DRAFT POST-DELISTING MONITORING PLAN

for the

Lesser Long-nosed Bat (*Leptonycteris yerbabuenae*)

Lesser long-nosed bats at a hummingbird feeder. *Photo by Richard Spitzer*

U.S. Fish and Wildlife Service
Region 2
Arizona Ecological Services Field Office
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Summary

The U.S. Fish and Wildlife Service (USFWS) has removed the lesser long-nosed bat from the List of Endangered and Threatened Wildlife due to recovery. The lesser long-nosed bat was delisted on April 18, 2018 (FR 83 17093) because information indicated that population viability was secure due to a reduction in threats; the implementation of education, outreach, and conservation activities; and documentation of an increased number of known roosts with stable and increasing population numbers as evidenced through ongoing monitoring (USFWS 2016). Under the Endangered Species Act (ESA), monitoring is required for not less than 5 years after delisting to ensure the species remains secure from the risk of extinction (section 4(g) of the ESA). The delisting of this species triggers the requirements of section 4(g) and the USFWS worked closely with state wildlife agencies and other conservation partners in the development of this plan. We will continue to work closely with these same entities during the implementation of this plan.

This draft PDM plan proposes two primary components to monitor the status of the lesser long-nosed bat, including continued roost occupancy and threats monitoring, and an assessment of forage availability through phenology and distribution monitoring of lesser long-nosed bat forage resources. While it is our determination that threats to the viability of the lesser long-nosed bat population have or are being addressed, the post-delisting monitoring components are meant to assess the resurgence or development of any threats to future species viability outlined in the *Species Status Assessment Report for the Lesser Long-Nosed Bat.* These threats are primarily related to the effects of climate change on forage resources and impacts affecting the viability of known roost sites.

The roost monitoring approach will occur at four of the known maternity roost sites in Arizona and northern Sonora, Mexico, as well as at a subset of six late-summer, transition roosts in Arizona. To geographically and functionally represent the range of the lesser long-nosed bat, roosts sites were selected in the U.S., as well as a key maternity site in northern Sonora, Mexico. All key maternity roost sites in the region were selected, as well as larger late-summer, transition roosts with a known history of occupancy so information is available for comparison. Lesser long-nosed bat forage phenology sites were selected to cover the geographic range of the lesser long-nosed bat in the U.S. across both the maternity season and the post-maternity/transition season. The PDM plan is proposed to be implemented over a 15-year period with an interim and final reporting schedule. We chose the 15-year timeframe because it is a useful timeframe over which to assess the progress of lesser long-nosed bat conservation efforts. It is also one of the timeframe that was used in the Species Status Assessment Report (SSA)(USFWS 2016) to evaluate future viability of the lesser long-nosed bat. Because of the lesser long-nosed bat's demographic and behavioral characteristics (generation time, survivorship, migration, ephemeral forage resources, roost occupancy and switching, etc.), it can take a relatively long period of time to assess and determine population trends and trends in long-lived forage species. As a result, a fifteen-year timeframe was selected and was based on the history and results 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; assessing forage resources; 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 and population trends. Monitoring thresholds are provided to ensure viability of the species through resiliency, redundancy, and representation. Monitoring thresholds incorporate information from The *Species Status Assessment Report for the Lesser Long-Nosed Bat* as appropriate (USFWS 2016).

If monitoring results show that variables fall below the thresholds within the PDM plan, responses are provided to identify and address the concern. Responses generally include extended or intensified monitoring effort, as well as coordination with experts and land managers to determine appropriate actions to address the concern. Additionally, an adaptive management approach is recommended to address both the effectiveness and usefulness of the proposed monitoring approach. If future information becomes available that indicates threats to the species have increased and it is likely the species may become endangered with extinction, the USFWS will initiate a status review and determine if relisting the lesser long-nosed bat is warranted.

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I. Introduction

Post-delisting monitoring (PDM) refers to activities undertaken to verify that a species that is delisted due to recovery remains secure from risk of extinction after the protections of the Endangered Species Act (ESA) no longer apply. One primary goal of PDM is to monitor the species to ensure the status does not deteriorate and to efficiently and accurately detect changes in the population or an increase in threats, triggering measures can be implemented to halt the decline so that re-proposing the lesser long-nosed bat as a threatened or endangered species is not needed.

Section 4(g) of the ESA requires the U.S. Fish & Wildlife Service (USFWS) to implement a program, in cooperation with the States, to monitor, for not less than five years, the status of all species that have recovered and been removed from the List of Endangered and Threatened Wildlife and Plants (lists). Section 4(g)(2) of the ESA directs the USFWS to make prompt use of its emergency listing authorities under section 4(b)(7) of the ESA to prevent a significant risk to the well-being of any recovered species. While not specifically mentioned in section 4(g), authorities to list species in accordance with the process prescribed in sections 4(b)(5) and 4(b)(6) may also be used to reinstate species on the list, if warranted.

The USFWS and States have latitude to determine the extent and intensity of PDM that is needed and appropriate. The ESA does not require the development of a formal PDM "plan." However, the USFWS generally desires to follow a written planning document to provide for the effective implementation of section 4(g) by guiding collection and evaluation of pertinent information in a consistent and useful fashion over the monitoring period and articulating the associated funding needs. Thus, this document was prepared to describe the PDM plan for the lesser long-nosed bat (*Leptonycteris yerbabuenae*). This PDM plan follows the USFWS's August 2008, *Post-Delisting Monitoring Plan Guidance Under the Endangered Species Act* (available on-line at http://endangered.fws.gov).

II. Role of PDM Cooperators (see also Appendix B and Table 2)

A. U.S. Fish & Wildlife Service (Ecological Services)

The USFWS is committed to cooperating with the States of Arizona and New Mexico, as well as our other conservation partners, to ensure that effective PDM of the lesser long-nosed bat is accomplished. The USFWS does not have sufficient personnel or financial resources available for conducting all the necessary fieldwork, data analysis, and reporting required for this PDM effort. However, the USFWS does manage three National Wildlife Refuges (San Bernardino/Lesley Canyon NWR, Buenos Aires NWR, and Cabeza Prieta NWR) that will continue to monitor the species and/or its forage resources on their respective properties (see Section F below). The USFWS will continue to work with our partners to seek funding opportunities through existing grant programs, such as, but not limited to Section 6 Endangered Species Cooperative Grant Program administered by the NMDGF and

AGFD, the Department of Defense's Legacy Resource Management Program, AGFD's Heritage Grant Program, grants through conservation partners, and base funding of cooperating agencies.

USFWS staff will participate in and maintain oversight of all activities undertaken as part of the PDM. This will include implementing monitoring at a roost site and a forage phenology site; developing and managing one or more grants or contracts; interpreting the intent of the PDM plan; reviewing and commenting on draft reports; distributing final reports and other information to interested parties; approving and documenting any changes to the PDM plan; conducting any necessary future status reviews of the lesser long-nosed bat; and determining when the PDM is complete.

B. Arizona Game and Fish Department

Upon delisting, the Arizona Game and Fish Department (AGFD) will assume authority for the conservation of the lesser long-nosed bat in Arizona. The AGFD has developed the Arizona Bat Conservation Strategic Plan to guide and direct bat conservation within Arizona. This plan includes goals and objectives for the monitoring of bat species and habitats, including roost sites. The AGFD has taken a lead role in developing the *Leptonycteris curasoae* Recovery Cooperative (LcRC) and has led the coordination of the annual simultaneous roost count monitoring that occurs at maternity roosts in June and late-summer transition roosts in August of each year. The AGFD has committed to maintaining this leadership role during PDM. The USFWS requested AGFD assistance in developing and implementing the PDM plan. The AGFD provided key input with regard to the PDM approach. We will work with AGFD to identify and pursue any potential funding avenues or other resources that will be useful for the PDM plan.

C. New Mexico Department of Game and Fish

Similar to the AGFD, the New Mexico Department of Game and Fish (NMDGF) would assume authority over the conservation of the lesser long-nosed bat in New Mexico upon delisting. The lesser long-nosed bat has a reduced occurrence in New Mexico as compared to Arizona, but NMDGF does oversee monitoring efforts in New Mexico due to the species' status as state threatened. The lesser long-nosed bat will remain on New Mexico's list of threatened species due to its limited range and occurrence in New Mexico and will continue to receive the conservation benefits of that listing. The USFWS requested that NMDGF assist in developing and implementing the PDM plan. NMDGF will continue to support efforts in New Mexico that further the purpose of this plan. The USFWS will work with NMDGF through our cooperative grants programs and other processes to provide funding or resources to implement PDM activities in New Mexico.

D. Fort Huachuca Military Installation

Fort Huachuca is the location of one of the most complete, long-term data sets for lesser long-nosed bat roost monitoring. The Fort has facilitated the monitoring of a number of lesser long-nosed bat roost sites for over 20 years. In addition to lesser long-nosed bat roost monitoring, Fort Huachuca implements cave and mine protections, as well as maintaining

agave management areas within the military installation. All of these activities have resulted in positive conservation outcomes for the lesser long-nosed bat. Fort Huachuca will continue to contribute to lesser long-nosed bat conservation by continuing appropriate lesser long-nosed bat resource monitoring after delisting as outlined in their Integrated Natural Resources Management Plan (INRMP).

E. The Nature Conservancy of Arizona

The Nature Conservancy of Arizona (TNC) is a substantial conservation partner in Arizona. TNC owns or manages numerous properties in the state, many of which support lesser long-nosed bat forage resources. TNC also maintains an extensive network of volunteers who help with monitoring and other activities. Subject to availability of volunteer and staff resources, TNC has committed to participate in the forage resource monitoring portion of the post-delisting monitoring plan and will provide valuable phenology data for lesser long-nosed bat forage species.

F. USFWS Refuge System

The USFWS Refuge System includes three national wildlife refuges that support the conservation of the lesser long-nosed bat by maintaining forage resources, roosting resources, or both. The San Bernardino/Leslie Canyon NWR supports lesser long-nosed bat forage resources that are used by bats roosting in adjacent mountain ranges. The Buenos Aires NWR supports agaves at higher elevation areas of the refuge, as well as low-density, widely-distributed saguaros. Both of these plants provide forage resources for the lesser long-nosed bat. Potential lesser long-nosed bat roost sites also occur in the Brown Canyon area of the Buenos Aires refuge. The Cabeza Prieta NWR in western Arizona supports one of three known lesser long-nosed bat maternity roosts in the United States. In addition, other lesser long-nosed bat roosts have been documented on the refuge. Forage resources needed by lesser long-nosed bats during the critical maternity period are found throughout the Cabeza Prieta NWR. These three NWRs will continue to provide important forage and roosting resources. Of particular importance will be the continued monitoring of the maternity roost on Cabeza Prieta NWR.

G. The National Park System

Four units within the National Park System in Arizona support roosting and foraging lesser long-nosed bats. Chiricahua National Monument manages an area used by foraging lesser long-nosed bats and is adjacent a number of documented post-maternity, late-summer lesser long-nosed bat roosts known as transition roosts. Coronado National Memorial contains an important lesser long-nosed bat late-summer transition roost with a long-term data set related to the monitoring of this roost. The roost site is also protected by bat gates and is an important site that continues to be used to test the compatibility of lesser long-nosed bats and bat gates. Coronado National Memorial has also been active in the restoration of agaves to areas disturbed by the construction of border infrastructure and fires. Saguaro National Park supports important lesser long-nosed bat forage areas, including both agaves and saguaros. In addition, a large late-summer transition roost site is located on the Park and has been monitored by various entities over the past two decades. Organ Pipe Cactus National

Monument is located in western Arizona and supports the largest of the three lesser long-nosed bat maternity roost in the United States. Currently, over 40,000 lesser long-nosed bats use the roost in Organ Pipe each summer to give birth to and raise their offspring. Staff at Organ Pipe Cactus National Monument have maintained roost-monitoring records for this roost site for over 20 years that provide valuable information related to the productivity of this species. Additionally, Organ Pipe personnel gather data on saguaro and organ pipe flowering phenology at established phenology plots. All of these National Park Service units will continue their monitoring and protection efforts throughout the implementation of the post-delisting monitoring program, as funding is available.

H. Bat Conservation International

Bat Conservation International (BCI) is a recognized leader in worldwide bat conservation. Local staff members from BCI have assisted in finding resources and providing technical assistance in many aspects of lesser long-nosed bat conservation. Specifically, BCI has programs addressing cross-border species such as the lesser long-nosed bat, including BCI's subterranean program and conservation science. BCI has three organizational divisions that have contributed to ongoing conservation efforts related to the lesser long-nosed bat, including BCI's conservation division, science division, and networks and partnerships division. BCI will continue to contribute expertise and resources to the implementation of the PDM plan for the lesser long-nosed bat.

I. Tohono O'odham Nation

The Tohono O'odham Nation contains one of the three known maternity roosts in the U.S. The Nation and the Cyprus Tohono Mining Corporation have contracted monitoring at this roost site for more than 20 years. The Tohono O'odham are important conservation partners for the lesser long-nosed bat due to the location of roost sites and foraging resources within the Nation. The Nation has also been an important cooperator in the development of large land use and conservation planning efforts such as Pima County's Sonoran Desert Conservation Plan and the Multi-Species Conservation Plan. We will continue to coordinate with the Tohono O'odham Nation to implement the PDM plan as appropriate.

J. USA National Phenology Network

We are collaborating with the USA National Phenology Network (NPN) to implement the forage monitoring portion of the lesser long-nosed bat PDM plan. The NPN developed Nature's Notebook, a project focused on collecting standardized ground observations of phenology by researchers, students and volunteers. The NPN also fosters phenology communities of practice, and the development of tools and techniques to support a wide range of decisions made routinely by citizens, managers, scientists, and others, including decisions related to allergies, wildfires, water, and conservation. The NPN has already established a Flowers For Bats project, which is featured on their website. This NPN program has a history of success and we are excited to use the NPN's resources and expertise to implement lesser long-nosed bat forage resource monitoring. These data will help us track changes in the phenology of important lesser long-nosed bat forage species and evaluate the potential effects of climate change on forage species.

K. Private Consulting Entities

Historical monitoring of lesser long-nosed bat roosts has often been accomplished by private bat researchers, including private consulting entities. While a good deal of the lesser long-nosed bat monitoring and research on private lands and associated with private projects has been accomplished by these private bat consultants, these same entities have voluntarily contributed to many of the efforts in southern Arizona related to lesser long-nosed bat conservation and research. Access to some lesser long-nosed bat roosts on private property is only granted to non-government personnel. Consequently, the efforts of these private consulting entities have resulted in a significant contribution to lesser long-nosed bat conservation. Indeed, these entities helped us develop the lesser long-nosed bat Species Status Assessment report and their data have helped us gain a better understanding of the status of the lesser long-nosed bat population. We anticipate that these entities will continue to help us by assisting with the implementation of the PDM plan, both as paid contractors and as volunteers.

L. Bureau of Land Management (New Mexico)

The Bureau of Land Management (BLM) in New Mexico is the land manager for the only publically-accessible lesser long-nosed bat roost in New Mexico at this time. This roost is a late-summer transition roost that also supports the Mexican long-nosed bat, *Leptonycteris nivalis.* The New Mexico BLM facilitates and participates in lesser long-nosed bat conservation activities in New Mexico, including roost protection, access management, research, and managing of forage resources.

M. U.S. Forest Service (Coronado National Forest)

The Coronado National Forest (CNF) is home to a number of known lesser long-nosed bat roosts and thousands of acres of forage resources, primarily agaves. Land management activities, including law enforcement, are carried out by the CNF. These land management activities contribute to the protection of lesser long-nosed bat roost and forage resources. CNF's monitoring of these Forest lands is important in both maintaining foraging and roosting habitat. CNF also grants permits and other permissions needed for monitoring of roosts and forage on CNF lands.

N. Pima County

Pima County has been active in land use and conservation planning over the past nearly two decades. The completion and implementation of their Sonoran Desert Conservation Plan and the Multi-Species Conservation Plan have contributed to the conservation of important lesser long-nosed bat habitat. The processes outlined in these two plans, as well as other policies and regulations implemented by Pima County, provide conservation for the lesser long-nosed bat at both project-level as well as landscape-level scales.

Appendix B and Table 2 of this PDM plan summarize PDM cooperators and their responsibilities under the PDM plan.

III. Summary of Species' Status

A. Species Information

A detailed discussion and analysis of the current and future status of the lesser long-nosed bat is found in The *Species Status Assessment Report for the Lesser Long-Nosed Bat* (SSA) (USFWS 2016). A general summary of the status of the species is included below.

The lesser long-nosed bat is a migratory pollinator and seed disperser that provides important ecosystem services in the Sonoran desert, arid forests, and grassland systems throughout its range in the U.S. and Mexico, contributing to healthy soils (pollination and seed dispersal contribute to functioning landscapes with diverse vegetation communities improving soil quality and decreasing erosion) , diverse vegetation communities (pollination and seed dispersal), and sustainable economic benefits for communities (pollination and ecotourism). The lesser long-nosed bat forages on columnar cacti and various agave species in the northern portion of its range, as well as on flowering deciduous trees in the southern portion of its range. The range of the lesser long-nosed bat extends from the southwestern U.S. southward through Mexico (Figure 1).

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

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. Columnar cactus flowers and fruit and Agave flowers represent the bat's core diet; thus, providing nearly all of the energy and nutrients for lactating females and migration. 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. Further, the best available information indicates that the lesser long-nosed bat is currently a single population. Ramirez (2011) investigated population structure of the lesser long-nosed bat in the United States and throughout Mexico and reported that individuals belong to one population. Consequently, individuals found in the northern migratory range and in Mexico should be managed as a single population.

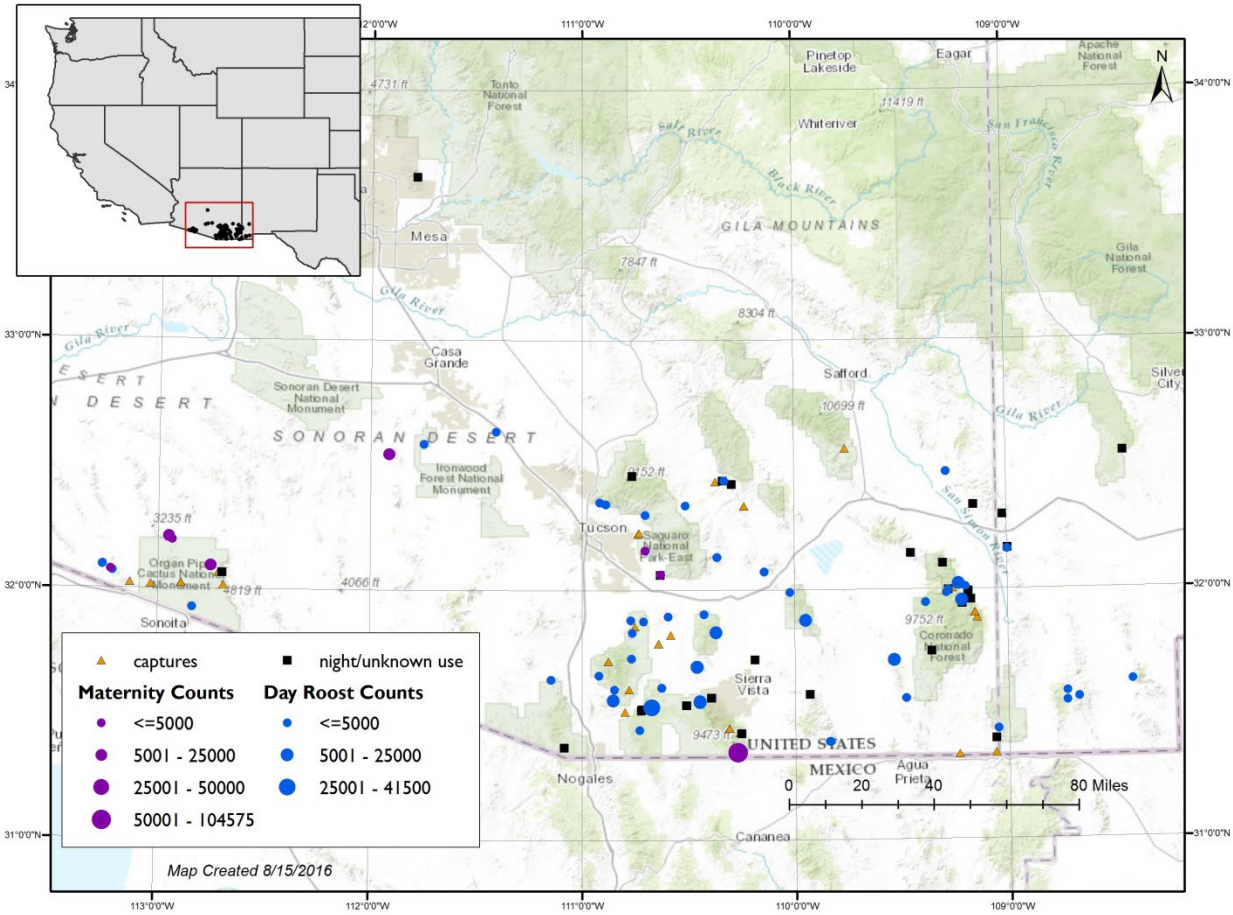

Figure 2. Approximate distribution of the lesser long-nosed bat roosts in Arizona and New Mexico (Map courtesy of BCI)

B. Species' Current Status

The USFWS conducted an assessment of the lesser long-nosed bat using the Species Status Assessment (SSA) framework. The SSA report (USFWS 2016) provides detailed information on the species resource needs and current status. The species' resource needs are described for individuals, the population and the species rangewide.

For the last twenty years following the completion of the lesser long-nosed bat Recovery Plan (USFWS 1997), 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 have 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 bat control and human disturbance at roosts). However, stressors 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. 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. Conservation actions have been implemented to the extent that we do not believe that these remaining stressors are negatively affecting the viability of the lesser long-nosed bat population.

Continual, site-specific management actions are not needed for the lesser long-nosed bat and thus, we do not consider the lesser long-nosed bat to be a conservation-reliant species, as described by Scott et al. (2005). Conservation-reliant species are animal or plant species that require continuing species-specific wildlife management intervention such as predator control, habitat management and parasite control to survive, even when a viable population is achieved. For example, some species of passerines require the continued mitigation of brown-headed cowbird parasitism in order to maintain viability. The lesser long-nosed bat does not require specific management actions such as predator control, habitat alteration, or population augmentation and thus, does not meet the definition of a conservation reliant species (see Goble et al. 2012; Scott et al. 2005).

Our SSA evaluated the current status of the population in relation to the population's resiliency, redundancy, and representation (the 3 R's) (USFWS 2016). Resiliency addresses the population's health and ability to withstand stochastic events (numbers of individuals and population trajectory). Redundancy addresses the population's ability to withstand catastrophic events (number and distribution of population segments). Representation addresses diversity within the population (genetic and habitat variation). 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 (USFWS 2016).

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. The future viability of this species is dependent on an adequate number of roosts in the appropriate locations and sufficient available forage

resources located in appropriate areas, including in proximity to maternity roosts and along the "nectar trail" used during migration.

C. Elements to be Monitored

In our evaluation of the future viability of the lesser long-nosed bat in our SSA, we determined that the two primary factors driving the future viability of the species continue to be the presence of suitable roost sites and the availability of forage resources across the range, including a viable "nectar trail" to sustain this species' migratory pathways. This means that PDM needs to assess impacts of activities that could affect the suitability of roost sites, as well as the potential results of climate change that may reduce the availability of lesser long-nosed bat forage or cause forage availability to be out of sync with the occupancy period of lesser long-nosed bats at maternity sites, late-summer transition roosts, and along migration corridors. Although we do not believe that these threats are currently occurring at a level that affects the viability of the lesser long-nosed bat population, there is the potential that conditions will change in the future and it is important to monitor them accordingly. Therefore, PDM will focus on assessing forage availability patterns and on roost monitoring to evaluate lesser long-nosed bat numbers and occupancy patterns, as well as roost site conditions (see Table 2 below). Other factors that could potentially affect lesser long-nosed bat viability in the future are related to wind energy, urban growth, and public perception. However, we considered these to be less significant and not likely to impact the viability of the population, and they do not lend themselves to effective or efficient monitoring under the scope of this PDM plan.

Based on the timeframes we used to evaluate species viability in the SSA report, the 15-year time frame of PDM in this plan will be adequate to evaluate the status of both types of factors potentially affecting the future viability of the lesser long-nosed bat. In the SSA, we discuss the reasoning behind 15-year timeframe. It explains that this is because it is a useful timeframe over which to assess the progress and impacts of lesser long-nosed bat conservation efforts. The life history of the lesser long-nosed bat (survivorship, productivity, migration, ephemeral forage resources, roost occupancy and switching, etc.) makes it difficult to determine population trends and patterns of behavior in a short period of time. Our use of a fifteen-year timeframe is based on the history of conservation implementation and effectiveness 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; assessing forage resources, 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. This species is fluid on the landscape and exhibits flexible behaviors, such as roost switching, to adapt to ephemeral and changing forage resources. Therefore, it often takes multiple years to understand if an observed action was due to real changes in the population, or simply a change in behavior due to the flexible and adaptable nature of the lesser long-nosed bat.

IV. Monitoring Methods

In the 1988 rule listing the lesser long-nosed bat as an endangered species (53 FR 38456) and in the 1997 recovery plan (USFWS 1997), the reasons behind placing the lesser long-nosed bat on the list of endangered and threatened wildlife were determined to be 1) long-term population

declines and absence of the species related, at least in part, to impacts and disturbance at roosts, and 2) loss or impacts to forage resources. The USFWS's 5-Year Review of the lesser long-nosed bat (USFWS 2007) and the recent SSA report (USFWS 2016) indicate that documentation of new roosts and more extensive monitoring of roosts has shown that the apparent decline or absence of lesser long-nosed bats is not occurring to the extent previously discussed. In fact, lesser long-nosed bat numbers estimated from monitoring show stable to increasing numbers at the vast majority of roost sites. Disturbance at roost sites, while identified as an ongoing concern in both the 5-year Review and the SSA, has been reduced at many roost sites due to roost protection measures (gating, fencing, closing roads, etc.), increased monitoring, and occurrence on Federal lands where coordination and cooperation of Federal land management agencies as part of their normal activities results in protection of these roost sites. Threats to forage resources from grazing and fire have been shown to be not as significant as thought at the time of listing. However, the SSA identified potential effects to forage resources from climate change, including changes in the flowering phenology of forage plants, as an ongoing concern that could affect the availability of lesser long-nosed bat forage resources. Therefore, PDM of the lesser long-nosed bat will include, not only the monitoring of lesser long-nosed bats roost sites, but also general observations of roost conditions and potential threats to roosts, as well as documenting the phenology and distribution of forage plants.

PDM for the lesser long-nosed bat will consist of several monitoring components: First, a total of four maternity roosts, including all of the known maternity roost sites in the U.S., as well as the primary maternity roost in Mexico, will be monitored. In addition, a subset of six known late-summer transition roosts will also be monitored. Monitoring will consist of multiple roost counts for each monitoring year, as well as a documentation of the physical condition of each roost and a description of any evidence of roost disturbance or vandalism. Second, lesser long-nosed bat forage plant phenology monitoring sites will be established across the range of the lesser long-nosed bat in the U.S. Phenology monitoring will utilize the existing phenology monitoring program of the U.S. National Phenology Network and the ongoing phenology monitoring at Organ Pipe Cactus National Monument. Finally, we will contract out a study to delineate the overall distribution of important agave populations within southern Arizona and New Mexico. We currently lack a comprehensive summary of the distribution of these important lesser long-nosed bat forage resources in the U.S.

The USFWS recognizes that we have limited authority and capability to develop PDM for the lesser long-nosed bat in Mexico. While we are not proposing any formal PDM for Mexico, we recognize the value of lesser long-nosed bat conservation being implemented by our conservation partners in Mexico. The majority of the lesser long-nosed bat's range is in Mexico and it is important that we continue to track the status of this species in Mexico. We and our other PDM cooperators will coordinate with our conservation partners in Mexico and request regular updates on conservation activities and the status of the lesser long-nosed bat in Mexico and include such updates in our PDM reports. In addition, through our partnership with BCI, we will include data from two maternity roosts and one male mating roost being monitored in Baja, Mexico.

Key assumptions: Beginning with the development of the lesser long-nosed bat recovery plan and continuing through the development of the SSA, our conservation partners and we have acknowledged that the lesser long-nosed bat roost monitoring data that have been collected over the past 20 years are not adequate to develop statistically rigorous population trend information. Therefore, our monitoring efforts to date represent more of an index of population size and trajectory based on a series of snapshots in time and the best professional judgement of the biologists and conservation partners involved in the monitoring of the lesser long-nosed bat. Roost switching, both within and between years, has been documented for this species. Therefore, within- and between-year variation of roost counts and use patterns does not necessarily indicate a decline in numbers or abandonment of a roost, a factor supporting the need for long-term monitoring approaches to determine an overall picture of bat occupancy and use patterns. The 15-year time frame of PDM for the lesser long-nosed bat using the outlined approach for roost monitoring will allow us to assess these parameters and formulate a determination regarding the ongoing viability of the lesser long-nosed bat in the U.S. after the removal of ESA protections. This period is long enough to allow us to smooth out the variable occupancy patterns that are typical of this species because of their fluid and adaptable behavior within and among years. Roost monitoring data as presented in the SSA analysis represent the baseline date we will use for comparison to data gathered under this PDM plan (see Table 2). We will complete interim monitoring status reports at years 5 and 10 of the PDM plan and a final monitoring status report at year 15. For any changes in status that occur in any given year and that constitute an emergency, based on the best professional judgement of the USFWS, AGFD, and other PDM cooperators, adaptive management actions will be implemented as soon as feasible. If the changes appear severe, a status review will be initiated as well.

Implementing a 15-year monitoring program will require the participation of qualified biologists and volunteers throughout the monitoring period. A number of biologists currently involved in lesser long-nosed bat monitoring are approaching the end of their careers. This necessitates the development and training of additional biologists and volunteers to not only take the place of those that retire, but to also cover the activities outlined in this PDM plan that are in addition to the activities currently being implemented by existing biologists and volunteers. PDM Cooperators will need to engage in a program to mentor, develop, and train additional biologists and volunteers that can move this PDM plan forward for the next 15 years. We must work together to provide opportunities and training to develop qualified personnel within each of our agencies and groups to ensure that future implementation of the PDM plan occurs.

Monitoring Methods: Cerro (2012) evaluated the occupancy and use patterns at a number of lesser long-nosed bat roosts and developed recommendations for roost monitoring that could provide statistically valid population trend estimates. Roost monitoring efforts to date have primarily been accomplished through volunteer efforts or paid contractors and generally not to the extent recommended by Cerro. Similarly, those recommendations cannot be realistically applied to PDM for the lesser long-nosed bat due to their high costs and resource requirements (travel and other resources needed to complete multiple annual visits requiring multiple personnel) and the limited resources available to implement the PDM plan. However, we have tried to incorporate Cerro's recommendations as was feasible, primarily by conducting more than one roost count during each monitoring year for late-summer transition roosts. This is an attempt to address seasonal and annual fluctuations in roost site use. The resultant data will give us an

even better basis upon which to draw conclusions about trends at these specific roost sites than the current monitoring approaches to these roost sites.

A. Maternity Roost Monitoring Sites

Entities managing the three lesser long-nosed bat maternity roost sites in southern Arizona and the important Pinacate maternity roost site in northern Sonora, Mexico have developed long-term monitoring programs at each of these sites. All of these sites have annual monitoring data going back at least 10 years and, if not annually, at least regular monitoring going back over 20 years. The three U.S. sites are Copper Mountain Roost managed by the NPS, Bluebird Roost managed by the USFWS Refuge Program, and the Old Mammon Roost occurring on the Tohono O'odham Nation. Because long-term data sets are very valuable in analyzing various life history activities and in identifying patterns over time, maintaining these existing long-term data sets is very important to understanding the status of this species. This is especially true because maternity sites represent the productivity of the population and because the occupancy and numbers of bats at these sites is far less variable than for late-summer transition roosts. There appears to be high site-fidelity at maternity roosts. Seasonal and annual roost numbers do not fluctuate substantially like late-summer transition roosts, nor does it appear that roost switching occurs to the same extent. This is likely due to birthing and caring for the young of the year that ties these individuals to these specific roost sites.

In an effort to gather data that are useful for not only assessing the numbers of bats using these roosts, but also to document the pattern of use as it relates to forage availability (see Forage Monitoring Approach below), this approach will require that roost sites be visited or some other method (acoustic loggers, cameras, etc.) be used such that the arrival of the bats at the site can be determined within a two week window of time. No roost counts are recommended during this effort. It is simply to track the date of arrival so that comparisons can be made to forage plant phenology. This approach also requires that one roost count be conducted during June, in coordination AGFD, to be consistent with historical maternity roost counts upon which the SSA and this PDM plan were based. This count will be the primary number used to compare year-to-year variation in roost numbers. Finally, a similar effort should be made at the end of the season to document the departure time frame as was made to document the arrival time frame earlier in the year. Timing should be relatively consistent each year to document occupancy patterns across time. We understand that some adjustments in timing will likely be needed based on an assessment of the current year's weather, forage phenology, resource availability, past pattern of use, etc. We expect those conducting the monitoring will use all of the information available to them to establish appropriate time frames for conducting the visits and the one roost count.

We recognize that our cooperators in this monitoring effort have limited resources available to complete this monitoring effort. If the entity doing the monitoring has the resources or a need to do additional roost counts during the year, we encourage that effort. Any additional roost counts will provide us with additional data on which to base our analysis of occupancy and use patterns at each site. Conversely, if the entity doing

the monitoring does not have the resources to complete the count as recommended, they should coordinate with the USFWS and the AGFD to determine if there are other resources available to complete the count. All counts should be conducted using infra-red recordings to be counted later on a computer or other device utilizing slow motion playback as needed to get the most accurate count of the emergence as is possible. This will also assist in species identification for those roosts occupied by multiple species. In addition, counts should use a standardized end point. For this PDM plan, the end point for counts will be when there are no bats out for 10 minutes (net number = # out – # in = 0 or there are more bats coming in). For larger roosts with more constant activity and higher overall numbers, the end point of the count will be when there are <10 bats out (net) for 10 minutes.

These roost visits also represent opportunities to assess roost conditions on a regular basis. We recommend that roost conditions be documented and recorded during each roost site visit. Any evidence of disturbance, human use, vandalism or other issues affecting the condition of the roost site should be reported. In addition, because many of these roost sites are abandoned mines, it is important to also document any failures in the roost structures themselves such as cave-ins, sloughing at the entrance, encroachment by vegetation, failure of timbers or other supports, etc.

Data from this monitoring approach will help us determine the future resiliency, redundancy, and representation of the lesser long-nosed bat population and assess whether any of the threshold numbers for these factors, as described in this PDM plan, have dropped below the threshold.

B. Late-Summer Transition Roost Monitoring Approach

Late-summer transition roosts are those roosts used by lesser long-nosed bats as they transition to agave forage resources to store up energy reserves for migration back south to Mexico in the fall of each year. These late-summer transition roosts are typically located in the sky island mountain ranges of southern Arizona and the boot heel of New Mexico. Lesser long-nosed bat roosts that support larger numbers of bats tend to be more consistently occupied. The six late-summer transition roosts that we have identified to be monitored under this PDM plan were selected because they are roosts that typically support greater than 1,000 bats and have a consistent level of historical roost monitoring that will contribute to our being able to make some level comparisons to past use as we move forward. It is important to note that not all of these roost sites have been monitored every year, but all have had some level of historical monitoring. These late-summer transition roosts also commonly have occupancy levels that have within-season and between-year fluctuations. Roost switching has been documented as occurring among these late-summer transition roosts, probably in response to seasonal and annual fluctuations in forage availability. Because of the tendency of these sites to have some variation over time, we are proposing that the recommendations of Cerro (2012) be followed to a large extent and are requiring that multiple roost counts be completed at each of these roost sites. The six late-summer transition roosts we are proposing for monitoring under this PDM plan are: Big Hatchet Roost in New Mexico and the

following Arizona roosts – Helena, Pyeatt, State of Texas, Middlemarch, and Gayleyville. These roosts generally cover the entire distribution of the late-summer transition range of the lesser long-nosed bat in the United States.

In an effort to gather data that are useful for not only assessing the numbers of bats using these roosts, but also to document the pattern of use as it relates to forage availability (see Forage Monitoring Approach below), we recommend that roost sites be visited or some other method (acoustic loggers, cameras, etc.) be used such that the arrival of the bats at the site can be determined within a two week window of time. No roost counts are recommended during this effort. It is simply to track the date of arrival so that comparisons can be made to forage plant phenology. Once the bats have arrived, we then recommend that three roost counts be conducted such that the counts include and bracket the time when the August simultaneous count has typically been conducted. August simultaneous count dates are selected in coordination with AGFD. In other words, one count would be completed prior to the August simultaneous count, one count conducted as the August simultaneous count, and one count completed after the August simultaneous count. This will allow us to be consistent with historical counts at these sites and will make the timing of these counts relatively straightforward. These counts will be the primary number used to compare year-to-year variation in roost numbers. Finally, a similar effort should be made at the end of the season to document the departure time frame as was made to document the arrival time frame earlier in the year. Timing should be relatively consistent each year to document occupancy patterns across time. We understand that some adjustments in timing will likely be needed based on an assessment of the current year's weather, forage phenology, resource availability, past pattern of use, etc. We expect those conducting the monitoring will use all of the information available to them to establish appropriate time frames for conducting the visits and the roost counts. For the Big Hatchet Roost in New Mexico, counts will need to account for the possibility that all the bats in this roost may not be *Leptonycteris yerbabuenae*, but may also be *L. nivalis*. Historically, the numbers of *L. nivalis* have been relatively small at this roost site, so an appropriate default approach may be to simply consider all bats counted as *L. yerbabuenae*. This should not have a meaningful effect on evaluating the numbers or occupancy pattern at this site.

We recognize that our cooperators in this monitoring effort have limited resources available to complete this monitoring effort. If the entity doing the monitoring has the resources or need to do additional roost counts during the year, we encourage that effort. Any additional roost counts will provide us with additional data on which to base our analysis of occupancy and use patterns at each site. Conversely, if the entity doing the monitoring does not have the resources available to complete all the recommended counts, they should coordinate with the USFWS and AGFD to see if there are resources available from other sources to complete the counts. All counts should be conducted using infrared (IR) recordings to be counted later on a computer or other device utilizing slow motion playback as needed to get the most accurate count of the emergence as is possible. This will also assist in species identification for those roosts occupied by multiple species. In addition, counts should use a standardized end point for the counts. For this PDM plan, the end point for counts will be when there are no bats out for 10

minutes (net number = # out – # in = 0 or more bats coming in). For larger roosts with more constant activity and higher overall numbers, the end point of the count will be when there are <10 bats out (net) for 10 minutes.

The State of Texas roost represents one of the few gated lesser long-nosed bat roosts. However, numbers have declined at this roost site subsequent to the installation of the permanent gate. Removal of some of the gate bars in 2016 resulted in an increase in the number of bats using the roost site, but numbers did not return to historical levels. As part of this PDM plan, we recommend continued testing of the gate configuration at this roost site to help us better understand what bat gate design is most acceptable to lesser long-nosed bats. We will work with the NPS to obtain funding to continue gate testing at this roost site.

These roost visits also represent opportunities to assess roost conditions on a regular basis. We recommend that roost conditions be documented and recorded during each roost site visit. Any evidence of disturbance, human use, vandalism or other issues affecting the condition of the roost site should be reported. In addition, because many of these roost sites are abandoned mines, it is important to also document any failures in the roost structures themselves such as cave-ins, sloughing at the entrance, encroachment by vegetation, failure of timbers or other supports, etc.

Data from this monitoring approach will help us determine the future resiliency, redundancy, and representation of the lesser long-nosed bat population and assess whether of the monitoring results fall below the thresholds for these factors, as described in this PDM plan.

Table 2. Lesser Long-Nosed Bat Roost Types and Land Ownership/Responsible Party

Roost Site	Roost Type	Land Ownership/Responsible Party
Copper Mountain	Maternity	NPS – Organ Pipe Cactus National Monument
Bluebird	Maternity	FWS – Cabeza Prieta NWR
Old Mammon	Maternity	TON – Cyprus Tohono (contracted)
Pinacate	Maternity	Pinacate Biosphere Reserve, Mexico – AGFD, Rodrigo Medellin
Big Hatchet	LST*	BLM New Mexico
Helena	LST	FS - Rosemont
Pyeatt (Upper)	LST	DOD – Ft. Huachuca
State of Texas	LST	NPS – Coronado NM
Middlemarch	LST	FS – Douglas RD
Gayleyville	LST	FS – Douglas RD

*Late Summer Transition Roost

C. Lesser Long-Nosed Bat Forage Monitoring Approach

In partnership with the USA National Phenology Network (NPN), we will establish lesser long-nosed bat forage phenology monitoring sites. We will attempt to establish these sites within 40 miles of each of the roost monitoring sites included in this PDM plan in order to be able to make useful comparisons between bat use patterns at the roosts and forage resource phenology within the typical foraging distance of each roost being monitored. The objective of the lesser long-nosed bat forage monitoring approach is to be able to document if forage resource availability is affected by climate change to the extent that bat occupancy periods are out of sync with forage plant flowering phenology. In other words, we want to be able to document if lesser long-nosed bat forage resources become unavailable because of changes in forage plant flowering phenology.

Plant phenology will be tracked for the following lesser long-nosed bat forage plants: saguaro (*Carnegiea gigantea*), organ pipe cactus (*Stenocereus thurberi*), Palmer's agave (*Agave palmeri*), Perry's agave (*Agave perryi)*, and desert agave (*Agave deserti*). At each monitoring site, monitors will identify a plant or group of plants to monitor. The frequency of annual visits will be relatively low to begin with – only as needed to document the initiation of flowering. Following flowering, monitoring will ideally occur one to two times per week until flowering has been completed. Date will be entered into the NPN database via computer or available phone applications. Appendix A describes the monitoring protocol in more detail. Data are then available through the NPN for analysis. This will allow us to document when lesser long-nosed bat forage resources first become available through the time period that flowers are available, and then when flowers are no longer available. We can then compare these data to the roost occupancy pattern data developed from the other monitoring approaches under PDM.

Our goal is to establish forage plant phenology monitoring sites across the geographic range of the lesser long-nosed bat in Arizona and New Mexico. In addition, we would like to have a minimum of five phenology monitoring sites for each forage plant species. We anticipate a total of 25 to 30 total forage plant phenology monitoring sites across the range of the lesser long-nosed bat in Arizona and New Mexico. We recommend placing phenology monitoring sites in areas where those conducting the monitoring would normally conduct regular activities. Following the NPN's protocol, site visits would typically take just a few minutes and if the those doing the monitoring are at the site anyway conducting other normal work activities, this monitoring approach will not require significant addition time or resources. Please see Appendix A for more information.

Currently, we lack comprehensive data regarding the distribution of agaves in southern Arizona and New Mexico. Understanding where agaves occur across the landscape is important information related to the conservation of lesser long-nosed bats. Forage resources, such as agaves, distributed across the range of the bat in appropriate proximity to roost sites contribute to the resiliency, redundancy, and representation of the species. As part of this PDM plan, we will contract a project to develop information on the distribution and occurrence of agaves in southern Arizona and New Mexico. These data

will contribute directly to the PDM plan by informing us of areas appropriate for the phenology monitoring described above. It will also provide us with important baseline data for future comparison in determining ongoing forage availability for lesser long-nosed bats. Determining whether agaves have a regular distribution across the landscape as opposed to a clustered distribution informs important decisions that influence the ongoing conservation of lesser long-nosed bats. We will pursue this project immediately with a target for completion within the first five-year interim monitoring period. In this way, the distribution data will be available to inform the appropriate portions of this PDM plan for the remainder of the 15-year monitoring period.

Data from this monitoring approach will help us assess whether the monitoring results fall below thresholds for resiliency, redundancy, or representation described in this PDM plan.

V. Monitoring Thresholds

To effectively implement this PDM plan, it is essential to identify the circumstances that trigger concern about the species' status that would warrant increased frequency or intensity of the monitoring or adaptive management. It is also important to identify the circumstances under which there is no new concern for the species' status and the requirements of the PDM have been fulfilled. The thresholds and responses described below are based on the information used to develop the SSA report and, as this plan is implemented, will be evaluated based on information collected under this PDM plan. This provides a structured process for evaluating the status of the species during the PDM timeframe. However, other circumstances could arise, such as new threats or increased intensity of residual threats that would warrant additional concern and responses for ensuring the status of the lesser long-nosed bat remains healthy. Possible responses for each threshold are described below. Generally, the alternative responses may include an extended or intensified monitoring effort, additional research, or other adaptive management activities at specific roost localities. Other responses may be proposed in the future, if warranted, based on the collection of new information arising from monitoring activities.

The SSA for the lesser long-nosed bat characterized viability of the species in terms of its resiliency, redundancy, and representation. For the lesser long-nosed bat, resiliency is measured in terms of roost occupancy and bat numbers at monitored roosts. The SSA measured redundancy in the lesser long-nosed bat by roost occupancy for each roost type across the overall range of the species. Representation of the lesser long-nosed bat population is measured through the breadth of genetic and ecological diversity as evidenced by roost occupancy across the range of occupied habitats.

A. Thresholds for Roost Monitoring

The roost monitoring approach in this PDM plan will evaluate the status of both maternity roosts and late-summer transition roosts in the United States. The results of this monitoring can be applied to help us assess each of the three R's in the United States. With regard to resiliency, if

roost count numbers remain similar to or greater than numbers reported in the SSA, this indicates that the resiliency of the population is being maintained. With regard to redundancy, if PDM shows that each of the maternity roosts and late-summer transition roosts are occupied on an ongoing basis, this indicates that we are maintaining redundancy across the range of the bat in the U.S. and that roost sites for each life history activity are available. For representation, the focus for PDM is maintaining representative roost sites within each ecologically diverse portion of the species' range in order to promote ecological and genetic diversity. If PDM shows that viable roost sites remain in each of the diverse ecological areas within the bat's range, this indicates that representation is being maintained.

Based on the description above, the threshold for roost monitoring will be to maintain roost occupancy at each of the identified maternity and late-summer transition roosts as appropriate. This means that each maternity site would be occupied at a level of 75% or greater of the baseline number in Table 3 for each year of monitoring (In 2017, prior to the implementation of this PDM plan, the Pinacate roost site experienced a greater than 80% decline in reported numbers. These numbers fall below the 75% threshold described in this PDM plan. We do not know what caused this decline, but, similar to what is being described in this PDM plan, we intend to increase monitoring at this site to document subsequent numbers and occupancy patterns to determine if further investigation or adaptive management is needed). For late-summer transition roosts, each roost site is occupied in at least four out of five years in each interim monitoring report at a level of 50% or greater of the baseline number in Table 3. If monitoring results do not fall below these thresholds, we will consider roost occupancy to be sufficient to maintain high levels of resiliency, redundancy, and representation.

As indicated above, roost monitoring visits are an opportunity to assess the current conditions at roost sites. The observation of evidence indicating roost disturbance or vandalism, increased or improved access to the roost site, encroachment by vegetation, loss of structural integrity, or any other action or occurrence or threat that reduces the suitability of the roost site should be documented and reported as soon as possible. USFWS, AGFD, and our PDM cooperators will discuss potential adaptive management activities that can be implemented to address the issue and maintain the suitability of the roost site. As mentioned above, if PDM indicates an emergency situation in any given year, as determined by USFWS, AGFD, and PDM cooperators, adaptive management actions will be implemented as soon as feasible.

We will also consider data on roosts and population status from Mexico as they become available. BCI has indicated they will provide us with status information from two maternity roosts and one mating roost in Baja. We will evaluate all of the information that is available at years 5, 10, and 15 to determine if any status updates are required or if any adaptive management measures are necessary to maintain the viability of the lesser long-nosed bat.

<u>Adaptive Management Actions</u> – If monitoring results fall below the thresholds related to roost monitoring, USFWS, AGFD, and our PDM cooperators will develop adaptive management actions to address issues potentially contributing to falling below thresholds. Adaptive management activities may include increased monitoring intensity at the roost site; additional roost monitoring at adjacent roost sites; obtaining updated information from Mexico related to the issue; eliminating or reducing sources of disturbance, vandalism, or other threats to

maintaining roost suitability; removing encroaching vegetation; or reinforcing or restoring roost structural stability. The appropriate adaptive management actions will be cooperatively determined by the USFWS, AGFD, and our PDM cooperators. These appropriate entities will coordinate resources to implement the adaptive management activities.

B. Thresholds for Forage Monitoring

Forage monitoring will occur across the range of the lesser long-nosed bat in Arizona and New Mexico. Therefore, determining the availability of important forage species across this geographic range will provide important data. With regard to resiliency, documenting forage availability patterns that are in sync with the lesser long-nosed bats' occupancy period and available within foraging distance (40 miles) of known roost sites will support a resilient lesser long-nosed bat population. Redundancy of roost sites can only be maintained if there are adequate forage resources to support those roost sites. The occurrence of forage resources across a diverse landscape will allow lesser long-nosed bats to occupy ecologically diverse areas within the landscape, which will promote representation within the species.

With regard to forage plant phenology, the threshold for this PDM plan will be that forage plant resource availability (open flowers and fruits for saguaro and organ pipe cacti and open flowers for agaves) occurs during 90 percent of the lesser long-nosed bat occupancy period for each five year interim monitoring period. Occupancy periods and forage availability will be evaluated and compared in each interim PDM report (years 5 and 10) and in the final PDM report (year 15).

With regard to agave distribution, we will use the final agave distribution report generated under this PDM plan to guide additional agave phenology monitoring as described in this PDM plan, and to promote the conservation of agave populations, if the monitoring indicates this may be necessary, within the range of the lesser long-nosed bat. The agave distribution mapping will also allow us to assess the overall numbers and distribution of this important forage resource. Forage availability is related not just to the availability of flowers and fruits, but to the number and distribution of forage species as well.

<u>Adaptive Management Actions</u> - If monitoring results indicate forage availability falls below the threshold related to forage monitoring, USFWS, AGFD, and our PDM cooperators will develop adaptive management actions to address issues potentially contributing to monitoring results falling below forage availability thresholds. We acknowledge that there may be little we can do to address issues at the scale of the effects of climate change or long-term weather patterns that are likely driving changes in forage phenology. However, there may be some actions we can take to assess the scale and extent of such occurrences. Adaptive management activities may include increasing the number of phenology monitoring sites to better represent the range of landscape conditions; conducting research to assess lesser long-nosed bat use of alternative forage resources; land use management refinements promoting the occurrence of known and alternative forage resources on the landscape; ensuring that suitable roosts occur across the landscape to allow lesser long-nosed bats to move to areas where forage is available; and obtaining updated information from Mexico related to the issue. The appropriate adaptive management actions will be determined cooperatively by USFWS, AGFD, and our PDM cooperators. The appropriate entities will coordinate resources to implement the adaptive management activities.

C. Relisting Considerations

If any of the monitoring results fall below the thresholds outlined in this PDM plan and if we believe there are reasons for substantial concerns regarding the status of the lesser long-nosed bat, or other significant concerns arise, the USFWS will initiate a status review of the species under section 4 of the ESA to evaluate the potential causes, including assessing roost disturbance, forage availability, disease, climate change, and any other possible limiting factors. The USFWS will work with our cooperators to consider necessary remedial actions or more intensive monitoring or research needs.

During any stage of the PDM period, the USFWS may initiate procedures to re-list the lesser long-nosed bat if data from this monitoring effort or from some other reliable source indicates that the species or its habitat is experiencing a significant decline and that a proposal to relist the species as threatened or endangered is warranted. Any relisting action taken by the USFWS under section 4(a)(1) of the ESA will be based on the best available information related to the five listing factors and will require public notice and comment. If the best available information indicates an emergency posing a significant risk to the viability of the species, then the USFWS will use ESA section 4(b)(7) authority (emergency listing) to prevent any significant risk to the viability of the lesser long-nosed bat population.

Table 3. Roost Numbers and Thresholds for PDM Roost Monitoring Approaches

Site	Roost Type	Recovery Plan	Avg. # for counts conducted over the past 10 yrs. (2007-17)	Last yr. bats observed/#s	75% Threshold (every year monitored	50% Threshold (in at least 4 out of 5 years monitored)
Big Hatchet	Transition	NA	900 (1 count)	2013/900		450
Bluebird	Maternity	3,000	5,077 (10 counts)	2016/8137	3,808	
Copper Mountain	Maternity	20,000	41,972 (10 counts)	2017/34,865	31,479	
Galeyville	Transition	NA	9,409 (2 counts)	2014/8,934		4,705
Helena	Transition	NA	5,528 (6 counts)	2016/4,070		2,764
Middlemarch	Transition	NA	4,492 (2 counts)	2014/7,634		2,246
Old Mammon Roost	Maternity	3,600	7,914 (6 counts)	2017/11,450	5,936	
Pinacate Roost	Maternity	130,000	117,308 (8 counts)	2017/20,547	87,981	
Pyeatt Cave	Transition	NA	12,050 (10 counts)	2016/13,100		6,025
State of Texas	Transition	20,000	Pre-gate(2007-10) 9,313 (3 counts) Post-gate(2010-17) 4,773 (4 counts)	2017/5,500		2,387

VI. Funding

A. Estimated Funding Requirements

An estimate of funding necessary to complete the PDM plan is presented in Tables 4 through 6 below. The total estimated monitoring cost over the 15-year timeframe of this PDM is $2,932,230. These estimates are not adjusted for inflation and assume that the monitoring schedule is consistent with the methodology and schedule contained in this plan. We acknowledge that available funding will drive the implementation of this PDM plan and that there may be periods of times when full funding or resources are not available to all entities implementing the PDM plan (see section about sources of funding below). At times when funding and resources are internally available to our PDM Cooperators, these Cooperators may bear the cost of the monitoring as in-kind funding and those costs would not represent funding for the PDM plan that would need to be obtained from other, external sources. The following is a representation of total costs for implementing the plan, but does not necessarily represent funding that must be obtained from external sources to implement the PDM plan because of the potential for in-kind funding.

Table 4. Estimated Costs of Monitoring under the Post-delisting Monitoring Plan – Maternity Roost Monitoring (2018 dollars).

		Unit	**Cost**
Personnel	Rate	Hours	
Biologist (GS-11 equivalent)	$33.00	60	$1,980
Biologist (GS-9 equivalent)	$28.00	45	$1,260
LE Personnel (Grade 10 equivalent)	$30.00	45	$1,350
Fringe Benefits	30%		$1,377
Travel		Days	
Lodging, meals, per diem – for above personnel	$177	6	$1,062
Mileage	$0.55	600	$330
Equipment			
IR Video set up			$1,500
Subtotal of Direct Costs			$8,859
Indirect Charges, 15% of Direct Costs	15%		$1,329
Total One-year Cost Estimate/Roost Site			$10,188
Total Annual Cost for 4 Maternity Roosts			$40,752
Total Maternity Roost Monitoring Cost of PDM (15 years)			$611,280

Table 5. Estimated Costs of Monitoring under the Post-delisting Monitoring Plan – Late-Summer Transition Roost Monitoring (2017 dollars).			
Personnel	Rate	Hours	Cost
Biologist (GS-11 equivalent)	$33.00	72	$2,376
Biologist (GS-9 equivalent)	$28.00	65	$1,820
LE Personnel (Grade 10 equivalent)	$30.00	30	$900
Employee Related Expenses (leave, insurance, taxes, etc.)	30%		$1,529
Travel			
Mileage	$0.55	1,000	$550
Lodging, meals, per diem – for above personnel	$177	8 nights	$1,416
Equipment			
		Units	
IR Equipment	$1,500	1	$1,500
Subtotal of Direct Costs			$10,091
Indirect Costs	15%		$1,514
Total Cost/Late-Summer Transition Roost			$11,605
Total Cost for 6 Late Summer Transition Roosts			$69,630
Total Late-Summer Transition Roost Monitoring Cost of PDM (15 years)			$1,044,450

Table 6. Estimated Costs of Monitoring for the Forage Monitoring Approach (2017 dollars).			
		Unit	**Cost**
Personnel	Rate	Hours	
Biologist (GS-9 equivalent)	$28.00	30	$840
Fringe Benefits	30%		$252
Travel		Units	
Mileage	$0.55	2,500	$1,375
Subtotal of Direct Costs			$2,467
Indirect Charges, 15% of Direct Costs	15%		$370
Total One-year Cost Estimate/Phenology Site			$2,837
Total Annual Cost for 30 Forage Monitoring Sites			$85,110
Total Forage Phenology Monitoring Cost of PDM (15 years)			$1,276,500
Total PDM Cost (15 years)			$2,932,230

B. Potential Funding Sources

While the ESA authorizes expenditure of both recovery funds and section 6 grants to the states to plan and implement a PDM plan, to date Congress has not allocated any funds expressly for this purpose. Funding of PDM activities will therefore require trade-offs with other competing species' needs. As with the effort it took to get us to the point of delisting the lesser long-nosed bat, the success of PDM is dependent on the ongoing participation of our conservation partners. Some of the cost will likely be borne as in-kind services provided by cooperating agencies and conservation partners. Working closely with our partners, we anticipate using grant programs and fund-raising to provide funding for activities that go beyond the resources available through in-kind services. Opportunities exist to compete for traditional section 6 grant funds or state wildlife grant funds. The USFWS, AGFD, NMDGF, and other cooperators will continue to work together to secure funding to implement this

PDM plan. Such funding resources may include DoD Legacy funding; Bat Conservation International programs, grants, and fundraising; or other similar funding programs. Some of the tasks in this PDM plan will be carried out by existing staff and will represent in-kind contributions to funding the effort.

C. Anti-Deficiency Act disclaimer

Post-delisting monitoring is a cooperative effort between the USFWS, States, other Federal agencies, and non-governmental partners. Funding of post-delisting monitoring presents a challenge for all partners committed to ensuring the continued viability of the lesser long-nosed bat following removal of ESA protections. To the extent feasible, the USFWS intends to provide at least some funding for post-delisting monitoring efforts through the annual appropriations process. Nonetheless, nothing in this Plan should be construed as a commitment or requirement that any Federal agency, including the USFWS, obligate or pay funds in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation.

VII. Reporting

Monitoring information collected under this PDM plan will be submitted to the USFWS's Arizona Ecological Services Field Office, AGFD, and NMDGF. At the completion of years five and ten, interim summary reports will be prepared by December 31st of those respective years. These reports will describe each PDM approach and the activities implemented for each of those approaches during the reporting period. The interim reports will report all activities and results carried out under the plan. The interim reports will include a discussion section that describes any deviations from the PDM plan and make any necessary recommendations for changes in the future PDM data collection or analysis. The lesser long-nosed bat SSA report will be updated using information from each of the interim reports so that the current status of the lesser long-nosed bat population can be readily available for consideration for any future or ongoing conservation actions.

A final report will be prepared following the conclusion of the 15-year period of the PDM and be prepared by December 31st of that year. This report will be similar to the interim report, but provide the final review and evaluation of the PDM plan, as well as a conclusion based on this information as described in section IX of this PDM plan. The lesser long-nosed bat SSA report will be updated using information from the final PDM report so that the current status of the lesser long-nosed bat population can be readily available for consideration in determining the completion of PDM and whether or not there may need to consider placing this species back under the protective measures of the ESA.

The USFWS will work with its partners to develop the reports under this PDM plan. The primary responsibility for reporting lies with the USFWS, AGFD, and NMDGF. All PDM plan reports will be available to the public and will be shared with participating agency and conservation partners.

VIII. PDM Implementation Schedule

Table 7. PDM Implementation Schedule (blue areas indicate the time period when these activities will occur)

Task	2024	2029	2034	Annually (2019 – 2034)
Monitoring approaches: Maternity Roost Monitoring Late-Summer Transition Roost Monitoring Forage Phenology Monitoring				
Agave Distribution Study				
Adjustments to intensity and location of monitoring (if needed)				
Reporting	Interim Report	Interim Report	Final Report	

IX. Conclusion of PDM

At the end of the planned PDM period, the USFWS will conduct a final review and summarize the results in the PDM plan report. Any relisting decision by the USFWS will require evaluating the status of the lesser long-nosed bat relative to the ESA's five listing factors (section 4(a)(l)). The USFWS intends to coordinate with and involve all of our partners in maintaining continued recovery of the lesser long-nosed bat so as not to require relisting the species. The following four conclusions are possible at the end of PDM for the lesser long-nosed bat:

1. PDM indicates that the species remains secure without ESA protections.

   PDM will be concluded at the completion of year 15 of the PDM plan and no further monitoring will be required. Additional monitoring may continue at the discretion of the USFWS and its partners dependent upon need, as well as available funding and resources.

2. PDM indicates that the species may be less secure than anticipated at the time of delisting, but information does not indicate that the species meets the definition of threatened or endangered.

   The duration of the PDM period may be extended and additional monitoring may be planned and carried out. A new monitoring plan should build upon the information gained from this PDM effort and describe future monitoring activities.

3. PDM yields substantial information indicating a decline in the species' status since delisting, such that listing the species as threatened or endangered may be warranted.

In addition to further monitoring activities discussed above, the USFWS should initiate a formal status review under section 4 of the ESA to assess changes in threats to the species, its abundance, productivity, survival, and distribution. The purpose of the review is to determine whether a proposal for relisting the lesser long-nosed bat as a protected species under section 4 of the ESA is warranted.

4. PDM documents a decline in the species' probability of persistence, at any time during the monitoring program, such that the species once again meets the definition of a threatened or endangered species under the ESA.

   If PDM reveals that the lesser long-nosed bat is threatened (i.e., likely to become endangered in the foreseeable future throughout all or a significant portion of its range) or endangered, then the species should be promptly proposed for relisting under the ESA in accordance with procedures in section 4(b)(5). Likewise, if the best available information indicates an emergency that poses a significant risk to the well-being of the species, then the USFWS should exercise its emergency listing authority under section 4(b)(7).

X. Review and Adaptation of PDM

This draft PDM plan for the lesser long-nosed bat is being made available for review and comment by the public through a Federal Register notice, as well as a press release and individual contacts. In addition, the USFWS will invite peer review this draft PDM plan in accordance with the 1994 peer review policy (59 FR 34270). The USFWS has and will continue to solicit independent expert opinions from knowledgeable individuals with scientific expertise that includes lesser long-nosed bat and forage ecology and conservation biology principles. All comments received from the public and peer reviewers, as well as solicited expert opinion, will be considered and incorporated as appropriate into the final PDM plan. Once finalized and approved by the USFWS's Southwest Regional Director, the PDM plan may be updated as needed to account for and respond to new information discovered as part of the ongoing data collection and analysis, or as new technology that enhances the effectiveness of monitoring becomes available.

This PDM plan is final when approved by the USFWS's Southwest Regional Director. However, it may be updated as needed to account for and respond to new information discovered as part of the ongoing data collection and analysis. If substantial changes are made to the PDM plan, the USFWS will document the changes and/or deviations. Future changes to the PDM plan will require approval by the Regional Director. The final PDM plan for the lesser long-nosed bat, including any future revisions will be made available on the USFWS's website (http://endangered.fws.gov) and the Arizona Ecological Services Field Office website (https://www.fws.gov/southwest/es/arizona/Lesser.htm).

XI. Other Research Considerations

There is a substantial amount of additional useful information that could be collected as part of a monitoring plan for the lesser long-nosed bat. However, the planned PDM efforts are limited by available resources to the minimum amount of information needed to accomplish the purpose of collecting information that can be used to determine continued viability of the lesser long-nosed bat absent the protections under the ESA.

Any additional data, if collected in combination with the information being collected as part of PDM, would allow a more robust estimate of survival and provide the basis for potential population viability modeling. Some of the information needed for population demographic analysis will already be collected as part of the PDM, but more intensive sampling and additional statistical analysis beyond the scope of the PDM, would be necessary to allow for a statistically rigorous population viability analysis.

The following are projects that should be considered for implementation, pending available resources, to complement the activities of the PDM plan in assessing the ongoing viability of the lesser long-nosed bat population.

A) Development of the use of PIT tags as a marking tool for lesser long-nosed bats – Recent research into the potential use of PIT tags as a marking tool for lesser long-nosed bats has shown promising results. Our ability to track large numbers of lesser long-nosed bats would vastly improve our understanding of life history elements for this species, as well as our understanding of movement and occupancy patterns. This ability would be a considerable contribution to our ability to track and assess the population viability of the lesser long-nosed bat.

B) Assess the design and use of bat gate by lesser long-nosed bats - Our experiences to date with bat gates at lesser long-nosed bat roosts seems to indicate that this species does not adapt as readily to bat gates as other species of bats. Only a few gates have been installed at lesser long-nosed bat roosts, but one site appeared to be abandoned by the bats and another site has seen the numbers of lesser long-nosed bats decline subsequent to gating. Bat gates have proven to be effective tools to protect bat roosts from human disturbance, but their value is decreased if the gates affect the ability of lesser long-nosed bats to occupy otherwise suitable roost sites. Research that will help us to understand and develop an appropriately designed bat gate that will allow us to protect lesser long-nosed bat roosts and maintain the suitability of these roosts is key to the long-term conservation of this species.

C) Continue gathering data on the timing of the arrival and departure of the lesser long-nosed bat in southern Arizona through the citizen science hummingbird feeder monitoring program. This program has over ten years of data related to the use of hummingbird feeders by lesser long-nosed bats. It is also a great way to do education and outreach related to this species and garners public support for conservation of the species.

D) Continue to evaluate acoustic monitoring as a tool to monitor lesser long-nosed bats at both roost sites and in foraging areas. This tool has the potential to gather long-term date with a reduced level of field labor and over a greater extent than other methods of monitoring.

XII. Literature Cited

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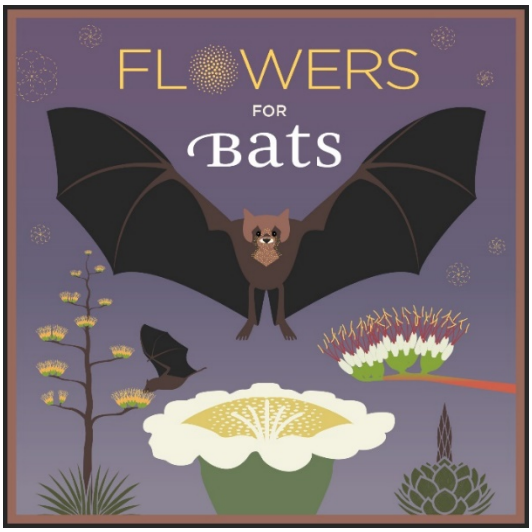
Appendix A – Lesser Long-Nosed Bat Forage Phenology Monitoring Protocol

Lesser long-nosed bat (*Leptonycteris yerbabuenae*) forage phenology monitoring protocol



Collaboration between USFWS and USA-NPN

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Posthumus, Erin E. and Jake F. Weltzin. 2018. Lesser long-nosed bat (*Leptonycteris yerbabuenae*) forage phenology monitoring protocol. Appendix A in U.S Fish and Wildlife Service, 2018. Draft post-delisting monitoring plan for the lesser long-nosed bat (*Leptonycteris yerbabuenae*). Region 2 USFWS, Arizona Ecological Services Field Office, Phoenix, Arizona. 53 pp.

Abstract:

The USGS-funded USA National Phenology Network (USA-NPN) is collaborating with the US Fish and Wildlife Service (USFWS) to track the phenology of five major forage species for the lesser long-nosed bat (*Leptonycteris yerbabuenae*). The objective of the lesser long-nosed bat forage monitoring program is to document whether forage resource availability is affected by environmental change to the extent that bat occupancy periods are out of sync with forage plant flowering phenology.

In order to track the status of the forage species, we will use the USA-NPN's *Nature's Notebook* plant and animal phenology observation program to record the onset, peak, and duration of flowering of the nectar species essential to the lesser long-nosed bats in southeastern Arizona and other parts of the bat's range. In 2017, we launched a data collection campaign called Flowers for Bats (fws.usanpn.org/Campaigns/flowersforbats) to engage partners and observers in documenting flowering of forage species.

Data from this monitoring approach will help the USFWS determine future resiliency, redundancy, and representation of the lesser long-nosed bat population and will help us assess whether the threshold for resiliency, redundancy, or representation have been exceeded.

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Introduction:

As part of the post-delisting process for the lesser long-nosed bat (*Leptonycteris yerbabuenae*) the U.S. Fish and Wildlife Service (USFWS) has created a draft post-delisting monitoring plan that proposes two primary components to monitor the status of the lesser long-nosed bat: continued roost occupancy and threats monitoring, and an assessment of forage availability through phenology and distribution monitoring of lesser long-nosed bat forage resources.

The USA National Phenology Network (USA-NPN; Box 1) is partnering with the USFWS to implement the forage monitoring portion of the lesser long-nosed bat post-delisting monitoring plan. The data collected will help the USFWS track changes in the phenology of important lesser long-nosed bat forage species and evaluate the potential effects of climate change on forage species.

Box 1. The USA National Phenology Network
Established in 2007, the **USA National Phenology Network** (www.usanpn.org) is a national-scale consortium of individuals and organizations that collects, stores, and shares phenological data, value-added data products, and information to advance science and to support natural resource decision-making across a variety of spatial and temporal scales. A diverse range of stakeholders contributes to and utilizes network knowledge, data, and tools, including researcher, resource managers, educators, and the public.

The USA-NPN's *Nature's Notebook* program is a plant and animal phenology observation program appropriate for professional and citizen scientists. Phenology data entered through the *Nature's Notebook* program are made freely available for download through the National phenology Database (NPDb). To ensure that the observational data in the NPDb are robust for use in scientific analyses and decision-making, the USA-NPN employs a range of quality assurance (QA) processes to improve species identification, phenophase status evaluation, and data entry. In turn, quality control (QC) processes evaluate and flag data according to standards of plausibility, validity, and reliability. QA and QC processes and activities are described in Appendix 2 of the USA-NPN Observational Data Documentation (available at www.usanpn.org/data/quality).

Nature's Notebook Phenology Monitoring Program:

In order to track the status of the forage species for the lesser long-nosed bat, we will use the *Nature's Notebook* plant and animal phenology observation program (Rosemartin et al. 2014; Box 2) to record the onset, peak, and duration of flowering of the nectar species (Denny et al. 2014) essential to the lesser long-nosed bats in southeastern Arizona. In 2017, we launched a data collection campaign called Flowers for Bats (fws.usanpn.org/Campaigns/flowersforbats) to engage partners and observers in using *Nature's Notebook* to document flowering of forage species.

Box 2. *Nature's Notebook*
Nature's Notebook is a national phenology program used by professional and citizen scientists to record plant and animal life stages. Participants in *Nature's Notebook* follow rigorous, standardized protocols to report on the phenological status of individual plants and of animal species at given locations and are encouraged to make regular observations over multiple years. Data are stored in the online National Phenology Database (NPDb) and can be accessed publically and freely through several query and visualization tools.

Nature's Notebook is a platform that can be used by individuals and groups alike. Group users are able to contribute data to the same locations, sharing the effort of observations among many.

When a particular Refuge, Park, or other unit is ready to begin monitoring, the designated leader for that site should submit a request (www.usanpn.org/nn/groups/group-interest) to the USA-NPN for their group to be created. Creation of a *Nature's Notebook* account will be required to access the form. The requestor will be notified when the group has been created.

Each member of a group should register an individual *Nature's Notebook* account, and join their respective group during registration. Individual accounts allow each data record collected to be tied back to an individual observer. For groups, a site leader is appointed as the group administrator, and is able to set up observation sites, and register plants at those sites. More than one administrator can be designated for a group. Other members can be set up as data entry technicians, to enter data on behalf of other users or edit existing data for the group.

Data will be entered via either a combination of paper data sheets and data entry via web browser or directly through the *Nature's Notebook* mobile application (which has offline capabilities). Once an administrator has set up observation sites and registered plants at those sites, a data sheet packet will be available for each site on each group member's *Nature's Notebook* Observation Deck within their online account. Data are stored in the National Phenology Database, and are freely available for download at www.usanpn.org/data/observational.

USA-NPN staff will provide eNewsletters to participants as part of the Flowers for Bats *Nature's Notebook* campaign. Any staff member or observer can sign up to receive these messages at fws.usanpn.org/flowersforbats. The messages are sent on an approximately monthly basis and contain reminders to observe, resources for observing, preliminary results, and stories shared by participating observers. The USA-NPN has found that this method of communication promotes observer retention.

Fig 1. Flowers for Bats badge image

A Flowers for Bats badge (Fig 1) is also available in each observer's Observation Deck as a motivator for observer participation. Observers can earn the badge by submitting data on one of the forage species in six separate weeks within the same year.

Species:

Desert agave (*Agave deserti*)
https://mynpn.usanpn.org/npnapps/species/Agave/deserti

Palmer's agave (*Agave palmeri*)
https://mynpn.usanpn.org/npnapps/species/Agave/palmeri

Parry's agave (*Agave parryi*)
https://mynpn.usanpn.org/npnapps/species/Agave/parryi

Century plant (*Agave americana*)
https://mynpn.usanpn.org/npnapps/species/Agave/americana

Saguaro (*Carnegiea gigantea*)
https://mynpn.usanpn.org/npnapps/species/Carnegiea/gigantea

Organ pipe cactus (*Stenocereus thurberi*)
https://mynpn.usanpn.org/npnapps/species/Stenocereus/thurberi

Cardon (*Pachycereus pringleI)*
https://mynpn.usanpn.org/npnapps/species/Pachycereus/pringlei

Species Protocols:

In the pilot year of the program, we tracked flowering phenology of panicular agave and saguaro cacti (*Carnegiea gigantean*) found throughout the Arizona portion of the range of the lesser long-nosed bats. Beginning in 2019, the addition of cardon (*Pachycereus pringlei*) and organ pipe (*Stenocereus thurberi*) cactus for monitoring in *Nature's Notebook* will allow the program to expand to other portions of the range including Baja Mexico.

Nature's Notebook uses status monitoring, wherein the same individual plants or patches of plants are observed repeatedly over time. This method provides a comparison of the same plants or populations of plants across years, and helps to determine which climate drivers and other environmental variables influence the phenology of these species.

For each individual plant or patch of plants, observers will document two types of data:

1. Status: A "yes" or "no" response to flower buds and open flowers on any plant in the patch.
2. Intensity: The number of flower stalks and percent of open flowers for the individual plant or for all plants in the patch.

The *Nature's Notebook* protocol that is used for both agave and columnar cactus is shown in Fig 2 below. Observers are asked whether they see "flowers or flower buds" or "open flowers", and the degree to which they see these **phenophases**, or life cycle events.

Note that flowers or flower buds is an overarching phenophase; when flowers open to expose their reproductive parts, observers should report “yes” for open flowers while also continuing to report “yes” for flowers or flower buds.

Phenophase definitions are provided to help observers know how to answer the questions on the datasheet. The phenophase definitions are written in great detail to take the guesswork out of observations. The definitions are available in the datasheet packets and on the mobile app.

Do you see...?

Flowers or flower buds
One or more fresh open or unopened flowers or flower buds are visible on the plant. Include flower buds or inflorescences that are swelling or expanding, but do not include those that are tightly closed and not actively growing (dormant). Also do not include wilted or dried flowers.
More...

How many flowers and flower buds are present? For species in which individual flowers are clustered in flower heads, spikes or catkins (inflorescences), simply estimate the number of flower heads, spikes or catkins and not the number of individual flowers.

- Less than 3
- 3 to 10
- 11 to 100
- 101 to 1,000
- 1,001 to 10,000
- More than 10,000

Open flowers
One or more open, fresh flowers are visible on the plant. Flowers are considered "open" when the reproductive parts (male stamens or female pistils) are visible between or within unfolded or open flower parts (petals, floral tubes or sepals). Do not include wilted or dried flowers.
More...

What percentage of all fresh flowers (buds plus unopened plus open) on the plant are open? For species in which individual flowers are clustered in flower heads, spikes or catkins (inflorescences), estimate the percentage of all individual flowers that are open.

- Less than 5%
- 5-24%
- 25-49%
- 50-74%
- 75-94%
- 95% or more

Fig 2. Nature's Notebook protocol for agave and columnar cacti flowering

Species: Agave palmeri
Common Name: Palmer's century plant
Nickname: Palmer's century plant-1

Do you see...?	Check when data entered online: ☐
Flowers or flower buds	y n ? ____
Open flowers	y n ? ____
Fruits	y n ? ____
Ripe fruits	y n ? ____
Recent fruit or seed drop	y n ? ____

Fig 3. Example datasheet for Agave palmeri

Fig 3 shows the protocol for *Agave palmeri* as it appears on the datasheet and the app. Observers answer "yes" or "no" and then enter the intensity of the phenophase question in the blank space. While using the paper datasheets, observers should refer to the phenophase definitions for the intensity categories (eg Less than 3, 3-10, etc). While using the app, the intensity categories are available in a drop-down menu.

Note that for agave, we are only interested in the flowering phenophases (though fruiting may also be recorded). For columnar cacti, we are interested in flowering and also encourage monitoring the fruiting phenophases, as bats are known to use the fruits of columnar cacti.

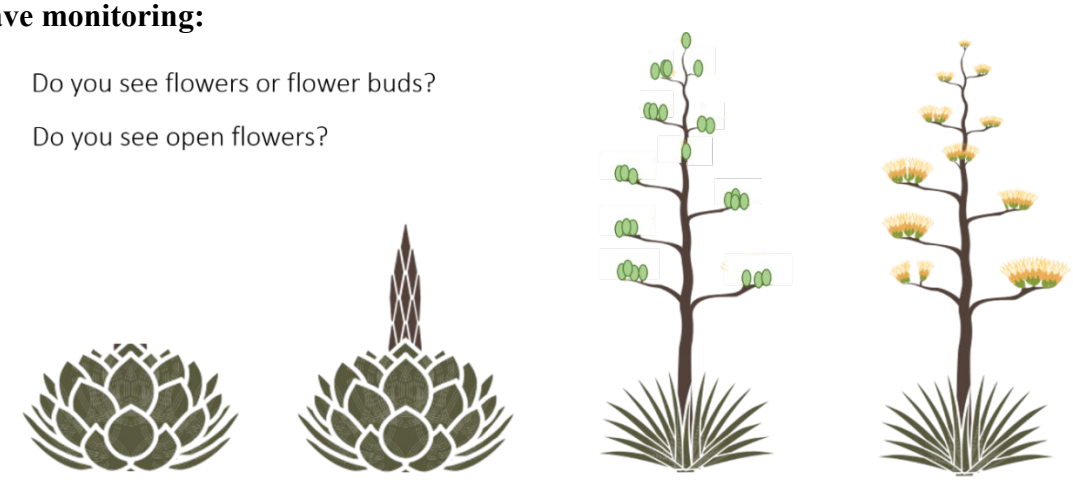
The way that we monitor and record agave and columnar cacti flowering is different. Please note that while the question, "How many flowers or flower buds are present" remains the same for all species in *Nature's Notebook*, for agave we are referring to the stalk as a single "flower". This reflects the structure of the agave, which is an inflorescence, and allows observers to more easily count the number of flowering stalks in patches of agave. For saguaro, we count each individual flower bud as an individual flower.

Here are some examples to help you know what to report for the yes or no and intensity questions on the datasheets for agave and saguaro.

Agave monitoring:

Do you see flowers or flower buds?

Do you see open flowers?



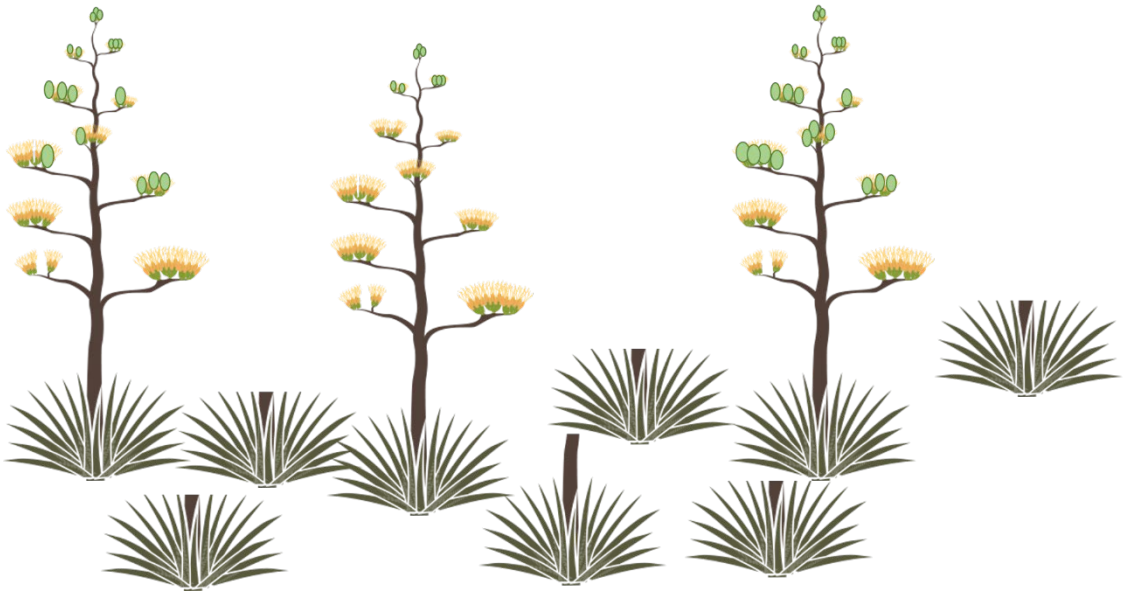
Flowers or Flower buds: No
Open Flowers: No
Observe every other week

Flowers or Flower buds: No
Open Flowers: No
Start observing once per week

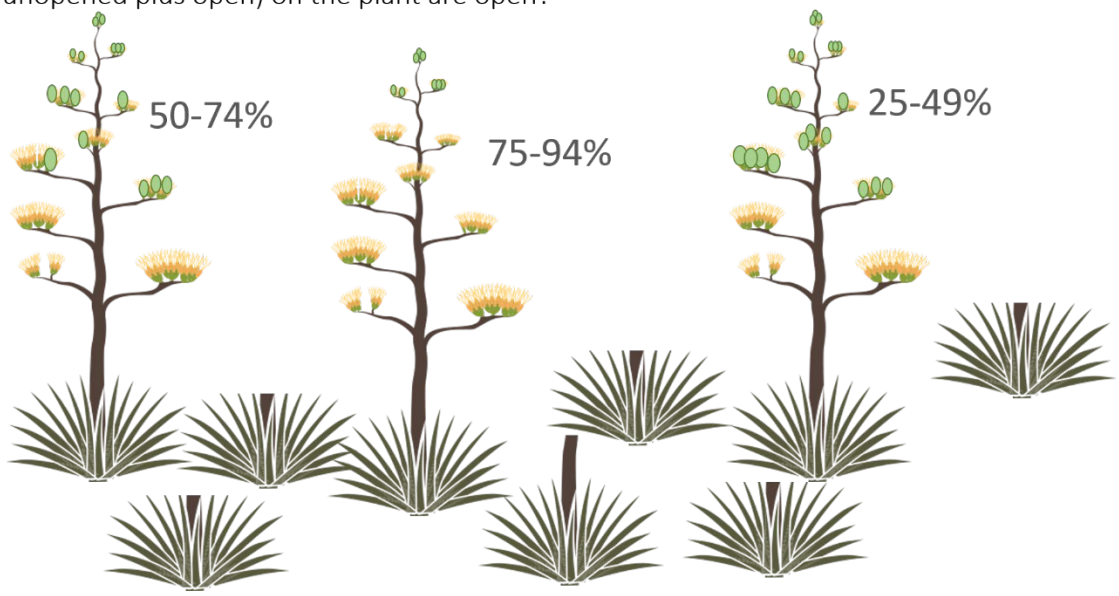
Flowers or Flower buds: Yes
Open Flowers: No
Continue observing once per week

Flowers or Flower buds: Yes
Open Flowers: Yes
Continue observing once per week

How many flowers or flower buds are present? ***3 for the patch***



What percentage of all fresh flowers (buds plus unopened plus open) on the plant are open? ***Average for the patch: 50-74%***



Saguaro monitoring:

Do you see flowers or flower buds?

Do you see open flowers?

Flowers or Flower buds: No
Open Flowers: No
Observing once per week

Flowers or Flower buds: Yes
Open Flowers: No
Observing 2-3 times per week

Flowers or Flower buds: Yes
Open Flowers: Yes
Observing 2-3 times per week

How many flowers and flower buds are present? ***11-100 flowers or flower buds***

What percentage of all fresh flowers (buds plus unopened plus open) on the plant are open? ***50-74% of flowers are open***

Monitoring Locations and Design:

We aim to establish lesser long-nosed bat forage phenology monitoring sites within 40 miles of the long-term and acoustic roost monitoring sites (Fig 4). This will allow comparisons between bat use patterns at the roosts and forage resource phenology within the typical foraging distance of each roost being monitored. Our goal is to have a minimum of five phenology monitoring sites for each forage plant species. We anticipate a total of 25 to 30 total forage plant phenology monitoring sites across the range of the lesser long-nosed bat in Arizona and New Mexico.

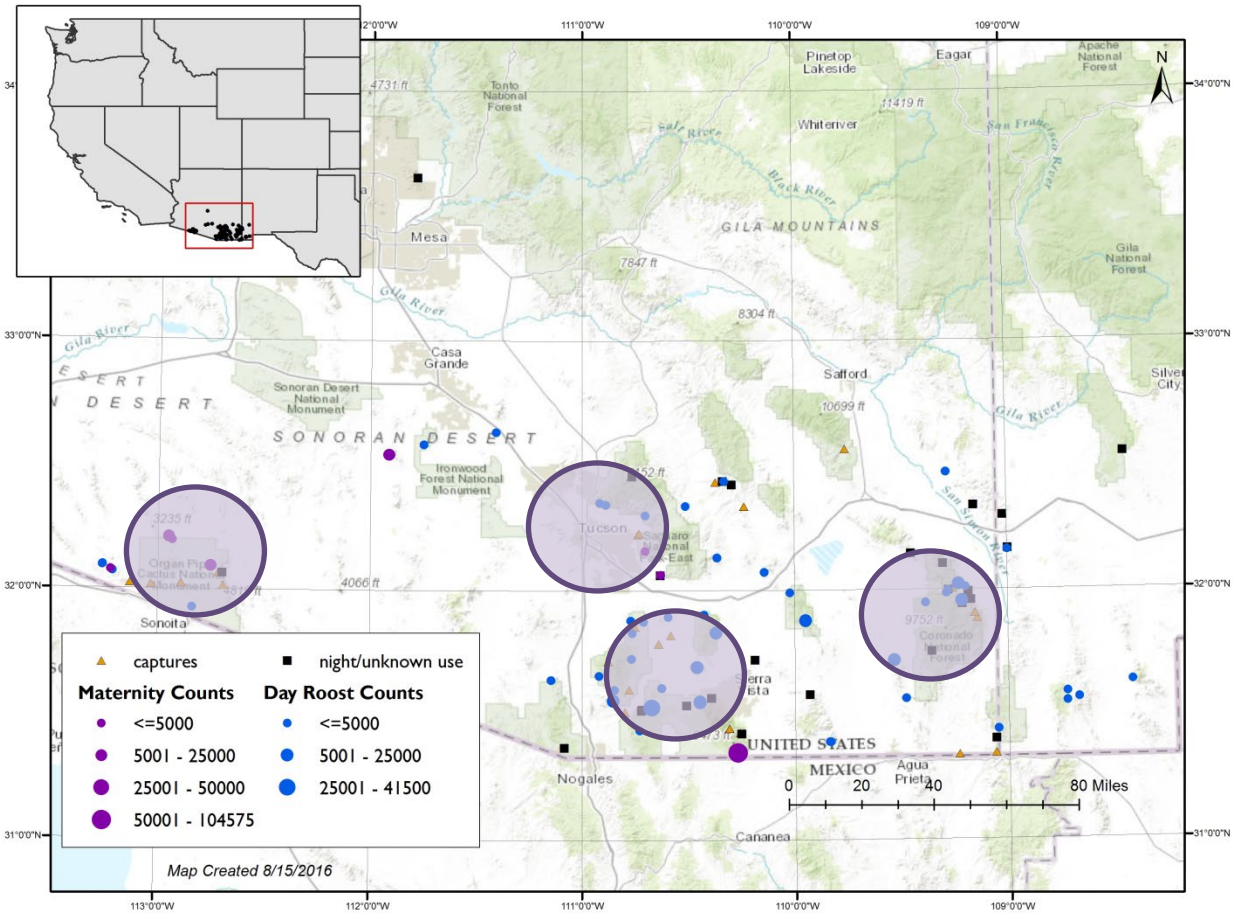


Fig 4. Approximate distribution of the lesser long-nosed bat roosts in Arizona and New Mexico (Map courtesy of BCI). Yellow circles indicate focus areas for forage resource monitoring. Monitoring may also take place outside of these areas.

In the Tucson area, we are interested in finding observers to adopt trails to track flowering of agave. This Google Map shows the trail locations at which we have found agaves present. Potential trail adopters should contact erin@usanpn.org to learn more about how to get involved.

Sites (Box 3) should be representative of the natural landscape, but may be selected for ease of access. Participants are encouraged to select sites that are already regularly accessed by staff and/or volunteers. Phenology monitoring only takes a few minutes and may be completed alongside other job duties.

Box 3. Definitions for Monitoring Design
Site – The physical observation location at which monitoring occurs, registered in *Nature's Notebook*. An agency or other organization may have more than one site. A site should represent a uniform ecosystem type, such as Sonoran desert scrub. A site should include at least 2-3 individual plants or patches of plants for each species. The size and shape of a site are flexible – a site may be defined by a trail that is walked or road that is driven to observe plants, a grouping of plants of a single species, an area including multiple groups of plants from multiple species, a single individual or patch of plants, etc.

Patch – Used when individual plants are clustered together on the landscape. Registered as an Individual Plant Patch in *Nature's Notebook*. Number of flowering stalks and percent of open flowers are estimated for the patch overall.

Individual Plant – Used when individual plants are dispersed on the landscape. Each plant is registered as an Individual Plant in *Nature's Notebook*. Number of flowers will always be counted as a single flowering stalk. Percent of open flowers are estimated for the individual plant.

Fig 5 below shows examples of sites. Sites may be made up of multiple patches of plants (Example Site #1), or a patch of individual plans that are dispersed along a trail or road (Example Site #2). Sites can be made up of multiple species (Example Site #3) or a site may be composed of only one plant, if no others are available (Example Site #4). A site may have a mix of plants occurring in patches and plants occurring as individual plants.

Nature's Notebook allows an observer to indicate the size of their observation site. This can be found by going to Edit Site and entering the details about the site on the bottom of the page. An observer can also use the Comments field associated with an individual plant to specify the size of the patch, the number of individual plants, the size classes, etc.

Saguaro and organ pipe cactus should always be monitored as individual plants. We recommend selecting at least three individuals per site.

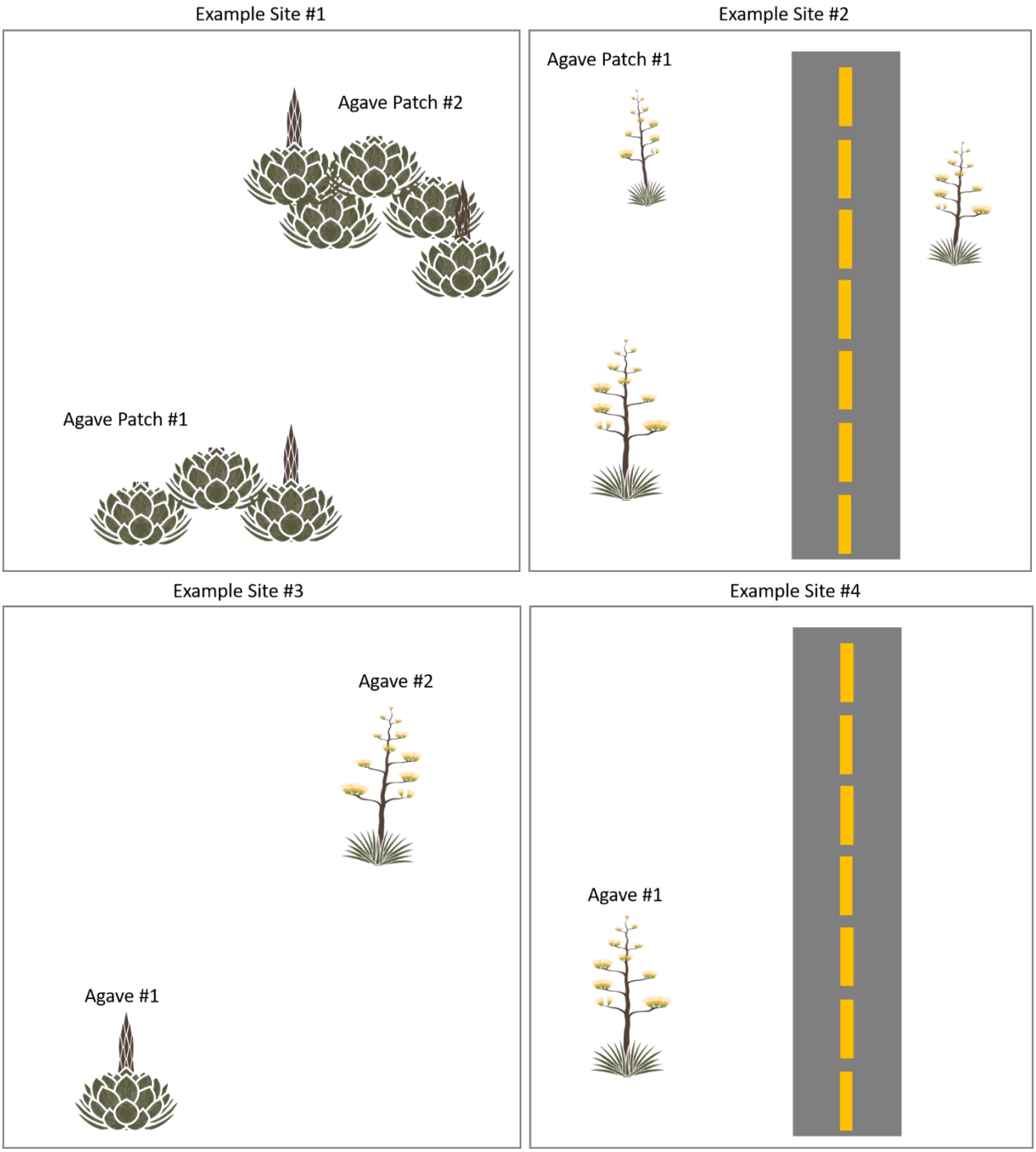


Fig 5. Examples of forage phenology monitoring sites. Sites may include plants that are grouped or a patch of plants that are dispersed along a trail or road. Sites may have multiple species or may include only one plant, if no others are available.

Recommendations for monitoring:

Generally, observers should not attempt to determine flowering stages of agaves or saguaros from a distance of more than 50 feet from the plant. Determination of whether the flowers are closed or open may be aided by the use of binoculars.

Agave monitoring recommendations:

Individual agaves or patches of agaves should be tagged for repeat monitoring. The USA-NPN recommends monitoring at least three individual plants or patches at a site.

Depending on whether agaves are clustered or dispersed on the landscape, we recommend different monitoring methods:

- Clusters of plants – a stationary count method may be used to count flowering stalks and determine percent of open flowers
- Dispersed plants – a walking or driving transect may be used to count flowering stalks and determine percent of open flowers

Columnar cacti monitoring recommendations:

Individual saguaro, organ pipe, and cardon cactus should be selected and tagged for repeat monitoring. Tags may include aluminum tags attached to the plant by wire, stakes or flags placed in the ground near the plant, or other methods appropriate to the individual site. The USA-NPN recommends monitoring at least three plants at a site. A stationary count method may be used to monitor saguaros and organ pipe cactus in most cases.

Because flowers of columnar cacti typically close by midday, we recommend that observations of flowering of these species be completed by 10 am.

Frequency of Monitoring and Estimated Time Investment:

We will focus on tracking flowering phenology, though fruiting phenology may also be recorded. For saguaros, the majority of flowering begins in April and ends in July, though flowering has been reported at other times of the year. For agaves, flowering typically begins in May and ends in September.

The frequency of annual visits will be initially low – only as needed to document the initiation of flowering. For agaves in particular, flowering stalks are large structures and visible from a distance. Agave flowering stalks will typically take at least 2 weeks following initiation of growth of the stalk to form flower buds. After flower buds form, monitoring will ideally occur once per week until flowering has been completed to capture the onset, peak, and end of open flowers.

Table 1. Estimated timeline and frequency of phenology monitoring for saguaro and agave:

	April	May	June	July	Aug	Sep
Columnar Cacti	Begin monitoring weekly	When flowers appear, monitor 1-2 times per week	When flowers appear, monitor 1-2 times per week	Fruits may optionally be recorded 1-2 times per week	No monitoring anticipated	Fall flowering may optionally be recorded
Agave	Begin monitoring monthly	When flowering stalks appear, monitor once per week	When flowering stalks appear, monitor once per week	When flowering stalks appear, monitor once per week	When flowering stalks appear, monitor once per week	When flowering stalks appear, monitor once per week

Estimated training and observing time:
Training. USA-NPN staff will provide training on how to use the *Nature's Notebook* program. Individual site consultations are available for selecting sites and individual plants. Ideally, observers will attend at least one training. Trainings may be offered at sites around Tucson in April. If you would like to set up a Nature's Notebook training at your location, contact Erin Posthumus, erin@usanpn.org, 520-621-1670. Training materials are also available on the *Nature's Notebook* website (see *Nature's Notebook* Resources section below).

Observing. An experienced observer will spend approximately 2-3 minutes per individual plant or patch of plants. For a single site with 2-3 individual plants, an observer will spend less than 10 minutes observing. Observers can share monitoring duties. For example, if four observers monitor a single site, each observer only needs to monitor once per month.

Observer management. At least one staff member at each unit will need to provide a supervisory role for their observers, as Local Phenology Leader. This person will also be the primary contact in communication with the USA-NPN, whose staff will provide support and answer questions. This Local Phenology Leader should plan to commit 2-3 hours a month to manage observer monitoring calendars, provide support to observers, and communicate with the USA-NPN staff.

Data Processing and Delivery:

Data from this project are stored in the National Phenology Database (www.usanpn.org/data/observational) and freely available for download and use in multiple summarized formats (Rosemartin et al. 2018). Phenology data can be downloaded along with twenty climate data variables derived from Daymet (gridded, daily surface weather and climate data, daymet.ornl.gov/overview.html). The USA-NPN's Phenology Visualization Tool allows

users to explore data and create graphs such as a phenology calendar to display the presence or absence of flowering and activity curves to display the peak in reports of flowering (Fig 6).

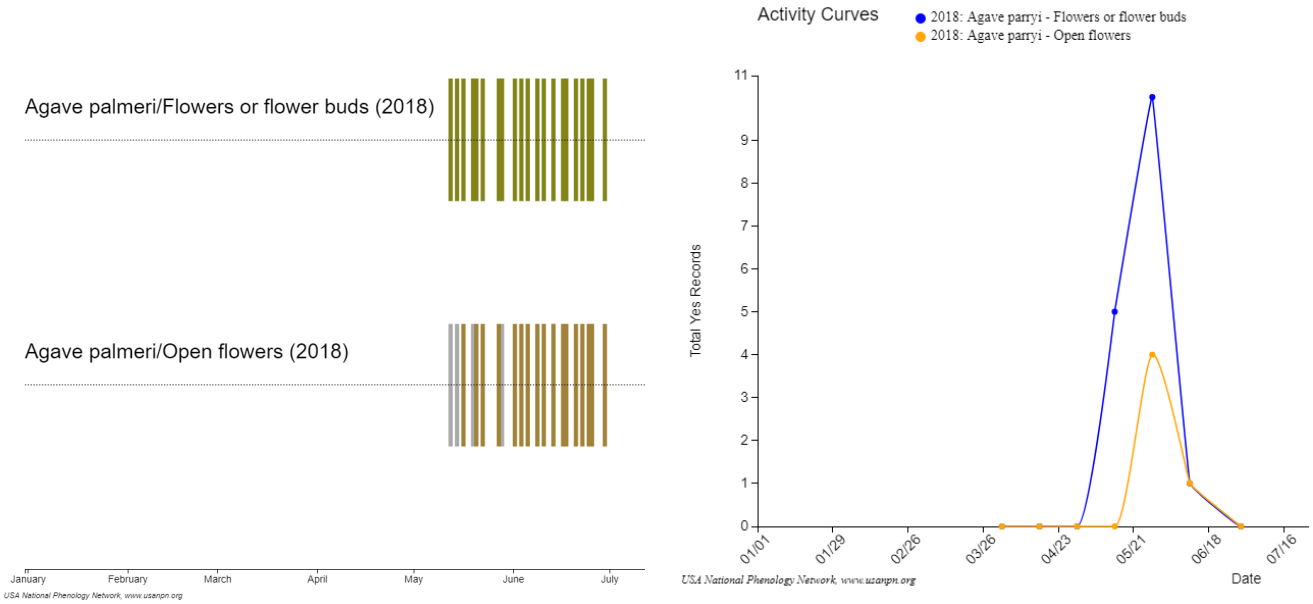


Fig 6. Phenology calendar depicting flowering reports for Agave palmeri in 2018 and activity curve depicting total yes records for flowers or flower buds and open flowers for Agave parryi in 2018. These visualizations were created with the USA-NPN's Phenology Visualization Tool.

Flowers for Bats Resources:

Flowers for Bats Campaign landing page: fws.usanpn.org/Campaigns/flowersforbats
Create a *Nature's Notebook* account: https://www.usanpn.org/nn/become-observer
Request a *Nature's Notebook* group for your organization: www.usanpn.org/nn/groups/group-site
Learn how to observe guidelines: www.usanpn.org/nn/guidelines/group-sites
Learn how to use the mobile app: www.usanpn.org/nn/mobile-apps

Phenophase Photo Guides for four species attached.

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This protocol has been peer-reviewed and approved for publication consistent with USGS Fundamental Science Practices (pubs.usgs.gov/circ/1367/).

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Appendix B – PDM Cooperators

Cooperator	PDM Plan Implementation Responsibilities
Arizona Game and Fish Dept.	Assume authority of conservation of lesser-long nosed bat in Arizona; Continue to oversee monitoring efforts; Continue to coordinate annual roost count monitoring at maternity roosts and late-summer transition roosts. Implement monitoring at one maternity roost site (Pinacate)
Bat Conservation International	Provide expertise and resources to help implement PDM plan. Facilitate obtaining data from Mexico related to ongoing research, and monitoring of lesser long-nosed bats for incorporation into PDM reporting and analysis. Provide roost site data from Baja.
Bureau of Land Management (NM)	Facilitate and manage PDM at the Big Hatchet Roost in New Mexico. Coordinate and participate in forage plant phenology monitoring.
Dept. of Defense – Fort Huachuca Military Installation	Monitoring of a late-summer transition roost. Manage agave management areas, including forage plant phenology monitoring.
The National Park System	Chiricahua NM – monitoring of forage areas adjacent to a number of late-summer transition roosts, including forage plant phenology monitoring; Coronado NM – monitoring of agave restoration area and a late-summer transition roost, including testing of bat gate configurations; Saguaro NP – monitoring of agave and saguaros forage areas and one late-summer transition roost; Organ Pipe Cactus NM – monitoring of one maternity roost and continued forage plant phenology monitoring.
The Nature Conservancy of Arizona	Participate in forage resource monitoring portion of the PDM plan.
New Mexico Dept. of Game and Fish	Assume authority of conservation and management of lesser-long nosed bat in New Mexico; Continue to oversee management and monitoring efforts.
Pima County	Facilitate monitoring on lands controlled by Pima County
Private Consulting Entities	Assist with access to roosts on private property; Assist with conducting roost and forage plant phenology monitoring.
Tohono O'odham Nation	Facilitate management and monitoring on Tohono O'odham lands, including monitoring at one maternity roost site.
USA National Phenology Network	Provide resources and expertise to help implement forage resource monitoring.
US Fish and Wildlife Service	Work with PDM partners to seek funding opportunities through existing grant programs; Staff will participate and maintain oversight of all activities listed in the PDM plan including implementing monitoring at roost and forage phenology sites, developing and managing grant(s)/contract(s), interpreting intent of PDM plan, reviewing/commenting on draft reports, distributing final reports/other information to interested parties, approving and documenting changes to PDM plan, conducting future status reviews of the LLNB, and determining when the PDM plan is complete.
US Fish and Wildlife Service – Refuge System	San Bernardino/Leslie Canyon and Buenos Aires NWR – provide conservation for bat forage resources; Cabeza Prieta NWR – monitor of bat forage resources and one maternity roost.
US Forest Service	Facilitate and participate in monitoring at roost and forage sites on the Coronado National Forest.