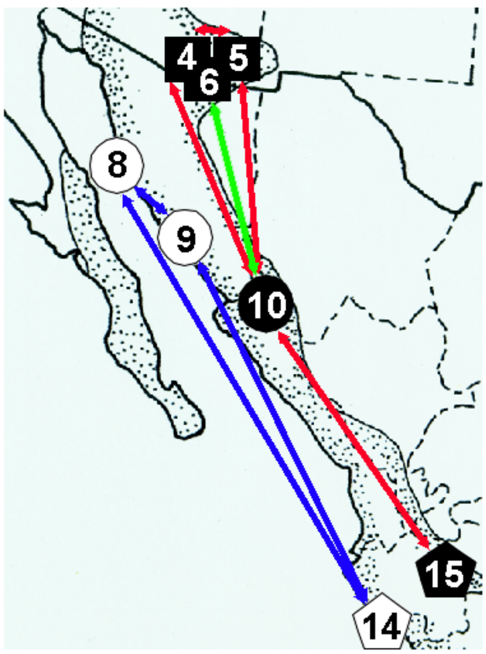

Figure 11. Hypothesized migratory pathways of *Leptonycteris curasoae* based on clusters of rare haplotypes sampled from individuals at multiple roost types. Shared identical or closely related haplotypes are designated by site color: B = white, OO/SS/G = black. Symbols indicate roost type: mating (pentagon), maternity (circle), or post-maternity (square) (Map from Newton et al. 2004, p. 38). **Note**: Not all known roosts are represented by this map. For example, maternity roosts in Arizona and northern Sonora are absent from this map. This map does generally represent the hypothesized migration pathways, but does not include all known roosts.

However, interestingly, not all segments of this species' population are migratory. It has been suggested that there are two female population demes: one that migrates from the center and west of Mexico toward the Sonoran desert in the summer where they give birth and another resident population that is maintained throughout the year in the tropical dry forest of the Pacific, generally found from Chiapas to Sinaloa, extending to la Cuenca de Balsa. This population segment gives birth in the winter in this region (Ceballos et al. 1997, p. 1226 – 1227; Stoner et al. 2003, p. 362 – 363; Ramirez 2011, p. 12; Medellín, pers. obs.).

Dr. Rodrigo Medellín provided a summary of population dynamics in Mexico based on his ongoing work (Medellín 2005). He indicates that this species has a complex life history with two female "demes" where reproduction is temporally and spatially displaced. On the one hand, the more discrete, temporally concentrated birth season happens in early May in the Sonoran Desert from southern Sonora to Arizona. The more diffuse (temporally and spatially) winter birth season happens primarily throughout the tropical dry forest of Mexico from Sinaloa to Guerrero and on to Chiapas along the west coast, and inland at least into the Balsas Basin. Dr. Medellín and his coworkers have documented maternity colonies in the states of Chiapas, Guerrero, Michoacán, Sinaloa, Jalisco, and Hidalgo, from November through February. He believes that there are many more maternity colonies in the winter (i.e. southern birth pulse) than in the summer (i.e. northern birth pulse). However, it appears that the winter maternity colonies are smaller numerically than the largest colony known in the Pinacate in Sonora. Most of the winter maternity colonies are around 20,000 to 30,000 pregnant or lactating females. On a single occasion, in the winter of 2000, they documented a much larger colony, an estimated 120,000 pregnant females, in the southernmost recorded maternity colony in the state of Chiapas. This colony is normally between 20,000 and 30,000.

Work in Mexico continues to track movements and provide information about seasonal feeding habits and dynamics. Dr. Medellín believes that it is accurate, at this point, to say that a certain proportion of the lesser long-nosed bat population remains in central Mexico year-round, as has been suggested in the literature. Although migratory as a species, the migration pattern is diffuse and opportunistic. In central Mexico there are food resources available year-round, with an important seasonal fluctuation. If sufficient resources are produced in certain years, more bats will remain behind and not migrate. If fewer resources remain during the summer, maybe more bats will show up in the Sonoran Desert. It is unknown whether these two ecosystems (tropical dry deciduous forest and Sonoran Desert) have any kind of correlation in terms of the production/availability of resources in a certain year, be it complementary, additive, or otherwise. Work in Mexico is aiming at understanding this pattern and process over the next several years.

A study by Cristobal et al. (2004) provides the first documentation of the continuous presence of a substantial female population of lesser long-nosed bats throughout the year in a single roost in the Mexican tropics. This indicates that some populations of lesser long-nosed bats in central Mexico complete their lifecycle without having to migrate. Rojas-Martinez et al. (1999) also examined the existence of migratory and non-migratory portions of the lesser long-nosed bat population. Stoner et al. (2003) emphasized the need to protect roosts that are used year-round by resident lesser long-nosed bats in Mexico, and not just focus on migratory routes and northern maternity roosts in Sonora and Arizona.

Dr. Medellín believes that there is genetic flow between the two described demes, and the genetic work by Ramirez (2011, p. 54 - 59) supports this supposition. How and why this flow happens is still an open question, although they are making progress in this sense too. Specifically, a particular female of this species is likely to reproduce but a single time in a year; in other words, it is highly unlikely that a particular female will reproduce once in the north in the summer and again in the winter in the south. This would provide a certain speciation pressure to make the two demes independent species, except for the fact that all bats of this species seem to coexist during the winter in central-western Mexico, where at least some genetic flow occurs, thus preventing speciation.

As an alternative to the above hypothesis, a more circular pattern of migration has been suggested. Under this hypothesis, lesser long-nosed bats move north in the spring to southwestern Arizona, to give birth in maternity roosts. During this season, columnar cacti are the primary food sources. Following birth, and after the young are volant, the coincidental decline of food resources around maternity roosts and the increase of available food in the form of blooming agaves, results in lesser long-nosed bats moving north and east to late summer roosts. Here, lesser long-nosed bats feed on agaves until they migrate south, back to Mexico, in October and November. The Arizona-Sonora Desert Museum completed a two-year study to determine if lesser long-nosed bats at maternity roosts in southwestern Arizona migrate north and east to southeastern Arizona in response to the end of maternity season and changing availability of food resources. Krebbs et al. (2004) and Krebbs (2005b) used a number of different marking techniques, including microchips and telemetry, to monitor lesser long-nosed bats when they left their maternity roosts. One bat in 2004 and one bat in 2005, each fitted with a radio transmitter, were located in southeastern Arizona after being marked in a maternity roost in southwestern Arizona. While this sample size is small, the study does provide evidence that, at least some lesser long-nosed bats move north and east to forage on agaves before moving south back to Mexico in late fall.

Ramirez (2011, p. 44) isolated 12 microsatellite markers from 16 locations in Arizona and Mexico. The average observed heterozygosity was 0.581 (range from 0.240-0.865). Ramirez (2011, p. 54 - 59) also investigated population structure of the lesser long-nosed bat and reported that combined results indicated sampled individuals belong to one population which suggests movement between maternity colonies in Arizona and southeastern transient roosts in Arizona. Consequently, individuals found in the northern migratory range and in Mexico should be managed as a single population.

CHAPTER 4. INFLUENCES ON VIABILITY

In this chapter, we evaluate the past, current, and future factors that are affecting what the lesser long-nosed bat needs for long term viability, including both positive and negative influences.

Issues such as illegal border activities, drought, catastrophic fire, and other impacts to roost sites and foraging habitat continue as potential threats to lesser long-nosed bat habitat in both the U.S. and Mexico. Our current state of knowledge with regard to threats to this species has changed since the development of the recovery plan. Threats to forage species from grazing, the tequila industry, and prescribed fire are likely not as severe as once thought. Bat roost occupancy and numbers appear to be stable to increasing on landscapes subject to livestock grazing; the tequila industry is working to reduce impacts to lesser long-nosed bats and contributing to conservation of the species; and data from prescribed fires indicate that a relatively small percentage (<10%) of agaves are significantly affected by the burns and the burns appear to remove competition from dense ground cover. Some progress has been made towards protecting known roost sites. However, a significant new threat in the form of illegal border activities has been observed. In addition, urban development, catastrophic fire and a changing fire regime resulting from non-native, invasive plants are threats that are ongoing or evolving and must still be considered. The colonial roosting behavior of this species exposes a high percentage of the population to impacts from existing threats. The realization of these threats at only one or two roost sites may have significant population-level impacts.

Roost threats - Much of the debate as to the legitimacy of the 1988 listing of the lesser long-nosed bat centers around the population numbers and trends recorded from roost site monitoring. At the time of listing, population numbers and trends used by FWS in determining the endangered status of the lesser long-nosed bat showed low numbers and a declining trend (Wilson 1985). Information gathered since the listing show higher population numbers and a generally stable to increasing trend (Cockrum and Petryszyn 1991, AGFD 2005, entire, AGFD 2016, entire). Regardless of the total numbers of lesser long-nosed bats counted at roost sites, the primary threat to this species comes in the form of roost site disturbance or loss. The colonial roosting behavior of this species, where high percentages of the population can congregate at a limited number of roost sites, increases the likelihood of significant declines or extirpation due to negative impacts at roost sites. Lesser long-nosed bats remain vulnerable because they are so highly aggregated – it is one of only three cave-roosting species in Mexico that regularly occur in colonies of over 200 individuals (Nabhan and Fleming 1993).

Border activities – One of the most significant threats to known lesser long-nosed bat roost sites are impacts resulting from use and occupancy of these roost sites by individuals involved in illegal border crossings, both from individuals crossing to look for work and the trafficking of illegal substances. Mines and caves which provide roosts for lesser long-nosed bats also provide shade, protection, and sometimes water, for border crossers (Figure 12). The types of impacts that result from illegal border activities includes disturbance from human occupancy, lighting fires, direct mortality, accumulation of trash and other harmful materials, alteration of temperature and humidity, destruction of the roost itself, and the inability to carry out conservation and research activities (Figure 13). Department of Homeland Security reports on apprehensions, marijuana, deaths, vehicle seizures and other information with regard to undocumented aliens (UDAs) on public lands in Arizona annually.

Figure 12. Border activities can result in disturbance and other effects to lesser long-nosed bat roost sites

The number of illegal border crossers increased dramatically in the early 2000's, but then activity was reduced through the installation of border infrastructure such as pedestrian and vehicle fencing and hi-tech monitoring towers. During this period of high border activity, the effects of increased border traffic became evident at some known lesser long-nosed bat roost locations. The Blue Bird roost on Cabeza Prieta National Wildlife Refuge was abandoned during three years due to illegal border activities (McCasland 2005). During this time, monitoring and research at the large maternity roost on Organ Pipe Cactus National Monument was reduced or eliminated because of researcher safety concerns related to border issues (Tibbitts pers. comm.). However, these restrictions have been removed in recent years. In addition, illegal border crossers had typically used the valley adjacent to the roost area. In 2005, trails, trash and other indicators of illegal crossing activities moved to an area adjacent to the maternity roost site (Billings 2005, p. 1). More recently, probably in response to new border infrastructure, much of the illegal traffic has shifted to more mountainous areas. However, this roost is remains quite visible and there is a concern that it is only a matter of time before there is occupancy or use of the roost site by people crossing the border.

Comments submitted by Curt McCasland, Assistant Refuge Manager at Cabeza Prieta NWR, during the 5-year Review process describe the gravity of this threat to the limited number of know roost sites. He stated, “There is evidence of illegal smuggling activities less than one tenth of a mile from the mine adit. We continue to be concerned that the fence will be damaged and the adit will be utilized by smugglers, possibly forcing the bats to once again abandon the adit (McCasland 2005).” Approximately two months after submitting these comments, the protective fence at this roost site was vandalized by smugglers and the bats abandoned the roost (McCasland pers. comm.).

Mr. McCasland continues, “Furthermore, we are aware of numerous smuggling trails in close proximity to the mine adit used by lesser long-nosed bats on Organ Pipe Cactus National Monument. Given the paucity of maternity colonies in the United States, any loss is significant.” “In fact, threats may now be more significant than at the time of the initial listing of the lesser long-nosed bat as an endangered species (McCasland 2005)." Recent data from Cabeza Prieta National Wildlife Refuge indicates that the current situation is still worrisome. Apprehensions of illegal border crossers as reported on Cabeza Prieta National Wildlife Refuge rose from 639 in 2015 to 998 in 2016, a percent change of 56% (USFWS unpublished data).

Information from this same time period provided by Organ Pipe Cactus National Monument echoes this concern. "However, in recent years, it appears anthropogenic threats, especially border related activities (e.g., illegal immigration and drug smuggling) appear to be increasing near this colony. These activities, which are at their peak of intensity from January through June, also correspond with the time period that *Leptonycteris* occupy the Copper Mountain roost. We are concerned that illegal immigrants and/or smugglers and/or law enforcement officers may enter Copper Mountain and cause disturbance of the roost during this critical time frame. Such human disturbance could potentially affect approximately 25,000 adult female bats and offspring. This event would have a substantial impact on the status of this species in the southwestern United States (Billings 2005, p. 1)." Recent data indicates that use of this area by illegal border crossers continues to be a concern. Apprehensions of illegal border crossers reported on Organ Pipe Cactus National Monument were 3,418 in 2015 and 4,915 in 2016, an increase of 44%. Patterns of cross border traffic are continually changing and, while the level of use in proximity to this important maternity roost may rise and fall, it nonetheless occurs in an area where it is vulnerable to disturbance by border traffic.

In another part of Arizona, a new late-summer roost was discovered in 2000. During the August 2005 simultaneous roost count, the individual monitoring this roost noted substantial evidence that the roost had been used by illegal border crossers. The landowner of this site confirmed that illegal border traffic had increased recently (Dalton pers. comm.). Evidence of illegal border traffic is still seen at this roost site.

Figure 13. Trash in a lesser long-nosed bat roost left by illegal border crossers using the mine as a stopover hiding location

Comments from Coronado National Memorial also received during development of the Lesser Long-Nosed Bat 5-year Review: “Heavy illegal cross-border traffic of undocumented aliens (UDAs), including immigrants and smugglers, intensifies the need to protect the roost site of the endangered lesser long-nosed bat (LLNB) at Coronado National Memorial. Specifically, UDAs often use mines and caves as hiding spots, yet the LLNB roost on the Memorial is currently protected only by cable nets, which can be (and have been) breached by lifting up the unsecured bottom sections or cutting. Therefore, the probability of disturbance to bats has increased with the rise in UDA traffic coming through the Memorial, and evidence of human presence has been found more frequently near the main roost site and at some potential roost sites in recent years. UDA apprehension on the Memorial rose from only 289 in 1996, to 2,551 in 2000, and to 7,633 in 2003. However, in 2003, the total number of UDAs detected entering the park was 30,626, over four times the number actually apprehended (total entry numbers are calculated from reported sightings by law enforcement personnel, sensor data, and apprehension data) (Mann 2005).” It should be noted that the roost site at Coronado National Memorial has since been gated and is no longer as vulnerable to disturbance. Increased border protection infrastructure has also reduced the level of cross-border traffic in this area, although it still occurs regularly. Apprehensions of illegal border crossers on Coronado National Memorial were 6 in 2015, and 3 in 2016, a decrease of 50%.

The threat of disturbance of roost sites by border crossers is not likely to decrease in the near future. Nearly half a million people cross into Arizona illegally each year. It has been estimated that each immigrant leaves behind approximately eight pounds of trash, resulting in nearly 2,000 tons of trash being dumped in the desert each year (USINFO 2005, entire; Judicial Watch 2012, entire). In 2016, more than 32,000 illegal border crossers were apprehended on U.S. Fish and Wildlife Refuge, DOD, National Forest, National Park, and reservation lands in Arizona alone (USFWS unpublished data). In addition, 206 vehicle seizures were reported by DHS in 2016 on U.S. Fish and Wildlife Refuge, DOD, National Forest, National Park, and reservation lands in Arizona (USFWS unpublished data).

It is important to note that impacts from border activities are not restricted to just the immigrants or smugglers. Management of this problem, including law enforcement and apprehension of illegal immigrants and smugglers can also result in impacts to lesser long-nosed bats and their habitat. Of particular concern is the creation of new roads for surveillance. Use of helicopters, off-road vehicles, lights, sensors and other enforcement equipment all have the potential for effects to lesser long-nosed bats and their habitat. Border enforcement is beginning to use drones as an enforcement tool. Use of drones by both the public and private sectors is an issue to monitor for potential effects to lesser long-nosed bats. The potential negative effects of border enforcement must be balanced with the fact that decreases in illegal border activities, which can often be more detrimental to the bat, are often the result of increased law enforcement presence on the landscape. Various local militia-type groups will also organize on occasion and implement patrols and monitoring to document and report illegal border activities. These groups are not likely aware of the location of lesser long-nosed bat roost or important foraging areas and may impact such areas with their activities.

Recreation – Caves and mines continue to attract recreational users interested in exploring these features. This threat has probably not increased since the listing, but continues to be an issue. Cave locations, some of which are lesser long-nosed bat roosts, are more widely known now than in the past. Managing recreational use of roost sites may be a substantial impact because of safety and liability concerns that may lead to the closing of the roost site (see the Mine Closure discussion below).

Vandalism – The deliberate destruction, damage, or defacing of caves and mines for whatever reason is a threat to lesser long-nosed bat roosts. This does not appear to be as big of a threat in the U.S., but vandalism has been identified as perhaps the single most important threat to the lesser long-nosed bat in Mexico (Medellín 2005). The 1988 listing rule stated that bats were often killed by vandals (USFWS 1988, p. 38459). However, significant changes in the public perception of bats are occurring. Educational efforts are beginning to make a difference.

Fire – Catastrophic wildfire may result in impacts to roost sites. The fire itself can result in short-term impacts from smoke and heat. More lasting impacts can result if the microclimate of the roost is affected by the impact of the fire (removal of vegetation, change in air currents, alteration of hydrology, etc.). In 2005, the Florida Fire in the Santa Rita Mountains, south of Tucson, burned in areas affecting late summer roost sites for the lesser long-nosed bat. Post-fire monitoring has not occurred, but smoke and suppression efforts (fire retardant and water drops, helicopters, etc.) could potentially affect these roost sites (USFS pers. comm.). The ongoing drought and past fire suppression efforts make fire a continuing threat to roost sites.

Fire is an associated threat resulting from the illegal border activities discussed above. In 2002, illegal immigrants are suspected of having caused eight major wildfires. The wildfires destroyed 68,413 acres (about 108 square miles). Escaped campfires start wildfires when border crossers attempt to warm themselves or cook food, especially during the colder months from late fall through spring (USINFO 2005).

Vampire Bat Control – Vampire bat control is implemented in portions of the lesser long-nosed bat range in Mexico. This control is necessary because of potential impacts to humans and livestock, including the transmission of rabies. Such control can result in the indiscriminate killing of non-target bats, including lesser long-nosed bats (Johnson et al. 2014; p. 1920 – 1922). Roost sites supporting lesser long-nosed bats can be destroyed as part of vampire bat control. Ongoing educational efforts have improved the identification of bat species in targeted vampire bat control and improved the understanding of the general public and agricultural operators with regard to methodology. While the occurrence of rabies transmitted by vampire bats has been reduced in some countries, it has actually expanded in Mexico (Johnson et al. 2014, p. 1922). Some of the general population still views bats with fear and suspicion. In Mexico, the impact of vampire bats on the livestock industry and perceived threats to humans has resulted in various vampire bat control and eradication efforts. Genuine vampire bat control is badly needed in some regions of Mexico and Latin America due to economic losses. If control efforts fail to differentiate between bat species, many other species of bats are killed, including lesser long-nosed bats. The promotion of properly applied, vampire-specific control methods, rather than indiscriminate methods, is still needed. Alternatively, actions, such as the vaccination of livestock, need to be investigated for wider use and the development of economically viable application of livestock vaccination needs to occur in order for farmers and ranchers to be able to use this approach (Johnson et al. 2014; p. 1921).

Mine closures – Many public agencies with land management responsibilities must consider the liability of caves and mines occurring on the lands for which they are responsible. If lesser long-nosed bat roosts in mines or caves are deemed a public safety threat, the agency may take action to permanently close the roost site. This obvious direct effect to a roost site would be significant. Most land management agencies (FS, BLM, NPS, etc.) have an ongoing program to close abandoned mine sites. Pima County, in southeastern Arizona, has pursued mine closures on lands that they have acquired for conservation purposes. A positive aspect of this mine closure process is that most agencies and landowners now understand the value of these features to bats and other wildlife. Typically, prior to closure, surveys and monitoring of these sites occurs to identify use by wildlife. Often, if bats are documented using the features, bat-friendly closure methods will be used, although current information leads us to believe that bat gates are not accepted as well by lesser long-nosed bats as they are by some insectivorous bats.

Forage Availability – Lesser long-nosed bats have the ability to forage over long distances to obtain resources. In fact, long commuting flights are a particularly striking aspect of the foraging behavior of lesser long-nosed bats. These long commuting flights are a likely a consequence of the gregarious roosting behavior of this species and the need for these relatively large concentrations of bats to obtain adequate forage resources from the available forage (Horner et al. 1998, p. 582 - 584). They will often bypass foraging sites close to their day roosts and utilize forage resources long distances from their roosts. While we do not completely understand why they do this, it emphasizes the need to protect forage resources not only in proximity to roosts, but also at relatively long distances (>40 miles) from known roosts. Impacts to forage availability include drought, invasive plant species, fire, grazing, and urban development.

Fire – In 2005, it became evident that fire is an important factor related to potential forage availability for the lesser long-nosed bat. As a result of ongoing drought and years of fire suppression on National Forests, two catastrophic wildfires (Florida and Cave Creek Complex fires) and a number of smaller ones affected potential foraging habitat for a number of lesser long-nosed bat transition roosts. While the effects of fire on agaves and saguaros have been studied to some extent, the long-term effects of fire on forage availability are not completely understood.

There is limited information available on the effects of fire on agaves and bats. Slauson and Dalton (1998) concluded that the short-term effects of fire on flowering agaves were limited. In fact, they found that burned plants produced significantly more nectar and had higher sugar concentrations than unburned plants. Pollen production and seed set were also unaffected by burning. Bat monitoring did not show a preference for agaves in burned or unburned areas. The short-term effects of fire on flowering agaves appear limited, but this study did not address the long-term impacts on agave survival, reproduction, or distribution.

Some agency monitoring has occurred post-fire for both wildfires and prescribed burns. This monitoring indicates that agave mortality in burned areas is generally less than 10% (USFS 2015b, p. 82 – 83; USFS 2013, p. 10 – 11). Thomas and Goodson (1992) and Johnson (2001, p. 37) reported 14% and 19% mortality of agaves, respectively, following burns. Contributing to this relatively low mortality rate is the fact that most fires burn in a mosaic, where portions of the area do not burn. Impacts of fire on agave as a food source for lesser long-nosed bats may not be a big concern for the following reasons: fire-caused mortality of agaves appears to be low; alternative foraging areas typically occur within the foraging distance from lesser long-nosed bat roosts; and most agave concentrations occur on steep, rocky slopes with low fuel loads (Warren 1996, p. 2 - 4). In addition, Johnson (2001, p. 35 – 36) reported that recruitment of new agaves occurred at higher rates in burned plots than in unburned plots, indicating that there may be an increased availability over time of agaves in areas that have burned, if the return rate of fire is greater than seven years.

However, Howell (2005) indicated that agave reproduction could be substantially affected by fire. While monitoring agaves for five years on Fort Huachuca, she found that most seeds germinate right under or among the dying leaves of the parent plant. Vegetative reproduction also occurs adjacent to parent plants. She found that the dead agave rosettes are very flammable, with the hearts of these old plant burning long and hot, resulting in the death of adjacent young plants. Johnson (2001, p. 37 – 38) also showed that agaves associated with adjacent trees or agaves had a higher mortality rate during a burn. Additionally, the increased occurrence of invasive plant species, particularly invasive grasses, may increase the potential for fire impacts on agaves. Conversely, land management agencies are implementing “firescape” planning that will reduce the potential for large, catastrophic wild fires that will likely reduce fire effects on agaves.

Slauson and Dalton (1998) correctly indicate that there is still much to learn related to agave/bat/fire relationships. Few data exist on this issue, and what has been generated is preliminary in nature. They suggest that additional research is needed to more clearly define the interrelationships between burning and 1) nectar volume and sugar concentrations; 2) pollinator populations and foraging behavior; 3) agave fruit- and seed set; and 4) long- and short-term effects of various burning frequencies on agave population biology. The effects of fire on lesser long-nosed bat forage species should be the subject of continued study.

Grazing – Cattle can preclude flower development in agaves by grazing the emerging flower stalk, ultimately reducing forage abundance for the lesser long-nosed bat. Widmer (2002) found that the number of agave bolts subject to herbivory was greater in areas where livestock grazing occurred during the bolting season (74.9%) versus areas that were not grazed by livestock during that time period (46.1%). Overall, inflorivory occurred on an average of 56% of the flowering plants. Obviously, livestock were not responsible for all of the utilization of agave flower stalks. Wildlife such as javelina, white-tailed deer, and small mammals also utilized agave flower stalks as a food resource. The extent of livestock use of agave flower stalks appears to be related to standing biomass and distance from water. Grazing intensity was higher during drier years when the standing biomass of alternative forage species was decreased. In addition, livestock use of agave flower stalks decreased the further from water the plants were located.

Livestock and wildlife will also break off the agave flower stalk to gain access to the flowers. Bowers and McLaughlin (2000) observed that 70.7% of 140 plants that initiated flower stalks were broken and did not flower. The proportion of flower stalks broken did not differ significantly between grazed and ungrazed areas.

Coronado National Memorial monitored agaves (*Agave palmeri*) in 9 plots (5 grazed, 4 ungrazed) annually in June from 1995 through 2004. Data collected include numbers of agaves in 5 different size classes, numbers of agaves that are flowering, and numbers of current-year flower stalks that have been eaten (by wildlife and/or cattle). Analyses of data from 1995 through 2003 show that compared to grazed plots, ungrazed plots have more agaves in all 5 size classes, more agaves that are flowering, and more current-year flower stalks that have been eaten. In addition, trend analyses of all data (1995-2003) indicate a drop in recruitment. That is, agaves in size class I (seedlings with a core and 1 leaf) in 1995 numbered 300, but for the years 2000 through 2003 none were present. The causes of this trend are unknown. The Memorial intended to continue this monitoring project and likely alter and expand it (Mann 2005), however, it is unknown if this has occurred. The Memorial did receive mitigation funding tied to border infrastructure projects and implemented an agave planting and restoration project that has been helpful in understanding protocols and methods for restoring area of agaves (USFWS 2013, p. 19).

Non-native invasives – Non-native, invasive plant species such as buffelgrass, Lehmann's lovegrass, red brome, and Sahara mustard have become established and are increasing in vegetation communities that provide important lesser long-nosed bat foraging habitat. Of primary concern is that the presence of these species significantly changes the fire regime. These non-native species are fire adapted, and the fuels they provide increase the occurrence and intensity of fire within the vegetation community. The Sonoran Desert is not a fire-adapted community, and the columnar cacti upon which the lesser long-nosed bat depends for food resources during the maternity season are not fire adapted. The occurrence of fire in the Sonoran Desert community results in the loss of these non-fire-adapted species. Microclimates in areas where these non-native plant species occur are not suitable for the germination and establishment of columnar cacti. The issue of non-native, invasive plants is significant in both the U.S. and Mexico.

In Mexico, millions of acres of Sonoran Desert and thornscrub are being converted to buffelgrass (*Pennisetum ciliaris*) which represents both a direct and an indirect loss of habitat because of invasion into adjacent areas and increased fire frequency and intensity (Burquez-Montijo et al. 2002). Buffelgrass occurs in areas purposely converted from native vegetation communities to buffelgrass plantations, and it is also invading into and becoming dominant in other areas of native vegetation. Conversion is achieved by first clearing the native vegetation by mechanical means, and then seeding with buffelgrass. The occurrence of buffelgrass <u>is changing the ecology of these areas</u> by increasing the frequency and intensity of fire, which in turn is resulting in the conversion of native vegetation communities into savanna grasslands. The consequent elimination of trees, shrubs, and columnar cacti from these areas is a serious threat to the availability of lesser long-nosed bat forage resources. The loss of saguaros is primarily a result of fire in the Sonoran Desert (Esque and Schwalbe 2002).

In Sonora, Mexico, 1.6 million ha of desert vegetation has been converted to buffelgrass pasture (about 10% of the state's area)(Burquez-Montijo et al. 2002). Up to 1/3 of the state's area has been targeted for conversion to buffelgrass (Navarro 1988 in Williams and Baruch 2000). This acreage is in addition to those areas that have also been cleared or converted for agriculture and urban development. Burquez and Yrizar (1997) state that "Given the government subsidies to establish exotic introduced grasslands, to maintain large cattle herds, and to support marginal cattle ranching, the desert and thornscrub in Sonora will probably be replaced in the near term by ecosystems with significantly lower species diversity and reduced structural complexity, unless control measures are implemented." Such replacement is and will continue to affect lesser long-nosed bat habitat availability.

In Arizona, many of the areas suitable for buffelgrass are managed as FWS wildlife refuges, national monuments and parks, or occur on the Tohono O'odham Nation, where purposeful conversions are unlikely to occur, although non-native grass invasions have occurred. These non-native grasses have increased the frequency and intensity of fires in the Sonoran Desert scrub of Arizona. Efforts are underway in some of these areas to restore areas where non-native plant invasions have occurred. Thus, ecosystem conditions are less likely to be altered in Arizona, at least with regard to the severity of ecological impacts of vegetation community conversion for livestock and agriculture that is occurring in Mexico.

Development – From 2010 to 2015, Arizona was the seventh fastest growing state in the country, with an increase of roughly seven percent. Growth rates in the three counties that support the known lesser long-nosed bat roosts (i.e., Pima, Santa Cruz, and Cochise counties) are mixed. The human population estimate for Pima County in 2015 was 1,010,025, an increase of 3% from 2010. The population estimate for Santa Cruz County in 2015 was 46,461, a decrease of 2% from 2010. And the population estimate for Cochise County as of July 2015 was 126,427, a decrease of 3.8% from 2010. Several years ago, growth projections for Benson and Sierra Vista in Cochise County were expected to be explosive. These two towns are currently relatively rural in nature. However, the Town of Benson has remained at approximately 5,000 since 2010 and the town of Sierra Vista decreased 4% from 45,140 in 2010 to 43,355 in 2015 (https://www.census.gov/). However, a significant development, the Villages at Vigneto, is currently in the planning and permitting stages near the Town of Benson. This is a planned development of 28,000 homes and amenities on approximately 12,000 acres (City of Benson 2016, entire). Data from Mexico is limited and the effects from urban expansion in Mexico are largely unknown.

Lesser long-nosed bats are affected directly by development which removes important foraging habitat, but also indirectly as growing numbers of people increase the potential for roost disturbance. The impacts to lesser long-nosed bat habitat are of considerable concern because they tend to be permanent, long-term impacts, as opposed to the often temporary, shorter-term impacts from fire, grazing, and agave harvesting. Lesser long-nosed bats are often able to react to temporary impacts by moving to alternative sites in the short-term. However, the permanent removal of habitat and long-term increased human presence on the landscape are significant and problematic threats to lesser long-nosed bat populations. Urban development and population growth were not identified as threats in the original listing or in the recovery plan. However, given the current population growth and expansion within the range for the lesser long-nosed bat, this threat must be considered as we assess the status of the population. Large, open landscapes once used for ranching are being converted to urban subdivisions as the human population shifts towards a more urban emphasis. The presence of hummingbird feeders used by foraging lesser long-nosed bats is a potential effect associated with urban development. As described above, effects may be both positive and negative. Studies are currently underway investigating the potential effects of hummingbird feeders on lesser long-nosed bats (Wolf and Dalton 2005).

In the past century, the extent and intensity of artificial night lighting has increased such that it has substantial effects on the biology and ecology of species in the wild (Longcore and Rich 2004). Studies have shown that artificial lights affect the movements of bats through the landscape, particularly slower flying bats. Stone et al. (2009, p. 1125) and Rydell (1992, p. 749) showed in separate studies that street lighting disturbed and even prevented movements by certain species of bats; primarily bats with slower flight behavior. Lesser long-nosed bats use a hovering, slow flight while foraging and, as the AGFD research suggests, may be avoiding areas with artificial lighting (AGFD 2009, p. 7 - 8), although it does seem that low levels of light near hummingbird feeders are tolerated by this species in urban areas. Light may be more of an effect as these bats select travel corridors. A study by Scanlon and Petit (2008) showed that urban parks without artificial lighting had higher bat use and bat species diversity than urban parks with artificial lighting, further indicating that artificial lighting can affect bat use and movements. A number of other studies also show negative effects on bat emergence, roost sites, movements, feeding behavior, and prey relationships (Boldogh et al. 2007, Holsbeek 2008, Fure 2006, Bat Conservation Trust 2008, Downs et al. 2003). During a study on a nectar feeding bat species more closely related to the lesser long-nosed bat, Winter et al. (2003) found that *Glossophaga soricina* locates forage using ultraviolet light reflected by forage species. Because this attribute has not been researched in lesser long-nosed bats, it is not known whether lesser long-nosed bats have this same ability. However, these bats are in the same taxonomic family, and artificial light may cause interference or redirect foraging lesser long-nosed bats keying on ultraviolet light sources or reflections. Similarly, a study by Lewanzik and Voigt (2014; entire) showed that in both captive and natural situations, the Sowell's short-tailed bat, *Carollia sowelli*, a frugivorous bat, used lighted areas less than dark areas for foraging on pepper plants. Lesser long-nosed bats are frugivorous to some extent and this study may provide additional evidence for light impacts on foraging lesser long-nosed bats.

Increasing urbanization results in an increased demand for energy. Cheaper and cleaner energy sources are constantly being tested and put into service. The demand for renewable energy continues. The development of wind energy has resulted in wind turbine facilities that are resulting in the deaths of significant numbers of birds and bats. Wind turbines are known to be dangerous for birds, but recent studies have started to turn their focus to the impacts on bats as well. According to Rydell et al. (2012, p. 4) the average number of bats killed by wind turbines in Europe and North America is higher than that of birds (2.3 birds/turbine/year compared to 2.9 bats/turbine/year). In fact, a recent summary report of the causes of multiple bat mortality events indicates that wind turbines are the leading cause of multiple mortality events in bats when looking at the cumulative frequency of 1180 reported multiple mortality events covering the period from 1790 to 2015. (O'Shea et al. 2016; p. 4). This has been a particularly significant morality factor since 2000 (O'Shea et al. 2016; p. 4). Mortality estimates at some wind facilities range to thousands of bats annually (O'Shea et al. 2016; p. 11).

The variation is very different between turbines, as some have no reported deaths, while others have killed many bats. The difference often depends on the location of the turbine. Currently, most bats being affected by wind turbines are tree bats and migratory bats. Until recently, no lesser long-nosed bats have been documented as being killed at wind facilities. However, a recently constructed wind energy facility in Cochise County, Arizona has resulted in the deaths of a number of lesser long-nosed bats over the past two years (Kenney 2016, p. 1; Fink 2015, p.1). The owners of this wind facility are currently working with the USFWS to develop a Habitat Conservation Plan to address the take of this endangered species. This occurrence provides evidence that wind turbines are a mortality factor for lesser long-nosed bats. The current extent of wind energy development in the range of the lesser long-nosed bat is limited and, while this is not expected to be a significant mortality factor within the lesser long-nosed bat population, it may affect local sub-populations. Additionally, as technology advances and the demand for renewable energy increases, more wind energy facilities may be constructed within the range of the lesser long-nosed bat and effects from wind energy facilities may be an increasing threat to this species.

Agave Harvesting – It has been suggested that lesser long-nosed bats, as important pollinators of agave, are affected by the harvesting of agave for the production of tequila. Arita and Wilson (1987, p. 3 - 4) indicated that this bat-plant relationship is so strong that the disappearance of one would threaten the survival of the other. However, it is more likely that the relationship between agaves and lesser long-nosed bats is "a loose association of less closely evolved organisms in a multiple-species pollination syndrome where the effects of one species' decline upon the other organism may be more subtle and complex than those of the "storybook" mutualisms that have become cliché (Nabhan and Fleming 1993, p. 457)."

There is no doubt that the harvest of wild agaves, removes significant lesser long-nosed bat food resources. Nabhan estimates that bootleg mescal makers are eliminating between 500,000 and 1,200,000 wild paniculate agave ramets a year in Sonora alone (Nabhan 1985 and Nabhan et al. 1992 in Nabhan and Fleming 1993, p.458). However, additional field observations by Nabhan suggest that areas where agave harvesting has eliminated a significant portion of the nectar-producing genets are few in number (Nabhan and Fleming 1993, p. 458).

Pressure to harvest wild agaves may have been intensified by the reduction of plantation agaves resulting from a 1997 fungus plague (CNN 2000, entire). The increased worldwide demand for tequila and the competition from African producers (MSNBC 2003, entire) may have also increased demands on the harvest of wild agaves in Mexico. However, recent education and outreach with commercial tequila producers has resulted in these groups now considering lesser long-nosed bat conservation in their production protocols (National Geographic 2016, entire).

Disease –

White-nose Syndrome – White-nose syndrome is a disease affecting hibernating bats caused by the pathogenic fungus *Pseudogymnoascus destructans* (Lorch et al 2011, p. 376). The fungus invades skin tissues while bats are hibernating causing skin lesions and disrupting natural torpor cycles, leading to mortality during hibernation (Meteyer et al. 2009, entire; Reeder et al. 2012;

Warnecke et al. 2012; Langwig et al. 2012). White-nose syndrome is associated with extensive mortality of certain bats in eastern and mid-western North America (Frick et al. 2010, Langwig et al. 2012, Frick et al. 2015). First documented in New York in the winter of 2006-2007, white-nose syndrome has spread rapidly across the eastern and mid-western U.S. and eastern Canada. Recently, it has been documented on the west coast of the U.S. in the state of Washington (Figure 14) (Lorch et al. 2016).

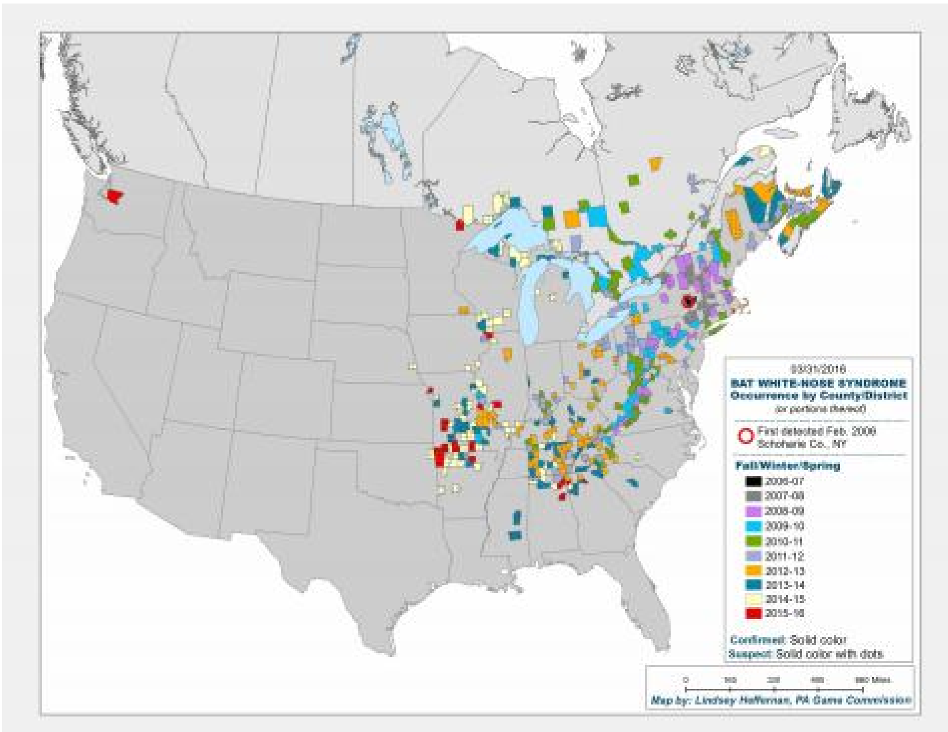

Figure 14. 2016 map of the distribution of the occurrence of white-nose syndrome in the U.S. and Canada. Note that white-nose syndrome is now documented on the west coast (USFWS 2016, p. 2).

Bats with white-nose syndrome act strangely during the cold winter months, including flying outside during the day and clustering uncharacteristically near the entrances of caves and other hibernation areas. Bats have been found sick and dying in unprecedented numbers in and around caves and mines. White-nose syndrome is estimated to have killed more than six million bats in the U.S. and Canada (USFWS 2016, p. 1). In some sites, 90 to 100 percent of the bats have died and some populations have suffered extensive population declines (Frick et al. 2010, Langwig et al. 2012, Frick et al. 2015).

All evidence to date suggests strong seasonality to Pd infection and white-nose syndrome disease (Langwig et al. 2015a) and that hibernating bats that spend extensive time in torpor are most at risk. The fungus that causes white-nose syndrome has temperature-limited growth range and does not grow above 20 degrees Celsius (Verant et al. 2012). Bats that suffer infection during winter appear to lose infection during warm months at maternity colonies when they are consistently euthermic (Langwig et al. 2012). Given that lesser long-nosed bats do not hibernate or use torpor, they are most likely not at risk of the white-nose syndrome disease. Currently, Pd/white-nose syndrome has not yet spread into the southwestern U.S. where lesser long-nosed bats occur and their use of warm caves that are not conducive to fungal growth and lack of co-habitating with bat species that hibernate further reduce the risk of impact of white-nose syndrome to lesser long-nosed bat populations. Lesser long-nosed bats have not been documented as being affected by white-nose syndrome, nor do we anticipate that this will be the case in the future.

However, it is important to remain vigilant to the potential spread of Pd which could affect sympatric bat species that hibernate. There is strong evidence that Pd resides in an environmental reservoir (Lorch et al. 2013, Langwig et al. 2015b) and that bats that do not hibernate have been known to carry the fungus (Bernard at al. 2015). The recent jump of this disease to the west coast of the U.S. is concerning for western bat conservation. Some limitations related to research in order to prevent or reduce the spread of white-nose syndrome have already made research and monitoring of lesser long-nosed bats more complicated and expensive. While necessary and appropriate, the additional costs and time associated with decontamination protocols and cave/mine closures designed to prevent the spread of white-nose syndrome can limit the opportunities for some researchers and managers to conduct research and monitoring at lesser long-nosed bat roosts. If this disease spreads into the southwest, additional limitations or other effects to research and monitoring of lesser long-nosed bats may be necessary. It is important to also be aware of any other emerging diseases that may affect the lesser long-nosed bat.

An extensive partnership of state and federal agencies, tribes, organizations, institutions, and individuals has been formed to work cooperatively to investigate the source, spread, and cause of bat deaths associated with white-nose syndrome. This partnership is developing management tools and strategies to minimize the effects of this disease (USFWS 2016, p. 2). While we expect that it is unlikely that white-nose syndrome will cause significant mortality of the lesser long-nosed bats, it is important for us to remain involved with the ongoing efforts to understand and manage this significant bat disease and be flexible enough to integrate appropriate management actions into the conservation of the lesser long-nosed bat.

Rabies – There is no evidence that rabies is a significant mortality factor in lesser long-nosed bats. While bats are vectors for rabies, a relatively small percentage of bats are actually carriers of the rabies virus (Johnson et al. 2014; p. 1920; Klug et al. 2011; p. 71 – 73). Other mammals such as skunks, raccoon, and foxes are often more responsible for rabies cases than are bats (CDC 2014; entire). We are unaware of any confirmed cases of rabies in lesser long-nosed bats and there are no documented cases of rabies resulting in lesser long-nosed bat mortality events (Van Pelt 2015; p.1). Control of bat species, such as vampire bats, that are known vectors of rabies potentially affecting both humans and livestock may result in the indiscriminate killing of lesser long-nosed bats. This is discussed earlier in this chapter under factors affecting roosts.

Climate Change –

Ecosystems within the southwestern U.S. are thought to be particularly susceptible to climate change and variability (Strittholt et al. 2012, p. 104 – 152; Munson et al. 2012, p. 1 – 2; Archer and Predick 2008, p. 23). Documented trends and model projections most often show changes in two variables: temperature and precipitation. Recent warming in the southwest is among the most rapid in the nation, significantly more than the global average in some areas (Guido et al. 2009, p. 3 - 5). Precipitation predictions have a larger degree of uncertainty than predictions for temperature, especially in the Southwest (Sheppard et al. 2002), but indicate reduced winter precipitation with more intense precipitation events (USGCRP 2009, p. 129 – 134; Archer and Predick 2008, p. 24). Further, some models predict dramatic changes in Southwestern vegetation communities as a result of climate change (Garfin et al. 2014, p. 468; Munson et al. 2012, p. 9 – 12; Archer and Predick 2008, p. 24).

Seager *et al.* (2007, pp. 1181–1184) analyzed 19 different computer models of differing variables to estimate the future climatology of the southwestern U.S. and northern Mexico. All but one of the 19 models predicted a drying trend within the Southwest; one predicted a trend toward a wetter climate (Seager *et al.* 2007, p. 1181). A total of 49 projections were created using the 19 models; all but three of the projections predicted a shift to increasing dryness in the Southwest as early as 2021–2040 (Seager *et al.* 2007, p. 1181). The current prognosis of climate change impacts on the Sonoran Desert includes fewer frost days; warmer temperatures; greater water demand by plants, animals, and people; and an increased frequency of extreme weather events (heat waves, droughts, and floods) (Overpeck and Weiss 2005, p. 2074; Archer and Predick 2008, p. 24, IPCC 2014, p. 53). For the Southwestern U.S., Bagne and Finch (2012 and 2013; p.107 – 116; p.150 – 160) investigated and summarized the following influences of climate change on lesser long-nosed bat habitat elements:

1. Annual increase in temperature of four degrees Fahrenheit by 2050.
2. No change in average rainfall by 2050, but possible changes in the timing of precipitation.
3. More droughts and intense storms.
4. Earlier and more intense flooding.
5. Summer monsoon changes are unknown.
6. Grasses favored over shrubs.
7. Increases in invasive, non-native grasses and fires.
8. Warmer temperatures and decreased soil moisture in Mexico.
9. CAM plants (succulents and cacti) will be more resilient to increasing temperatures.
10. A reduction in Madrean woodlands.
11. Upward shifts in montane species.

In addition, Strittholt *et al.* (2012, pp. 104-152) analyzed average annual temperature projections, seasonal summer temperature (July–September), and winter temperature (January–March) as simulated by 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° C increase by 2060 in some locations, particularly in the southwestern portion of the ecoregion (Strittholt *et al.* 2012, p. 126). 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 (IPCC 2014, p. 53). 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).

The U.S. Geological Survey produced a mapping tool that allows climate change projections to be downscaled to local areas including states, counties, and watershed units. We used this National Climate Change Viewer (U.S. Geological Survey 2016) to compare past and projected future climate conditions for Pima, Santa Cruz, and Cochise counties, Arizona. The baseline for comparison was the observed mean values from 1950 through 2005, and 30 climate models were used to project future conditions for 2050 through 2074. We selected the climate parameters of April maximum temperature and August and December mean precipitation to evaluate potential effects on lesser long-nosed bat forage resources. These particular parameters were selected from those available because they represented those most likely to impact the survival and flowering phenology of individual forage species.

Similar to the more general climate change effects discussed above, the downscaled analysis also showed warming spring temperatures which could result in an early blooming period for lesser long-nosed bat forage species (USGS 2016). Precipitation changes were evaluated for changes to monsoon and winter precipitation. In line with the general climate projections, changes during the evaluated time periods were greater for winter precipitation than for monsoon precipitation. Changes projected for monsoon precipitation were minimal, but projected to be reduced by approximately one inch per 100 days for winter precipitation (USGS 2016).

The effects of climate change have the potential to be a significant issue for the lesser long-nosed bat (Healy 2007, p. 27 – 31). Shifting distributions and changes in flowering/fruiting phenology of forage species may affect the timing and extent of forage availability for the lesser long-nosed bat. While there is much uncertainty related to the future effects of climate change, there is already evidence that climate change is affecting the ecosystems upon which the lesser long-nosed bat depends. The prediction of what the effects of climate change will be in the future is dependent on scientific modeling efforts and, while models are only as good as the information upon which they are built, they do represent the best available information upon which to base our analysis.

Many of the predictions about the impacts of climate change are based on modeling, but many predictions have already occurred. Climate change trends are highly likely to continue (Overpeck *et al.* 2012), with the impacts to the lesser long-nosed bat being complicated by interactions with other factors (e.g., interactions with nonnative species, fire, and other land use activities).

The following plant species are considered major food plants for the lesser long-nosed bat in the U.S.: Palmer's century plant (*Agave palmeri*), Parry's agave (*A. parryi*), desert agave (*A. deserti*), saguaro cactus (*Carnegia gigantea*), and Organ Pipe cactus (*Stenocereus thurberi*). Food types provided by these plant species for the lesser long-nosed bat include nectar, pollen, and/or fruit (USFWS 1997, p. 7 - 10). A dearth of information in the literature exists for the three species of agave. Information is summarized below for *C. gigantea* and *S. thurberi* related to climate change and its potential effects on these lesser long-nosed bat forage resources.

Saguaro:

Thomas et al. (2012, entire) modeled plant distributions in the southwest, which included the saguaro. The authors developed spatial models of the predicted modern-day suitable habitat of 166 dominant and indicator plant species of the southwestern U.S. and then conducted a coarse assessment of potential future changes in the distribution of their suitable habitat under three climate-change scenarios for two time periods. Future suitable habitat models were based on climate models of future temperature and precipitation developed by the Climate Wizard collaboration (*http://www.climatewizard.org/*) of The Nature Conservancy, The University of Washington, and The University of Southern Mississippi. One of the plants in their model is the saguaro. Risk categories consisted of categorical rankings of a species' vulnerability and potential scores combined. Vulnerability was defined as the proportion of the area of suitable habitat predicted to decrease by 2050. Moderate to high was defined as the following: species will maintain 25 to 75 percent of modern day suitable habitat and will gain 25 percent to 75 percent new suitable habitat in the future. According to the author's results, the saguaro was assigned a moderate to high vulnerability, with potential scores of 55 and 57 percent, respectively, for the year 2050. These author's risk analyses showed the saguaro having a moderate to high vulnerability and a moderate potential to gain suitable habitat in the future. In addition, the saguaro was one of 428 plant species analyzed to evaluate whether significant trends in springtime first flower dates existed during a study period of 1984-2003 (Crimmins et al. (2010, entire). The saguaro was recorded along a route to Mt. Kimball in the Santa Catalina Mountains, near Tucson, Arizona. The author's results indicated slope coefficients for the saguaro trending in a negative direction (Crimmins et al. 2010, Fig. 1), meaning toward an earlier onset of flowering (Crimmins et al. (2010; p. 1044, 1055).

Winter cold and drought are thought to limit distributions of saguaros (Steenbergh and Lowe 1977; p. 103 - 118). Trends modeled by Rehfeldt et al. (2006, p. 1140) supported the findings by Steenbergh and Lowe (1977; p. 103 - 118). Further, a recent modeling study that included saguaros in Arizona concluded that lesser long-nosed bat may benefit from a northward range expansion of saguaros resulting from climate change (Pollo 2016, Pers. Comm.).

Organ Pipe Cactus:

Bustamante and Burquez (2008) studied the spatial and temporal variation in the reproductive phenology of the Organ Pipe cactus and its association with plant size and environmental clues. The authors found significant variation in the timing of flowering within and among populations. Large plants produced more flowers, and bloomed earlier and for a long period than small plants. The onset of flowering was primarily related to the variance in winter minimum temperatures and duration with the autumn-winter mean maximum temperature. Further, indications of clinal variation in the timing of flowering and reproductive effort suggest selection pressures related to the arrival of migrating pollinators, climate, and resource economy in a desert environment (Bustamante and Burquez 2008).

Synthesis of Climate Change on Forage Plants:

As we consider what the lesser long-nosed bat needs to maintain viability by characterizing the status of the species in terms of its resiliency, redundancy, and representation, maintaining adequate and seasonally available forage resources is a key component. The seasonal phenology of saguaros and Organ Pipe cacti appears to be changing in terms of timing. Saguaros may be flowering earlier and Organ Pipe cacti may be blooming earlier, but for a longer period of time. While the mutualistic relationship between the lesser long-nosed bat and its forage species may not be as strong in the northern part of its range, from the perspective of the bat, seasonally available forage is crucial to maintaining life history events such as migration and reproduction. As stated previously, studies showed that lesser long-nosed bats accounted for nearly 45% of fruit set in saguaros and 30% in the organ pipe cactus. Forage resources and their phenology currently support population numbers of lesser long-nosed bats that exceed the levels known and recorded at the time of listing in 1988. In general, the trend in overall numbers has been stable or increasing in both the U.S. and Mexico (USFWS 2007).

The best available information indicates that ongoing climate change will result in changes in the phenology and distribution of lesser long-nosed bat forage resources. How this affects the viability of the lesser long-nosed bat population is less clear. There is much uncertainty and a lack of information regarding this issue. The biggest effect will occur if forage availability gets out of sync along the “nectar trail” such that bats arrive at the portion of the range they need to meet life history requirements (migration, mating, birthing) and there are inadequate forage resources to support that activity. If timing changes, but changes consistently in a way that maintains the nectar trail, this species may be able to adapt to those changes in timing. Adaptation is less likely if changes result in forage availability being out of sync in various parts of the range and pathway such that forage and energy reserves cannot support the life history needs of the species. Such an event appears to have occurred a number of years ago at the Pinacate maternity roost when bats appeared to arrive too late and missed the columnar cactus bloom and a large number of young-of-the-year bats perished at this roost (Medellín and Viquez, pers. comm.). We know that this species has shown considerable adaptability in regard to adverse forage conditions. In these instances, the numbers and productivity of the lesser long-nosed bat has not appeared to be negatively impacted, at least in the short term. Again, effects from climate change on this species are not occurring in isolation. Compounding factors related to loss and alternation of habitat due to increases in invasive species, changing fire regimes, urbanization, agriculture, and other land uses will play a role in the overall impact of climate change on this species’ viability.

Bagne and Finch (2012 and 2013; p. 107 – 116; p. 150 – 160) assessed the vulnerability of the lesser long-nosed bat to the effects of climate change in the areas of the Barry M. Goldwater Range (southwestern Arizona) and at Fort Huachuca (southeastern Arizona). They concluded that the lesser long-nosed bat was moderately vulnerable to declines related to global climate change. Vulnerability was increased by reliance on the quantity and timing of flowering of a limited number of plant species, while resilience is incurred by flexible migratory behaviors and the probable resilience of forage plant populations to increasing temperatures. They also predicted that changes in climate are expected to exacerbate current threats. One of the primary factors related to the vulnerability of this species to climate change was the adaptability of non-native grasses and the potential changes in fire regime that are expected under most climate change scenarios.

As Mexico evaluated whether to remove the lesser long-nosed bat from its endangered species list, one of their criterion showed that the lesser long-nosed bat does not seem to present any particular characteristics that make it especially vulnerable to any change in environmental conditions or stochastic shocks. The current population condition of the lesser long-nosed bat appears to indicate that lesser long-nosed bats may be showing some resiliency with regard to fluctuating food plant flowering cycles. Although we are still not sure to what extent the environmental conductions described in climate change predictions will affect lesser long-nosed bat forage resource distribution and phenology, we have documented that lesser long-nosed bats have the ability to change their foraging patterns and food sources in response to a unique situation, providing evidence that this species is more resourceful and resilient than may have been previously thought. We find that the lesser long-nosed bat is characterized by flexible and adaptive behaviors that will allow it to remain viable under changing climatic conditions.

We certainly do not understand all of the ramifications of climate change on lesser long-nosed bats. For example, in early summer of 2016, an unusual die off of lesser long-nosed bats occurred at the Pinacate roost in northern Sonora. Dead lesser long-nosed bats were found in bushes around the roost site, as well as in the roost itself. Dead and dying lesser long-nosed bats were also reported from nearby ranches, where, at least at one ranch, these bats apparently perished after coming into the ranch to drink water (drinking water directly is an unusual behavior for lesser long-nosed bats). This die off coincided with a period of unusually hot temperatures and strong winds. This heat wave may have caused these bats to succumb (Medellín 2016, entire). If heat waves become more common during the maternity season, such die offs could impact the long-term status of the population. Similar die offs of Australian flying foxes during heat waves have also been documented (Welbergen et al. 2008). This example indicates that we must be cautious to not discount the ramifications of changing climatic conditions and climate-related stochastic events, but there is considerable uncertainly with regard to this issue.

Perceptions of Bats by Humans – Efforts to conserve bats are complicated by human impressions and perceptions of them. Historically, although bats in some cultures were perceived as strong positive symbols, generally, bats have been viewed in a negative light and are symbols of darkness and evil (Fenton 1997; p. 10). Much of this negative perception is based on ignorance and misunderstanding. The role of bats in public health further complicates their image. The presence of bat-specific strains of the rabies virus shows that bats harbor rabies and are integrally involved in the epidemiology of some strains of this disease (Fenton 1997; p. 10). Conversely, an increased understanding of the role of bats in the ecosystem has led to a more positive perception of bats as consumers of insect pests, pollinators, and providers of other ecosystem benefits. In fact, in some areas, people are taking measures to actually attract bats in recognition of their important role in the environment. The use of social media and other widespread communication avenues have allowed a greater distribution of positive and beneficial information related to the values and benefits of bats. It is extremely important to ensure that accurate and correct information regarding bats and their roles in the environment is disseminated to the public. The repercussions to bat conservation are significant if bats are inappropriately portrayed as evil, dark, harmful creatures or their roles and life histories continue to be misunderstood, such as discussed earlier in this SSA Report with regard to vampire bat control.

Conservation Efforts -

- The Blue Bird Mine on Cabeza Prieta National Wildlife Refuge was fenced in 2004 to protect a known lesser long-nosed bat maternity roost (Figure 15). Bats reoccupied this abandoned roost following the installation of this protective fencing. Unfortunately, the fence was vandalized in 2005, resulting in subsequent abandonment by lesser long-nosed bat. The fence has been repaired (McCasland 2005), and there has been no subsequent abandonment of this roost.

Figure 15. Fencing protecting a lesser long-nosed bat roost on the Cabeza Prieta National Wildlife Refuge

- Telemetry projects have been implemented to discover new roost locations. A number of new transition roosts have been documented. One of these roosts is on private land where efforts are being made to promote the conservation of this roost site. Efforts to protect a new roost on BLM land are being coordinated with the local lease holder and the AGFD (Wolf and Dalton 2005).

- The Arizona-Sonora Desert Museum has conducted studies on seasonal movements between lesser long-nosed bat roosts in Arizona, a migratory pollinator study, roost monitoring in the U.S. and Mexico, and conducts educational activities related to bats (Krebbs 2005a).

- Experimental gate designs were studied at a late summer lesser long-nosed bat roost at the Coronado National Memorial (Mann 2005, entire; Frederick 2008, entire). These results and subsequent work completed by Wolf and Dalton (2010; entire) were used to construct a permanent gate structure on the roost site in 2010 (Figure 16). This roost site has been monitored annually since this gate as installed. The overall number of bats using this newly gated site has declined since the gate was installed (Westland Resources 2014, p. 27 - 37). It appears that the gate structure has affected the number of bats that this site can support. In 2016, a number of bars were experimentally removed from the gate to see if this would increase the number of bats using this roost site. Initial results indicate an increase in the number of bats using this roost in 2016 (Wolf pers. comm). This experiment will continue over the next two to three years to test how gate design and structure are affecting the use at this roost site.

Figure 16. Final bat gate structure installed on a lesser long-nosed bat roost on the Coronado National Memorial.

- Significant efforts are being made on Fort Huachuca to protect and monitor known lesser long-nosed bat roosts (Sidner 2005; entire; Buecher 2016; entire). These efforts include:

    - annual roost monitoring
    - road closures
    - roost improvements and closures
    - increased enforcement of closures
    - agave monitoring (Fehmi et al. 2004)
    - lesser long-nosed bat foraging studies

- Investigations were initiated related to the distribution and use of hummingbird feeders by lesser long-nosed bat in the Tucson area (Wolf 2006). This program has been continued and expanded through a citizen scientist program being coordinated by the USFWS, AGFD, the Town of Marana, the University of Arizona, and a system of volunteer citizen scientists now number over 100. Information on arrival and departure dates, peak use periods, and population characteristics are being gathered to increase our understanding of lesser long-nosed bat life history.

- Some habitat restoration work has begun in Mexico. (Medellín 2005)

- A mine site on the Tohono O'odham Nation that supports a lesser long-nosed bat maternity colony has been structurally stabilized to maintain roost integrity (Wolf and Dalton 2005).

- Annual long-term monitoring is ongoing at important roost sites such as Copper Mountain, Pyeatt Cave, State of Texas, and Old Mammon (NPS 2016, Buecher 2016, Mann 2005, Wolf 2015).

- The exhaust fan was removed from the historical Colossal Cave maternity roost in an effort to get lesser long-nosed bat to recolonize this roost. So far, no lesser long-nosed bats have recolonized this cave (AGFD 2005, entire). More recently, in 2015, a gate blocking the entrance to the bat roost at Colossal Cave has been replaced by a more bat friendly gate.

- Educational programs are being given at organized events such as SW Wings Birding Festival. Other programs are being given as requested, but efforts are sporadic (AGFD 2005). In Mexico, bat biologists are working with elementary schools, providing "bat-pollination" and other games for school children who previously had known little about and had little concern for bats. This educational effort has been successful in passing along this information to siblings and teachers are sharing the program (Medellín 2011; p. 9).

- The USFWS and other agencies and partner organizations are raising the awareness of pollinators in general, and bat pollinators specifically, through an education and outreach efforts that include events across the U.S.

- A protective gate was installed at the Cave of the Bells roost site. This site has not been occupied since gating (AGFD 2005, entire). It is not entirely clear if the gating was responsible for abandonment of this roost, but additional research has indicated that gating may be problem for lesser long-nosed bat based on colony size and flight speeds. Bat gates are an excellent conservation tool for bat roosts, but they may not be as suitable for lesser long-nosed bats (Ludlow and Gore 2000). Further research, similar to efforts at Coronado National Memorial, is needed before the effectiveness of this tool can be determined (Bucci et al. 2003).

- The Arizona Bat Conservation Strategic Plan, which identifies priority actions to guide bat conservation activities statewide, was finalized in 2003. Many of the priority actions are related to investigations to better understand the status of the lesser long-nosed bat.

CHAPTER 5. CURRENT CONDITION AND FUTURE SCENARIOS

We have considered the life history requirements of the lesser long-nosed bat and its needs, both from individual and population perspectives (Chapters 2 and 3), and we reviewed the factors that are driving the historical, current, and future viability of the species (Chapter 4). We now consider what the species' current and future conditions are likely to be. We apply future forecasts to the concepts of resiliency, redundancy, and representation to describe the future viability of the lesser long-nosed bat.

Table 4. Population conditions used to categorize the condition of resiliency, redundancy, and representation for the current condition and the future scenarios discussed below.

	High	Moderate	Low	None
Resiliency	Occupancy in at least eight out of ten years during the appropriate season in known maternity, mating, and transient roosts. Annual maternity and mating roost numbers are consistent with historical levels.	Occupancy in at least five out of ten years during the appropriate season in known maternity, mating, and transient roosts. When occupied, numbers at maternity and mating roosts are at least 50% of the historical levels.	Occupancy in less than five out of ten years during the appropriate season in known maternity, mating, and transient roosts. When occupied, numbers at maternity and mating roosts are at less than 50% of the historical levels.	There is no occupancy over a ten year period during the appropriate season in known maternity, mating, and transient roosts.
Redundancy	At least 80% of the known maternity, mating and transient roosts are occupied throughout the appropriate portions of the range.	At least 50% of the known maternity, mating, and transient roosts are occupied throughout the appropriate portions of the range	Less than 50% of the known maternity, mating, and transient roosts are occupied throughout the appropriate portions of the range.	There are no consistently occupied maternity, mating, and transient roosts distributed throughout the appropriate portions of the range.
Representation	Occupied roosts representing both the migratory and non-migratory segments of the population are distributed throughout the diversity of habitats within the appropriate portions of the range for each population segment. Migration patterns are functional.	Occupied roosts representing both the migratory and non-migratory segments of the population are absent in some portion of the diversity of habitats within the appropriate portions of the range for each population segment. Migration patterns are partially compromised.	Occupied roosts representing both the migratory and non-migratory segments of the population are absent in the majority of the diversity of habitats within the appropriate portions of the range for each population segment. Migration patterns are substantially compromised.	Occupied roosts are absent in either or both the migratory and non-migratory segments of the population. Migratory patterns are not functional.

Current Condition – For the last twenty years following the completion of the lesser long-nosed bat Recovery Plan, there has been a steadily increasing effort related to the conservation of this species. Better methods of monitoring have been developed. The number of known roosts has increased throughout its range. Protection measures have been implemented at a number of roosts in both the U.S. and Mexico. Increased public and academic interest and available funding has resulted in additional research leading to a better understanding of the life history of the lesser long-nosed bat. Certain perceived historical threats (livestock grazing and fire) have been shown to not be as much of an impact on the viability of this species as previously thought. Other threats have been reduced (collateral damage from vampire control and human disturbance at roosts). However, threats to this species still remain in the form of roost disturbance, particularly in the border region between the U.S. and Mexico; habitat loss due to various land uses; and, to an unknown extent, climate change.

We have been able to better document the migratory nature of this species, as well as identify a segment of the population that is resident in southern/central Mexico. Migration follows the "nectar trail". Important reproduction sites include mating roosts and maternity roost in both central and southern Mexico and the southwestern U.S. have been identified and their occupancy patterns described. In the U.S., we currently know of between 50 and 60 roost sites. In Mexico, 25 – 30 known roosts have been reported. It is important to note that not all of these roosts are of equal value. As indicated in Figure 4 and Figure 6 above, some of these roosts have only a few bats, while other roosts support larger numbers of bats. However, as discussed above, as a transient and migratory species that utilizes ephemeral forage resources, each of these known roosts plays an important role in supporting opportunities for the lesser long-nosed bat to use regularly changing forage resources. Of particular importance are roosts that support reproductive activities. Of these known roosts, there are at least four mating roosts (all in Mexico) and 13 maternity roosts in U.S. and Mexico. Available roost sites are an important habitat feature that is key to all aspects of this species' life history. Currently, approximately 50 percent of these roosts sites in both the U.S. and Mexico have some degree of protection due to being located on Federal lands, private lands with limited public access, or are inaccessible due to location and terrain. Recent conservation actions have resulted in the active protection of at least 10 roosts in the U.S. and Mexico, including gating, fencing, road closures, monitors, etc. Agency land-use plans and general management plans contain objectives to protect cave resources and restrict access to abandoned mines, both of which can be enforced by law enforcement officers. In addition, guidelines in these plans for grazing, recreation, off-road use, fire, etc. will continue to prevent or minimize impacts to lesser long-nosed bat forage resources (USFS 2005, entire; BLM 1991, entire; DOD 2001, entire).

About the same time as the Recovery Plan was completed, Wilkinson and Fleming (1996; p. 336) determined, using mtDNA analysis, that the effective population size of the lesser long-nosed bat throughout its range must have recently been between 50,000 and 100,000 individuals. Based on current numbers observed at known roost sites, the current population of lesser long-nosed bats is probably > 200,000 individuals, and may be closer to 300,000, although this estimate is simply our best professional opinion and is not based on statistically rigorous data. While part of this increase is surely related to the increased number of known roosts located within the past 20 years and better monitoring techniques, researchers and managers working with this species also feel that population trend has been stable to increasing based on their experiences. Medellín and Torres (2013; p. 11) indicate that data collected by the Program for the Conservation of Bats in Mexico and other researchers in Mexico show a trend of stability or growth indicated by monitoring at 13 lesser long-nosed bat roosts. The conservation status in Mexico has been determined to be secure enough to be removed from their list under the following rationale: 1) the distribution of lesser long-nosed bats is extensive within Mexico, covering more than 40 percent of the country; 2) the extent and condition of lesser long-nosed bat habitat is only moderately limiting and this species has demonstrated that it is adaptable to varying environmental conditions; 3) the species does not exhibit any particular characteristics that make it especially vulnerable; and 4) the extent of human impacts is average and increased education, outreach, and research have reduced the occurrence of human impacts and disturbance. The lesser long-nosed bat is considered widespread and abundant in Mexico (Arita and Prado 1999). While the extent of the lesser long-nosed bats distribution is not nearly as great in the U.S., we have determined that, for these same factors, this also represents the current condition in the U.S. Much of the range of this species in the U.S. is on federally-managed lands; outreach and education, particularly with regard to pollinator conservation, has increased and human attitudes towards bats are more positive now than in the past; and the lesser long-nosed bat has demonstrated adaptability to adverse environmental conditions within the portion of its range that is in the U.S.

The following table summarizes the current condition of the lesser long-nosed bat with regard to the resiliency, redundancy, and representation (see Chapter 1 for description of the 3R’s).

Table 5. Current population condition for the lesser long-nosed bat

	Population Condition
Resiliency	High
Redundancy	High
Representation	High

Future Scenarios – The viability of the lesser long-nosed bat depends on the future availability of appropriate roost sites, particularly mating and maternity roosts, and the availability of forage resources across its range in areas occupied seasonally by the lesser long-nosed bat, including migration corridors. Because we have uncertainty regarding how and when roost site conservation may be implemented or maintained, and also what the effects of climate change will be on the range-wide availability of forage resources, we have forecasted what the effects to the lesser long-nosed bat may be in terms of population resiliency, and species redundancy and representation under three plausible future scenarios over two reasonable time frames: 15 years and 50 years. We chose the 15-year timeframe because it is an appropriate timeframe over which to assess the progress of lesser long-nosed bat conservation efforts. Fifteen years is based on the history of conservation implementation in the past. Past conservation efforts such as identifying and monitoring roost sites; completing the processes for identifying, permitting, implementing, and monitoring roost protection measures; conducting education and outreach and seeing changes in public perceptions; and implementing regulatory change can often take up to 15 years to determine the impacts on conservation. We selected the 50-year timeframe because it falls within the range of available climate change prediction models at a level where there is less uncertainty regarding the models. The following three general scenarios are included in our analysis:

1) Best Case – The majority of known roost sites are protected (not necessarily gated, but some form of protection that could include gating, fencing, location within Federal or other protected lands, law enforcement or community patrols or monitoring, etc.). Forage resources are maintained or enhanced, including areas along the “nectar trail”. Migration pathways are protected throughout the species’ range and over a range conditions. White-

nose syndrome or other newly emerging disease is not a concern for this species. Attitudes towards bat conservation are positive and conservation actions are being implemented across the range of this species.

2) Moderate Case – More than 50 percent of known roosts remain unprotected. Some areas of forage resources are reduced or become unavailable or out of sync with migration patterns as a result of climate change and changing land uses. Tropical dry forests are more heavily impacted than northern habitats. Some migration corridors are lost or compromised, but some remain intact and in protected status. White-nose syndrome or some other newly emerging disease does not affect the species or their forage plants, but spreads into the distributional range of the lesser long-nosed bat such that restrictions are placed on research and monitoring. Attitudes regarding the conservation of bats remain mixed and conservation measures are being implemented in some areas, but struggle to get support in other areas; and

3) Worst Case – Roost protection is lost at some roosts or is not being implemented adequately. Available forage resources are lost or reduced in all areas of the range, including those necessary to support migration, due to climate change and changing land uses. Migration pathways are lost or compromised. White-nose syndrome or other newly emerging disease occurs within the distributional range of the lesser long-nosed bat. Attitudes towards bat conservation are generally negative and conservation efforts are minimal.

For each scenario, we used the scale in Table 6 below to estimate likelihood that the scenario will occur.

Table 6. Explanation of confidence terminologies used to estimate the likelihood of scenario occurrence.

Highly likely	**We are more than 90% sure that this scenario will occur.**
Moderately likely	We are **70 to 90% sure** that this scenario will occur.
Somewhat likely	We are **50 to 70% sure** that this scenario will occur.
Moderately unlikely	We are **30 to 50% sure** that this scenario will occur.
Unlikely	We are **10 to 30%** sure that this scenario will occur.
Highly unlikely	We are **less than 10%** sure that this scenario will occur,

Because there is uncertainty related to how climate change will affect future forage availability; whether white-nose syndrome will affect this species; and to what extent attitudes regarding conservation of these bats and associated roosts and migration corridors will be positive or negative; examining how the lesser long-nosed bat populations will respond to these three scenarios allows us to consider the range of future effects from these factors on the lesser long-nosed bat.

Worst Case Future Scenario – In a worst case scenario, lesser long-nosed bat roosts cannot be protected and roosts currently protected are no longer protected. The number and distribution of maternity, mating, and transient roosts is reduced. Forage resources become reduced across the range or out of sync along the "nectar trail" because of development, agriculture, or climate change. Specifically, additional impacts to tropical dry forests in Mexico and columnar cacti and agaves in the northern portion of the range are lost or reduced in occurrence. Invasive species, such as buffelgrass, continue to expand and affect lesser long-nosed bat forage resources through changing fire regimes and alteration of ecosystems. Migration pathways are lost or compromised due to changes in land uses. Dependence on hummingbird feeders increases in the northern part of the lesser long-nosed bat range and this use affects health and migration patterns. White-nose Syndrome is documented within the distributional range of the lesser long-nosed bat and restricts research and monitoring. Attitudes regarding the conservation of bats remain or become negative and conservation efforts are reduced or cease in both the U.S. and Mexico.

Within the 15-year time frame, our confidence in this scenario occurring is unlikely. The issues described above are not likely to occur within this time frame due to the current support and interest in the conservation of this species; the expected longer time frame for effects from climate change to be manifest; the relatively slow rate of change in land use throughout the range of the species; and the extremely limited likelihood that white-nose syndrome will affect this non-hibernating bat, especially in such a short time frame.

Within the 50-year time frame, our confidence in this scenario occurring is also unlikely. While we can anticipate that some changes in human attitude towards and support of lesser long-nosed bat conservation will occur, it is anticipated that there will be long-term support for conservation of this species due to its ecological and economic benefits to society. We also anticipate ongoing loss of or reduction of key lesser long-nosed bat habitats, but we do not anticipate that the extent of this loss or reduction will cause significant loss of roosts, forage, or migration pathways to the extent described in the worst case scenario. We have determined that it is unlikely that white-nose syndrome will be documented affecting this species, even at this longer time frame, due to the fact that this bat does not spend prolonged time in torpor or roost in cold hibernacula. In short, we are not very confident that the drastic changes outlined in the worst case scenario will materialize within either of the evaluated time frames.

Table 7 describes anticipated effects to resiliency, redundancy, and representation within the lesser long-nosed bat population under the worst case scenario.

	Population Condition	
	15-Years	50-Years
Resiliency	Moderate	Low
Redundancy	Moderate	Low
Representation	Moderate	Low

Moderate Case Future Scenario – Under a moderate case scenario, the current conditions are basically maintained with currently unprotected roosts remaining unprotected, but those roosts currently protected remain in protected status. Some new roost sites may be identified, but they may or may not be protected. Also similar to the current condition, some forage resources are reduced or become unavailable across the range and out of sync along the “nectar trail” due to development, agriculture, or climate change. The scope of scale of these impacts is expected to be similar to impacts that have historically occurred and to which the lesser long-nosed bat has adapted. These reductions are not anticipated to be of an extent that it prevents the lesser long-nosed bat from completing life history activities. It is anticipated that some migration corridors are compromised due to changes in land uses, but we expect that migration movements will still be able to be completed by the lesser long-nosed bat. Invasive species impacts to lesser long-nosed bat forage resources, while still occurring are limited in extent by ongoing management. Our prediction is that white-nose syndrome will not affect this species. However, protocols to prevent the occurrence and spread of white-nose syndrome will continue to be implemented and this may limit or prevent some research and monitoring activities. Ongoing outreach and education will continue, but not all these efforts are successful, particularly in rural areas with long-held traditions that may not be conducive to lesser long-nosed bat conservation. As a result, attitudes regarding the conservation of bats remains mixed and conservation measures are implemented in some areas, but struggle to get support in other areas in both the U.S. and Mexico. These conservation measures are expected to result in continued monitoring and research, some improvements in habitat related to roost protection and forage management (tequila industry, vampire bat control, bat gates or fences protecting roosts, and a continued improved understanding of life history requirements.

Within the 15-year time frame, our confidence that the moderate case scenario will occur is moderately likely. We anticipate that current efforts related to the conservation of bat roost sites and forage resources will not significantly be reduced within this time frame. Human attitudes towards lesser long-nosed bats and their conservation are not anticipated to change drastically within this 15-year time frame. As a result, we find that it is moderately likely that many of the same conservation actions, as well as threats potentially impacting the lesser long-nosed bat will continue at similar levels to current conditions which have led to a stable or increasing population status and which fit well with the anticipated conditions under this moderate case scenario.

Within the 50-year time frame, our confidence that this scenario will occur is also moderately likely. Under this scenario, even out to 50 years, we anticipate that actions affecting the status of the lesser long-nosed bat will remain in a similar balance as described under the current condition above. That is, we anticipate that an increase in negative effects to roosts, habitat, and human attitudes that will certainly occur over this time frame will be offset or balanced by ongoing conservation efforts. At this longer time frame, we expect that issues related to climate change will begin to be manifest. We also expect that these issues will result in negative effects to the lesser long-nosed bat population. However, this longer time frame will also allow for the lesser long-nosed bat to adapt to changing conditions which increases our confidence in this moderate case scenario reflecting reality. We do not anticipate that the positive trends in conservation and public support will drastically change within this time frame.

Table 8 describes anticipated effects to resiliency, redundancy, and representation within the lesser long-nosed bat population under the moderate case scenario.

	Population Condition	
	15-Years	50-Years
Resiliency	High	High
Redundancy	High	High
Representation	High	High

Best Case Future Scenario – In the best case scenario, support and resources are adequate to implement monitoring and protection of known lesser long-nosed bat roosts and the majority of known roost sites are protected. Local support is high for bat conservation and communities take ownership for protecting roost sites. Our understanding of and ability to manage lesser long-nosed bat forage resources is improved and forage resources are maintained or enhanced. Conversely, if forage resources continue to be lost or altered, lesser long-nosed bats adapt to the loss or reduction of forage resources resulting from development, agriculture or climate change by using new forage species or expanding their distribution to use existing forage resources. In particular, loss and reduction of tropical dry forests are halted and restoration and enhancement of habitats impacted by invasive species is being implemented. Migration patterns are described and migration pathways identified. These corridors are maintained and protected over a range of conditions such that changes in the distribution and availability of forage resources across the range and along the “nectar trail” in response to climate change and land use changes is maintained in the long term. White-nose syndrome is not a threat to lesser long-nosed bats, therefore, even if species known to be affected by white-nose syndrome are associated with lesser long-nosed bats in shared roosts, no effects from white-nose syndrome are anticipated. Consequently, limitations related to research and monitoring are removed. Public attitudes regarding the conservation of bats continues to improve due to outreach and education and conservation measures are supported and adequate resources are available to implement conservation measures across the range of the lesser long-nosed bat in both the U.S. and Mexico.

Within the 15-year time frame, our confidence that the best case scenario will occur is somewhat likely. We anticipate that current efforts related to the conservation of bat roost sites and forage resources will not significantly be reduced within this time frame, but, realistically, resources for such actions will continue to be finite. Human attitudes towards lesser long-nosed bats and their conservation are not anticipated to change drastically within this 15-year time frame, but there will continue to be some segments of society that will not understand or support bat conservation. As a result, we find that it is only somewhat likely that conservation actions will occur at a majority of sites important to lesser long-nosed bat viability. Similarly, threats potentially impacting the lesser long-nosed bat cannot be completely eliminated or managed, even if good progress is made towards addressing some of the threats in portions of the lesser long-nosed bat’s range.

Within the 50-year time frame, our confidence that this scenario will occur is also somewhat likely. Under this scenario, given the longer time frame of 50 years, it is realistic to anticipate that only positive actions will occur with regard to the conservation of the lesser long-nosed bat. That is, we anticipate that there will continue to be negative effects to some roosts and habitat, and human attitudes certainly change and adapt to the current thinking within society. Although some adaptation by lesser long-nosed bats to the effects of climate change are likely, at this longer time frame, we expect that issues related to climate change will begin to be manifest. We also expect that these issues will result in negative effects to the lesser long-nosed bat population that may not be able to be overcome through adaptation.

Table 9 describes anticipated effects to resiliency, redundancy, and representation within the lesser long-nosed bat population under the best case scenario.

	Population Condition	
	15-Years	50-Years
Resiliency	High	High
Redundancy	High	High
Representation	High	High

CHAPTER 6. SYNTHESIS

The decision to list the lesser long-nosed bat in the U.S. in 1988 caused considerable public controversy and disagreement. This carried over into the scientific community as well. One publication, that came out soon after the listing, questioned whether the lesser long-nosed bat truly was an endangered species (Cockrum and Petryszyn 1991, entire). In addition, during the development of the Recovery Plan for the lesser long-nosed bat, the author had to address the ongoing disagreement related to the status of this species that was evident through comments submitted during the public review of the draft recovery plan (USFWS 1997, p.1, 43 - 49).

Despite the disagreement over the information upon which the listing relied, both the public and the scientific community have expressed support for the ongoing conservation of the lesser long-nosed bat. Concurrently, significant progress has also been made in Mexico with regard to public support and understanding of the need for conservation of the lesser long-nosed bat. Despite our lack of understanding in some areas of lesser long-nosed bat life history, our knowledge base and extent of information has increased and, as a result, we are currently in a much better position to describe the status and viability of this species.

Predicting the future viability of the lesser long-nosed bat is somewhat more difficult than for species that occur in discrete, mostly consistent habitats (ponds, springs, specific soil types, etc.). The lesser long-nosed bat population is fluid and constantly adapting to changing environmental conditions over a large, bi-national range. Lesser long-nosed bat roost sites are discrete and consistent, but the lesser long-nosed bat may use these roost sites in a changing and adaptable manner to take advantage of ephemeral and constantly changing forage resources with both seasonal and annual differences of occurrence. Therefore, observations of occupancy and numbers of bats using these roosts may not be a complete or accurate representation of the status of the species across its range. The future viability of this species is dependent on an adequate number of roosts in the appropriate locations, sufficient available forage resources located in appropriate areas, including in proximity to maternity roosts and along the “nectar trail” used during migration, and positive human attitudes towards the conservation of bats such that conservation actions are implemented related to protecting roost sites, forage and migration resources, and research is supported to better understand this species life history needs, including the potential effects of disease.

Although the portion of the overall range for the lesser long-nosed that occurs within the U.S. is relatively small, threats affecting their protection and conservation have been under special attention and priority due to its current endangered status under the Act. Outreach and education, particularly in Mexico where efforts have been made to increase public understanding related to vampire bat control and the tequila industry, public attitudes towards bat conservation in general, and towards lesser long-nosed bats specifically, appear to be improving. While still ongoing for many species of bats, human disturbance has not been documented to be having the same significant negative effect on the populations of the lesser long-nosed bat that it may have had in the past. In addition, and in contrast to the U.S., the distribution of this species in Mexico is very wide and covers almost the entire country.

However, even in the U.S., watching the evening exit of lesser long-nosed bats from a roost site, one may be tempted to think that there are plenty of lesser long-nosed bats around. But as one pulls back to a more landscape-level perspective, it becomes obvious that these seemingly large numbers of bats are found at a relatively few roost locations. With colonial species such as the lesser long-nosed bat, the appropriate unit for assessment of threats may not be total population numbers, but rather total colony (roost site) numbers.

There is no question that current population numbers of lesser long-nosed bats exceed the levels known and recorded at the time of listing in 1988. A number of publications have documented numbers of lesser long-nosed bats throughout its range that far exceed the numbers used in the listing analysis (Fleming et al. 2003; p. 64 – 65; Sidner and Davis 1988; p. 494) and, in general, the trend in overall numbers has been stable or increasing in both the U.S. and Mexico (AGFD 2005 and 2016, entire; Medellín and Torres 2013, p.11 – 13; Buecher 2016, p. 10; Cerro 2012, p. 23). Additionally, the number of known roost sites has increased, particularly in the U.S. However, there has not been a significant increase in the number of maternity roost sites. At the time of listing, three maternity roost sites were known to be used by lesser long-nosed bats in Arizona. Currently, there are still only three maternity roost sites known to be used by lesser long-nosed bats in Arizona. Total number of roosts <u>monitored</u> in the U.S. is 10-20, depending on resources, and 10-20 in Mexico, again depending on resources. The occurrence or numbers of roost sites in other countries are unknown. Although disjunct, with some gaps, the distribution of this species runs generally from south-central Arizona to northern Central America. For such a wide distribution, there are relatively few known roost sites. We acknowledge that we certainly do not know of all roost sites, but even if we were to double the number of known roosts, it is still a relatively small number for the large geographic area covered. In addition, the roost-switching behavior of lesser long-nosed bats makes the relatively small number of known roosts even more significant to the population. A particular group of bats may move among several roost sites; in fact, they may <u>require</u> multiple roost sites to meet their foraging and reproductive needs (Cole and Wilson 2006, Newton et al. 2004, p. 13 - 17). This roost-switching behavior to follow food resources or accomplish reproduction makes population estimates very difficult. A reduction in numbers or absence of lesser long-nosed bats from a particular roost site in any given season or year does not necessarily mean that the roost site is insignificant or that bat numbers have declined. New roost sites have been located. However, it is often unknown if these roost sites have a history of occupancy. Have they been used for some time, or are lesser long-nosed bats now using this roost because of the destruction or disturbance of other roosts? Until these questions can be answered, the location of new roosts should be viewed with cautious optimism with regard to what that actually means for the status of the population.

Increased lesser long-nosed bat numbers and positive trends at most roosts have reduced concerns expressed in the final listing rule with regard to low population numbers and an apparent declining trend. However, threats to roost sites continue. The mere location of roost sites on public lands does not necessarily increase protection or reduce threats. A good example is the Blue Bird Mine on Cabeza Prieta NWR. Some Federal agencies have guidelines to protect these sensitive habitats and, as discussed above, generally, roosts on Federal lands benefit from monitoring by agency personnel and a law enforcement presence resulting in these roosts being exposed to fewer potential impacts than they otherwise would be. Agency land-use plans and general management plans contain objectives to protect cave resources and restrict access to abandoned mines, both of which can be enforced by law enforcement officers. In addition, guidelines in these plans for grazing, recreation, off-road use, fire, etc. will continue to prevent or minimize impacts to lesser long-nosed bat forage resources (USFS 2005, entire; BLM 1991, entire; DOD 2001, entire). In addition, while one Federal law and one State Statute protect caves and animal life in caves, the effectiveness of these laws is also dependent on enforcement capability. One of the most obvious and easily implementable tools for roost protection, bat gates, may not be able the most appropriate tool to use for this species. However, over the past five years, there has been considerable effort and success in understanding lesser long-nosed bat roost protection options and many roosts have had roost protection measures implemented.

Lesser long-nosed bats can be sensitive to disturbance at roost sites. Recreation specifically related to caving, as well as curiosity by recreationists in general, can affect roost sites. Even one occurrence can result in long-term effects. Researchers often concentrate their work at roost sites because of the availability of study animals. Research methods are often intrusive. Oversight exists at the Federal, State, and land management levels to reduce the likelihood of excessive disturbance of roost sites. However, unscrupulous researchers or researchers who fail to obtain the required permits can cause the disturbance of important roost sites. Repeated disturbance of an ongoing nature has the potential to significantly affect the integrity of roost sites. Disturbance of roosts by recreationists and researchers is a continuing threat, although it is probably not as significant as it was in the past.

Significant information regarding the relationship of lesser long-nosed bats to their forage resources has been gathered over the past decade. While the demise of lesser long-nosed bats would not likely result in the complete loss of the ecosystem (Fleming et al. 2003; p. 67), there is strong evidence of the dependence of lesser long-nosed bats on certain plant groups, as well as a reciprocal benefit to the plants provided by lesser long-nosed bats, especially further south in their range. It is important to not just focus on saguaros and agaves in Arizona where the mutualism is heavily skewed towards lesser long-nosed bats. In the southern parts of the lesser long-nosed bat's range, there are very strong mutualistic ties between the lesser long-nosed bat and their forage species. The loss of one would certainly lead to impacts to the other. Because lesser long-nosed bats are highly specialized nectar-, pollen-, and fruit-eaters, they are extremely vulnerable to loss of or impacts to forage species. However, lesser long-nosed bats are also highly effective at locating food resources and their nomadic nature allows them to adapt to local conditions.

Some nectar bats of the genera *Glossophaga* and *Anoura*, feed regularly on pollen and nectar, but also consume many insects. In contrast, more specialized species, such as long-nosed bats (*Leptonycteris curasoae* and *Leptonycteris nivalis*) and the Mexican long-tongued bat (*Choeronycteris mexicana*) depend almost exclusively on nectar, pollen, and fruit. Specialists tend to be more vulnerable to extinction than generalists. Consequently, nectar-feeding bats, such as the lesser long-nosed bats, should be particularly sensitive to habitat loss and the concomitant disappearance of the plants from which they obtain food (Arita and Santos-Del-Prado 1999). However, over the past 10 years, southern Arizona has experienced a number of years where either columnar cacti or agaves have produced significantly fewer flowers and fruits than normal and lesser long-nosed bats have been able to adapt to reduced forage availability and have maintained their numbers and roost occupancy in this part of their range. However, we do not know how the lesser long-nosed bat population will respond if such effects to forage availability are more long-term in nature, i.e. more than just a single year of a single forage species being affected.

For example, the resiliency of lesser long-nosed bats became evident in 2004, when a widespread failure of saguaro and organ pipe bloom occurred. The failure was first noted in Organ Pipe Cactus National Monument, and such a failure had not been noted in the recorded history of the Monument (Billings 2005, p. 3 - 4). The failure extended from Cabeza Prieta NWR on the west to Tucson on the east, and south into central Sonora, Mexico. The large-scale loss of this lesser long-nosed bat food resource was somewhat offset by the fact that small numbers of both saguaro and organ pipe flowers continued to bloom into August and September. Such a failure would have been expected to result in fewer lesser long-nosed bats using roosts in this area or reduced productivity at these roosts. However, this was not the case. Maternity roost numbers remained as high as or higher than previous years, with some 25,000 adult females counted during 2004 monitoring (Billings 2005, p. 5). Ultimately, it appears lesser long-nosed bats were able to subsist and raise young in southwestern Arizona in this atypical year. It is likely they did so by feeding more heavily on agaves (evident by agave pollen found on captured lesser long-nosed bats) than they typically do. The agave species utilized (*Agave deserti*) is not the agave species lesser long-nosed bats typically feed on in southeastern Arizona, which is *Agave palmeri*. Lesser long-nosed bats also likely had to travel greater distances and more widely to find the few saguaro and organ pipe blooms that were available. Notably, white-winged doves (*Zenaida asiatica*), which are largely dependent on the saguaro bloom, became very uncommon by late May as it became clear that the bloom was not simply late, but a near complete failure (Billings 2005, p. 3 - 4). The ability of lesser long-nosed bats to change their foraging patterns and food sources in response to a unique situation provides evidence that this species is more resourceful and resilient than may have been previously thought. This is particularly noteworthy considering that this type of a situation had not previously been documented within the past 60 – 70 years. Other observations over the past 20 years, including some years of significantly reduced agave availability, have indicated that the lesser long-nosed bat is highly adaptable to changing forage resource availability. This adaptability leads us to a determination that forage availability will not significantly affect the viability of the lesser long-nosed bat population.

Some efforts have been undertaken to protect known roost locations. The effects of livestock grazing and prescribed fire are probably not as significant as originally thought. The effects of agave harvesting are limited to bootleggers, which are probably occurring at the same levels as when the species was listed, however, this is not considered significant. Significant new threats to roosts are occurring in the form of illegal border activities and urban development. Invasive, exotic plant species and catastrophic wildfires are resulting in vegetation community conversion and reducing available lesser long-nosed bat foraging habitat. Urban development and expansion is resulting in permanent loss of lesser long-nosed bat habitat. A critically important threat is the potential for migration corridors to be truncated or interrupted. Significant gaps in the presence of important roosts and forage species along migration routes would affect the population dynamics of this species. The lesser long-nosed bat continues to be faced with loss and modification of its habitat throughout its range. However, habitats used by this species occur over a very wide range (see Figures 1 and 2) that cover a wide diversity of vegetation and ecological communities. These are habitat characteristics that would not make this species intrinsically vulnerable with regard to habitat limitations. That is to say, the wide variety of ecosystems that this species uses, over a relatively expansive range, result in available areas characterized by the asynchronous flowering of forage resources making up the diet of the lesser long-nosed bat, buffer this species from potential loss or reduction of habitats as a result of stochastic events, including climate change, among others. However, given the ongoing threats affecting ecosystems in the region of the North Pacific, including both tropical dry forest and Sonoran desert communities, the actual realization of this buffer should be a continued point of research and monitoring. However, the ability of lesser long-nosed bats to continue to persist and carry out essential life history activities, such as reproduction, in the face of recent drought and forage resource failures, indicates the adaptable and flexible nature of this species and its ability to remain viable in the landscape. However, recent experiences, such as the die off associated with a heat wave in 2016, continue to point out that some uncertainty remains with regard to what and how factors affect this species. The primary objective for ensuring the conservation of this species is to maintain the spatial and temporal availability of forage resources in the form of nectar, pollen, and fruits from plants associated with the species. This is achievable given the extent and diversity of the lesser long-nosed bat's range and its flight capabilities and foraging adaptability (Sperr et al. 2011).

The more we study lesser long-nosed bat population dynamics, the more insight and understanding we gain, but this insight and understanding also generates many more questions about this complex species. New information suggests a very complex population structure and dynamics. However, many questions still remain regarding migration patterns, reproductive strategies, genetic relationships, and inter-specific interactions. This complex structure does suggest that each part is critical and impacts to, or loss of, any part could have significant implications rangewide. The interactions of each part suggest a metapopulation structure, with each subpopulation within the metapopulation playing a key role.

Disease is not known to be a significant threat to lesser long-nosed bats. There is an anecdotal observation that may indicate a limited die-off at a specific roost in Mexico, but there is no current information indicating an ongoing threat, or that the die-off was disease related. However, as a colonial species, once a disease did manifest itself, it could affect significant numbers of the population. Predation does contribute to the mortality of lesser long-nosed bats at roost sites. Specifically, barn owls have been observed preying on lesser long-nosed bats at the maternity roost at Organ Pipe Cactus National Monument for many years and snakes have been observed predating on lesser long-nosed bats in Baja California Sur, Mexico. However, at large aggregations, such as bat roosts, predation is likely an insignificant impact on the population. However, at small roosts, predation may be a significant factor. Likely predators include snakes, raccoons, skunks, ringtails, bobcats, coyotes, barn owls, great-horned owls, and screech owls.

The current listing of the lesser long-nosed bat in the U.S. and the past listing of the bat in Mexico on their respective endangered species lists provides this species with some level of protection. Outside of this, there are no laws or regulations protecting this species in Mexico. In fact, the lack of regulation related to control of vampire bats in Mexico is continuing to result in the mortality of the lesser long-nosed bat due to the lack of requirements to properly identify the target species. In the U.S., State laws and regulations provide some additional level of protection

(ARS Title 17 in Arizona and NMAC Title 19 in New Mexico), but this protection is for individual animals only, and does not apply to the loss or destruction of habitat. In Arizona, Title 17 prohibits the taking of bats outside of a prescribed hunting season and, per Commission Order 14, there is no open hunting season on bats, meaning it is always illegal to take them. Provisions for special licenses to take bats and other restricted live wildlife are found in Arizona Game and Fish Commission Rule 12, Article 4 and are administered by the Arizona Game and Fish Department.

In the past, bats have had a bad reputation. However, significant changes in the public perception of bats are occurring. Educational efforts are beginning to make a difference. In Mexico, in particular, public education in the form of radio and television spots, and educational materials, have been implemented. Agencies now receive calls for assistance in non-lethal solutions to bat issues. Progress is being made, even if it is slow. Often, the general public does take the time to understand or differentiate when it comes to emotional issues such as rabies or vampire bats. Until there is a more general public acceptance of bats as an important ecological component, support for bat conservation will continue to be limited. With vulnerable species such as lesser long-nosed bats, lack of support can significantly affect the conservation and continued existence of the species.

The best available information indicates that ongoing climate change will result in changes in the phenology and distribution of lesser long-nosed bat forage resources. How this affects the viability of the lesser long-nosed bat population is less clear. There is much uncertainty and a lack of information regarding this issue. The biggest effect will occur if forage availability gets out of sync along the “nectar trail” such that bats arrive at the portion of the range they need to meet life history requirements (migration, mating, birthing) and there are inadequate forage resources to support that activity. If timing changes, but changes consistently in a way that maintains the nectar trail, this species may be able to adapt to those timing changes. Adaptation is less likely if changes result in forage availability being out of sync in various parts of the range and pathway such that forage and energy reserves cannot support the life history needs of the species. We know that this species has shown considerable ability to adapt to adverse forage conditions. In these instances, the numbers and productivity of the lesser long-nosed bat has not appeared to be negatively impacted, at least in the short term. Again, effects from climate change on this species are not occurring in isolation. Compounding factors related to loss and alternation of habitat due to increases in invasive species, changing fire regimes, urbanization, agriculture, and other land uses will play a role in the overall impact of climate change on this species’ viability. Bagne and Finch (2012 and 2013; p. 107 – 116; p. 150 – 160) assessed the lesser long-nosed bat as being moderately vulnerable to global climate change. Although we are still not sure to what extent the environmental conductions described in climate change predictions will affect lesser long-nosed bat forage resource distribution and phenology, we have documented that lesser long-nosed bats have the ability to change their foraging patterns and food sources in response to a unique situation, providing evidence that this species is more resourceful and resilient than may have been previously thought. We find that the lesser long-nosed bat is characterized by flexible and adaptive behaviors that will allow it to remain viable under changing climatic conditions.

Progress towards the conservation and recovery of the lesser long-nosed bat is evidenced by an analysis that was conducted in Mexico in 2013 to evaluate whether the lesser long-nosed bat should maintain is protected status in that country (Medellín and Torres 2013, entire). The protocol for determining the classification of protection in Mexico includes the evaluation of four criteria (extent of the distribution of the species; status of the habitat related to the needs of the species; intrinsic vulnerability of the species; and the impact of human activities of the species) and assigning a value to each criterion. This quantified approach places the species in the appropriate category of protection defined as follows: Endangered (score of 12 – 14) or Threatened (score of 10 - 11) (Sánchez et al. 2007, p.36).

The lesser long-nosed bat scored a 1 under the distribution criterion; a 2 under the status of the habitat criterion; a 2 for the intrinsic vulnerability of the species; and a 3 for the human impact criterion. This results in a total score of 8 for the lesser long-nosed bat which falls outside the score needed to classify it as endangered or threatened. The species was removed from the Mexican endangered species list (Norma Oficial Mexicana NOM-059-ECOL-2010) in 2015 (SEMARNAT 2015, entire).

Bats are difficult animals to survey and monitor because of their nocturnal, cryptic, and wide-ranging behavior. They are difficult to study and to establish status and trend for populations. Because of their volancy and high spatiotemporal variability across their range, large scale regional or range-wide assessments are critical to understanding population viability and status. As discussed above, downward trends observed at any given roost or foraging area may simply reflect a shift in local resource use or be the result of some localized environmental perturbation rather than an actual synoptic population decline (Rodhouse et al. 2012; p. 1098 – 1099). Regional-scale assessments drawing upon surveys or monitoring events at many sites representative of the region are needed to reflect true population conditions (O'Shea et al. 2003).

With regard to the lesser long-nosed bat, Cerro (2012; entire) investigated the monitoring effort needed at lesser long-nosed bat roosts in Arizona so that statistically robust estimates of populations and trends could be determined. She concluded that, given the number of breeding and transient roosts in the region, trends of even one to two percent have relatively low chances of being detected with a moderate amount of annual survey effort (4 roosts surveyed/year with 3 surveys/roost/year), even over a 30-year period. The amount of effort required to detect smaller trends for species similar to lesser long-nosed bats will be high; therefore, managers might consider sacrificing detection of smaller trends for more attainable targets.

For species such as lesser long-nosed bats where abundance varies naturally, both temporally and spatially, large variation in estimates of abundance can make monitoring efforts especially challenging. High temporal variation and low precision of abundance estimates have a large influence on the ability to detect trends in many bat species, and often call for an extended monitoring period to attain adequate data needed to detect trends. Thus, it is particularly important to reduce variation in estimates of abundance where possible, such as employing survey techniques that yield the highest possible precision.

In general, increasing the number of surveys per roost each year had a larger influence on power than increasing the number of roosts surveyed per year. For both maternity and transient roosts, increasing the number of roosts surveyed from 4 to 6 has a substantial effect on power, resulting in a -3% annual trend being detected 5 years earlier. Cerro (2012; p.46) recommended monitoring at least 6 transient roosts per year, ≥ 3 surveys per year, so that an annual trend of -3% has a high probability of being detected within about 15 years. A standardized protocol should be implemented across roosts that includes recording emergences with video equipment and infrared lighting, which yields estimates that are more precise than those from live counts. Further, retaining experienced observers to record and quantify emergences from video recordings will decrease sampling error. For lesser long-nosed bats, monitoring is likely to be successful only when performed under a rigorous sampling framework that has been designed carefully and can be implemented over a reasonable time frame. For both types of roosts, managers need to first establish a time frame acceptable for the magnitude of the desired trend to be detected, while recognizing that the ability to detect smaller trends is critical for species in peril.

Historical, current, and future monitoring efforts are unlikely to be able to provide robust enough data to determine population size and trend for this species because agency and conservation partner resources are generally lacking throughout the range of the lesser long-nosed bat for such intensive monitoring efforts. However, past and future effort related to monitoring lesser long-nosed bat roost is likely to be able to provide simple occupancy and distribution data across much of the range of this species. Measures of occurrence or distribution, as well as the rates of change in distribution, can often be more easily generated that abundance data. Although distribution is a less informative metric than abundance, it is widely considered a fundamental population attribute that is expected to reflect underlying abundance and can sometimes be used for assessing population status and trend at broad spatial scales. A dynamic distribution model may provide baseline and subsequent data to describe population declines in bat species (Rodhouse et al. 2012' p. 1098 – 1099).

If we look at occupancy and distribution of lesser long-nosed bat roost across its range, we may be able to, at least generally, say something about the population trend of this species. For example, over the past 20 years, survey and monitoring of lesser long-nosed bat roost sites in Arizona and Mexico have shown a consistent and regular distribution of occupied roosts throughout its range. As indicated above, actual numbers at roosts sites may not represent the true population status. However, as we look at lesser long-nosed roost site monitoring over the past 10 years in both the U.S. and Mexico, occupied roosts are documented to be regularly and appropriately distributed across this species' range, including maternity, mating, and transition roost sites. This consistent occupancy and distribution indicates that the lesser long-nosed bat is currently able to complete all its life history activities throughout its range. While actual numbers of bats observed at roost sites may not support a statistically valid population trend, the overall numbers of bats observed at roost sites can be used as an index of population status. Although most data related to lesser long-nosed bat roost counts and monitoring have not been collected in a way that is statistically rigorous enough to draw conclusions about the trend of the population, in the professional judgment of biologists and others involved in these efforts, the total numbers of bats observed at roost sites across the range of the lesser long-nosed bat are considered stable or increasing at nearly all roost sites being monitored. The total number of bats currently being documented is many times greater than those numbers upon which the listing of this species relied, and while this may simply reflect a better approach to survey and monitoring in subsequent years, it gives us better information upon which to evaluate the status of the lesser long-nosed bat population. While we did not formally model occupancy or distribution for this SSA Report, we did elicit input from a wide range of professionals working on this species across its range and conducted a thorough evaluation of the available literature for this and related species. The species is characterized as being widespread and abundant in Mexico (Arita and Prado 1999). This general evaluation the available data for occupancy and distribution, as well as the opinions of experts familiar with this species, indicates to us a viable population status with a stable to increasing trend.

As we looked into the future at 15 and 50 years under the worst case scenario, a moderate case scenario, and the best case scenario, we see that the viability of the lesser long-nose bat remains high for all but the worst case scenario. We do not have confidence that the worst case scenario is likely to be realized. Based on our experience and the past and ongoing actions of the public and the commitment of management agencies in their land-use planning documents to address lesser long-nosed bat conservation issues, both now and in the future in both the U.S. and Mexico, such drastic impacts are unlikely to occur (10 to 30 percent sure this scenario will occur). In fact, for the conditions outlined in the worst-case scenario, we find that certainty of the worst-case scenario occurring is closer to 10 percent than to 30 percent sure that this scenario would actually occur based on the commitment to conservation of this species and the adaptability of the lesser long-nosed bat. However, even under the worst case, at the 15-year timeframe, moderate viability is maintained. We cannot foresee a scenario that we are confident will occur that will result in a significant reduction in the viability of the lesser long-nosed bat population.

Table 10. Summary of the current viability of the lesser long-nosed bat population and the predicted future viability of the population under the described future scenarios.

3 Rs	Needs	Current Condition	Future Condition (Viability)
Resiliency: Population segments able to withstand stochastic events	• Multiple roosts of each type distributed across the range (maternity, mating, migration, transition), including alternate roost sites • Diversity of forage resources occurring at the appropriate times for life history events • Intact migratory pathways	• Multiple roosts are currently found in both resident and migratory segments of the population. • Multiple mating sites are known; multiple maternity sites are known; and transition roosts are located in areas used by both the resident and migratory segments of the population. Adequate roost sites exist to support roost switching to use seasonally and annually ephemeral forage resources. • A number of roost sites of each type (maternity, mating, transition) are protected in both the U.S. and Mexico. • Currently, forage and roosting	• **Best Case –** We anticipate that the resiliency of the lesser long-nosed bat population will remain high and improve over the current condition at both time frames. • **Moderate Case –** We anticipate that the resiliency of the lesser long-nosed bat population will remain high and similar to the current condition over both time frames. • **Worst Case –** We anticipate that the resiliency of the lesser long-nosed bat

		resources are available in an adequate number and distribution to support residence and migration throughout the range.	population will decrease to moderate within the 15-year time frame and to low within the 50-year time frame.
Redundancy: Number and distribution of population segments to withstand catastrophic events	• Multiple roost sites within each population segment that provide, as appropriate, maternity, mating, and transition roosts in proximity to available forage resources. • Multiple potential migration pathways that provide connectivity among population segments, including resident and migratory population segments and that support adequate forage resources.	• Multiple maternity roosts are known in both resident and migratory segments of the population. • Multiple mating roosts are known in the areas of Mexico where mating for both the resident and migratory segments of the population occur. • Multiple transitions roosts occur in both the resident and migratory segments of the population in a distribution that allows this species to use available forage resources. • Currently, migration pathways are currently intact along both the Pacific Coast and Sierra Madre hypothesized migration pathways. Lesser long-nose bats have shown the ability to adapt to historical fluctuations in the availability of forage across its range.	• **Best Case –** We anticipate that redundancy within the lesser long-nosed bat population will remain high and may improve slightly over both time frames. • **Moderate Case –** We anticipate that redundancy within the lesser long-nosed bat population will remain high and similar to the current condition over both time frames. • **Worst Case -** We anticipate that redundancy within the lesser long-nosed bat population will decrease to moderate within the 15-year time frame and to low within the 50-year time frame.
Representation: Genetic and ecological diversity to maintain adaptive potential	• Genetic representation is maintained across the range and across population segments. • Ecological diversity is maintained across the range, including adequate roosts and forage resources in both resident and migratory segments of the population.	• The best available information indicates that the lesser long-nosed bat is currently a single population. Genetic variability occurs, but not to the extent that different populations can be identified. Current genetic diversity is likely to be maintained due to the large range of this species and the intermixing of both the resident and migratory population segments for reproductive activities. • Currently, this species' large range is characterized by diversity in vegetation communities, topography and climate. This diversity allows this species to carry out its life history activities that requires	• **Best Case –** We anticipate that representation within the lesser long-nosed bat population will remain high and similar to the current condition over both time frames. • **Moderate Case –** We anticipate that representation within the lesser long-nosed bat population will remain high and similar to the current condition over both time frames. • **Worst Case -** We anticipate that

		seasonal and annual changes in activities and behavior.	representation within the lesser long-nosed bat population will decrease to moderate within the 15-year time frame and to low within the 50-year time frame.

Recommendations for Future Actions -

- A roost monitoring plan should be created and implemented throughout the range of this species, including protocols for monitoring and use of a centralized data repository for the data. Existing programs should be supported and expanded as appropriate to include information and efforts in both the U.S. and Mexico. We should strive to increase the reliability and quality of data for all ongoing and future activities. Because multiple visits are required to develop data that is statistically rigorous enough to determine population trends, funding should be obtained to support the needed network of roost monitors at a level of effort that would make monitoring meaningful. Funding should be investigated in both the U.S. and Mexico. Investigation into more effective and efficient and accurate ways of monitoring roosts should continue. Complete and consistent monitoring reporting needs to be emphasized and implemented.

- Significant efforts should be made to obtain adequate research funding to increase our understanding of population dynamics, roost vulnerabilities, forage relationships, and the impacts of new threats such as border activities and introduced exotics. Specific efforts should be made to fund and coordinate work in Mexico. Emphasis should be placed on a landscape-level forage monitoring program looking at flowering phenology of columnar cacti and agaves, tying that data to environmental variables such as temperature and precipitation. We should continue to take advantage of citizen scientist efforts, such as the hummingbird feeder monitoring project and the National Phenology Network, to gather and assess information related to the life history of the lesser long-nosed bat.

- We should continue with and even increase our effort with regard to educational programs, both in Mexico and in the U.S. Educational efforts should target not just the general public, but agencies and groups responsible for land management, agave harvest, vampire bat control, and conservation activities. Developing local community support and ownership for important conservation sites (roosts, forage patches, migration pathways, etc.) is critical to the conservation of this species.

- We should work closely with land management agencies to develop more appropriate guidelines for grazing and prescribed fire. Guidelines should focus more on ecosystem health rather than on individual forage species.

- Work closely with agency and conservation partners to develop appropriate roost protection measures, including appropriately designed gates. More work needs to be done to develop specific gate designs that will allow for protection of the roost, but still maintain or increase lesser long-nosed bat occupancy of gated roost sites.

- We should continue to build and expand partnerships with private landowners who own and manage lands that support lesser long-nosed bat roost sites and forage resources. We should work to build a feeling of ownership of these sites by the landowners such that they feel incentive to protect and manage these important resources and conduct outreach and education for neighboring landowners. We need to develop a network and support system for partner landowners.

- Continued efforts should be made to monitor for the occurrence of white-nose syndrome and promote the use of methods to prevent the occurrence or spread of the white-nose syndrome (decontamination protocols, restriction of the use of equipment from areas of known white-nose syndrome occurrence, etc.).

- We should work with partners across the country to assess the potential impacts of renewable energy facilities, particularly wind energy facilities, on lesser long-nosed bats. Best management practices should be developed to prevent or reduce potential impacts to lesser long-nosed bats (e.g. spacing of turbines or towers, avoiding colors that may attract bats, locating turbines or towers an adequate distance from roosts, etc.).

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