# Species Status Assessment Report for

# Peñasco least chipmunk
# (*Neotamias minimus atristriatus*)

Photo Credit: Jim Stuart, New Mexico Department of Game and Fish

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*This document was prepared by Michelle Christman, New Mexico Ecological Services Field Office and Angela D. Anders, Southwest Regional Office.*

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## EXECUTIVE SUMMARY

This Species Status Assessment reports the results of a status review for the Peñasco least chipmunk (*Neotamias minimus atristriatus*). In this report, we used an analytical approach to assess the subspecies' needs, current condition, stressors, and potential future viability using the best available information. For the purpose of this assessment, we generally define viability as the ability of the Peñasco least chipmunk to sustain populations in natural systems over time. The SSA Framework uses the conservation biology principles of resiliency, representation, and redundancy (collectively known as the "3Rs") as a lens to evaluate the current and future condition of the subspecies.

The Peñasco least chipmunk is one of 17 recognized subspecies of least chipmunks. Least chipmunks are smaller than most other chipmunk species belonging to the mammal family Sciuridae. The Peñasco least chipmunk occurs as a disjunct subspecies at the southern-most distributional extent of all least chipmunks (Verts and Carraway 2001, p. 3). The Peñasco least chipmunk is known from the Sacramento and White Mountains in Lincoln and Otero Counties, New Mexico. The Sacramento Mountains and the White Mountains are two distinct mountainous areas formed by different geological processes, and the Peñasco least chipmunk occupies two different ecological settings in each of these two mountain ranges. In the Sacramento Mountains, the habitat of the Peñasco least chipmunk was historically described as meadows and grasslands that occurred between the elevation of 2,103 to 2,438 meters (m) (6,900 to 8,000 feet (ft)) in canyon bottoms. The subspecies also occurred in the understory and interspersed open meadows of old growth ponderosa pine forests consisting of a low density of trees and a park-like understory of native grasses. In the White Mountains to the north, the habitat of the Peñasco least chipmunk is described as occurring in high-elevation (above 3,109 m (10,200 ft)) Thurber's fescue grassland meadow communities with rock outcrop areas.

Historical records for the Peñasco least chipmunk (1902-1982) are primarily from areas within Mescalero Apache tribal land boundaries. We do not have data within the last 35 years regarding the status of the subspecies nor its habitat within Mescalero Apache Tribal boundaries in the White Mountains or the Sacramento Mountains. Areas of historical observations of the subspecies in the Sacramento Mountains coincident with more recent survey efforts are limited. The exception is James Canyon, on U.S. Forest Service lands, where the most descriptive accounting of the historical condition of the subspecies and its habitat occurred. Multiple survey efforts by several researchers have not yielded any observations of the Peñasco least chipmunk in the Sacramento Mountains since 1966. For this reason, it has been postulated that the Sacramento Mountains population could be or is likely extirpated (Sullivan et al., Undated, p. 21; Hope and Frey 2000 p. 10; Frey and Boykin 2007, pp. 12–18; Frey et al. 2009, p. 5; Frey and Hays 2017 p. I; New Mexico Department of Game and Fish 2016, p. 4). We are not aware of any recent surveys on Mescalero Apache tribal land, such that the subspecies may still occur there. Because of the intensity of survey effort in James Canyon since 1966 with no detections, it is likely that the Peñasco least chipmunk is extirpated from James Canyon. If the Peñasco least chipmunk still occurs in the Sacramento Mountains, it likely persists there in isolated patches or at extremely low numbers, due primarily to loss of suitable native grassland habitat. In the White Mountains, historical trapping data are limited to the following detections: 2 Peñasco least chipmunk in 1982 with 153 trap-days; 5 Peñasco least chipmunk were captured with 4,193 trap-days of effort from 2000 to 2016, and preliminary data from the 2018 field season report that 12-17 individuals have been captured with 1,683 trap-days. The 2018 captures were from the previously known area of occupancy on Lookout Mountain and a small open area adjacent to the Lookout Mountain meadow. Importantly, the Lookout Mountain meadow observations are within the same meadow as historical observations from 1902-1982 on Mescalero Apache Tribal lands. Suitable habitat does not appear to be a limiting factor in the White Mountains. Despite the relatively higher counts in 2018, compared to other least chipmunk subspecies and relative to early historical records for this subspecies, more recent capture rates (2000-2018) for the Peñasco least chipmunk appear to be low to very low in the White Mountains.

Peñasco least chipmunk habitat in the Sacramento Mountains appears to be significantly altered due to a variety of land use and management practices over the past 120 years, including agricultural and livestock use, timber harvest, and fire suppression that has resulted in an overall lack or elimination of suitable mature ponderosa pine forest habitat in the Sacramento Mountains. Alterations to habitat conditions have likely impacted and will continue to impact the ability of the Sacramento Mountains population to persist, if present or reintroduced. Peñasco least chipmunk habitat in the White Mountains is affected by recreational use and development and forest encroachment into meadow habitat on a relatively small scale, but overall appears to be intact and similar to historical conditions. Habitat condition in the White Mountains does not appear to be a limiting factor in the status of the subspecies there.

To support the overall viability of the subspecies, the Peñasco least chipmunk needs at least two resilient populations, each with some degree of sub-population structure. Resilient populations are those able to withstand stochastic events arising from spatially and temporally random factors, and that are distributed across the subspecies range, to maintain persistence into the future and to avoid extinction. Several factors may influence the resiliency of a population in response to stochastic events; however, for the Peñasco least chipmunk, factors related to extremely small population size are the most significant. These factors include:

- Abundance – populations large enough that local stochastic events do not eliminate all individuals, allowing the overall population to recover from any one event
- Subpopulations – multiple subpopulations per population so that local stochastic events do not eliminate the entire population

Additionally, the Peñasco least chipmunk needs suitable habitat that provides for all of its life history requirements, including:

- Abundant food sources occurring in open areas, where the sympatric gray-footed chipmunk is less likely to compete for food resources
- Vegetation that is tall enough in height, and open enough near the ground to allow for foraging and escape from predators
- Substrate that allows for sentinel perching, nesting, and overwintering

Table ES–1 provides our assessment of the current condition of Peñasco least chipmunk populations, as it relates to the three R's (resiliency, representation, and redundancy). To assess the Peñasco least chipmunk's resiliency, we assessed both demographic and habitat factors, and categorized the current condition. Specifically, for each population, we assigned a condition category for the following factors (Table 5.2.3):

- Trap rate (number of individuals per trap-day) as coarse surrogate for density
- Population trends
- Connectivity between populations
- Subpopulations within populations
- Suitable habitat size to support population persistence
- Change in habitat availability
- Habitat quality

Representation is the ability to adapt to changing environmental conditions as measured by the breadth of genetic or environmental diversity within and among populations. Redundancy is ability of the subspecies to withstand catastrophic events, measured by the number of populations, their resiliency, and their distribution and connectivity. Based on allozyme data, Peñasco least chipmunks in the White Mountains show the lowest levels of within-population genetic variation out of nine least chipmunk subspecies in New Mexico, Arizona, and Colorado, with 1 allele per locus, 4.2% polymorphic loci, and an observed heterozygosity of 0. We assume that if the Peñasco least chipmunk still occurs in the Sacramento Mountains, it is likely that genetic diversity within that population would also be very low. Whether the Sacramento Mountains population is extirpated or persists in isolated areas or at extremely low numbers, it is highly unlikely that it could ever recolonize without significant habitat restoration and human-mediated movement of individuals. Currently, the Peñasco least chipmunk is thus represented by one known extant population in the White Mountains that occurs with very low numbers of observed individuals.

To evaluate the biological status of the Peñasco least chipmunk into the future, we assessed a range of conditions for the time periods of 2025-2049 to allow us to consider the subspecies' resiliency, representation, and redundancy over the next 30 years. This timeframe is reasonable for assessing the future condition of the Peñasco chipmunk, as it represents approximately 30 generations into the future; it is the timeframe for near-term climate projects; and it is a timeframe that would be minimally necessary to see results from future conservation actions. Our analysis of the past, current, and future influences on Peñasco least chipmunk long-term viability indicate that the factor that poses the greatest risk to future viability of the subspecies is that it occurs as only a single extant population in one location with few individuals. Any stressor that affects Peñasco least chipmunks may therefore have a greater impact than it would for a species or subspecies with highly resilient populations and some level of redundancy.

A *stressor* is a chemical or biological agent, environmental condition, external stimulus or an event that causes stress to an organism. Risk is the possibility of the stressor impacting the organism. Potential stressors to the Peñasco least chipmunk include 1) changes to habitat that cause reductions in food availability or cover, 2) disease outbreaks (e.g. plague), 3) impacts from non-native feral hogs (including predation, habitat modification, and disease vectoring), and 4) small population size and lack of connectivity. These stressors likely play a significant role in the future viability of the Peñasco least chipmunk. Populations of the Peñasco least chipmunk have lost resiliency and have been or are vulnerable to extirpation, with concurrent losses in representation and redundancy. Overall, one population of the Peñasco least chipmunk may have been extirpated or persists at extremely low numbers, and the other persists with what appears as abundant habitat but low to very low densities where detected. Both populations face high levels of risk into the future from current very low population levels that can be exacerbated by natural and anthropogenic stressors. We specifically assessed the following potential stressors and stressor sources in this SSA:

- Vegetation shifts, wildfire, and forest encroachment
- Recreation, development, land use, and land management
- Disease
- Non-native feral hogs
- Small population size and lack of connectivity
- Interspecific competition
- Scientific collection
- Climate change

We have forecasted what the Peñasco least chipmunk may have in terms of resiliency, representation, and redundancy under three future plausible scenarios (Table ES–1). We evaluated the past, current, and future stressors and stressor sources that affect Peñasco least chipmunk needs for long-term viability, and carried the following potential stressors and stressor sources forward into our assessment of possible future scenarios:

- Vegetation shifts, wildfire, and forest encroachment
- Recreation, development, land use, and land management
- Disease
- Non-native feral hogs
- Small population size and lack of connectivity

We developed three future scenarios to consider the range of potential future conditions against which to assess the viability of the Peñasco least chipmunk. The three scenarios are:

- Scenario 1 – Continuing Conditions
- Scenario 2 – Optimistic
- Scenario 3 – Increased Stressors

Scenario 1 – Continuing Conditions. Under Scenario 1, we assume that no conservation actions are implemented, as none are currently being implemented, and effects from stressors continue at the same rate. Under this scenario, we expect the viability of Peñasco least chipmunk to be characterized by a loss of resiliency, representation, and redundancy at the level that is currently occurring. Because the Peñasco currently lacks resiliency, representation, and redundancy, any further loss as projected under this scenario would result in extremely low or non-viability for the subspecies.

Scenario 2 – Optimistic. Under this scenario, we considered the viability of the Peñasco least chipmunk with the implementation of plausible but significant and expensive conservation measures. The potential conservation measures included in this optimistic scenario include an effective captive propagation program that relies on a genetic management plan and an overall reintroduction and augmentation plan; habitat restoration and reintroduction of animals from a captive program in the Sacramento Mountains and possibly into the White Mountains; plague control; and forest and range management specifically for the conservation of the chipmunk. Under this scenario, we expect the viability of the Peñasco least chipmunk to be characterized by higher levels of resiliency, representation, and redundancy than it exhibits under the current condition, but still low over the assessed time period.

Scenario 3 –Increased Stressors. Under this scenario, we considered the viability of the Peñasco least chipmunk with either an increase in stressors, an increase in the effect of stressors, or a decrease in conservation actions. However, we are not aware of any current conservation actions that could be decreased for this scenario. Potential new stressors included the initiation of livestock grazing in the White Mountains, changes in habitat or food sources resulting from new development, new encroachment of feral hogs, and novel disease impacts. New or increased stressors included climate change affecting winter torpor and increasing tree encroachment into open meadows. An increase in stressors or in the effect of stressors would decrease the viability of Peñasco least chipmunk with a reduction in resiliency, representation, and redundancy. As with Scenario 1, because the Peñasco least chipmunk currently lacks resiliency, representation, and redundancy, any further loss as projected under this Scenario 3 would result very high vulnerability to extirpation.

We examined the resiliency of Peñasco least chipmunk populations under each of these plausible future scenarios (Table ES–2). Only under Scenario 2, with significant and long-term conservations actions, could the resiliency of the Peñasco least chipmunk be improved from current very low conditions to low/moderate condition.

Table ES-1. Species Status Assessment summary reflecting the 3 Rs for Peñasco least chipmunk.

| 3Rs | Needs | Current Condition | Future Condition (Viability)<br>Projections based on future scenarios from 2025-2049: |
|---|---|---|---|
| **Resiliency:<br>Population<br>(Large populations and habitat with good condition able to withstand stochastic events)** | • High abundance populations<br>• Multiple subpopulations within each population<br>• Abundant food sources occurring in open, non-forested areas<br>• Vegetation that allows for cover in open areas<br>• Substrate that allows for sentinel perching, nesting and overwintering<br>• Low rates of predation<br>• Low incidence of disease | • Extremely low density in the White Mountains and may be extirpated in the Sacramento Mountains<br>• No identifiable sub-population level structure (no known subpopulations or groupings)<br>• Habitat (including veg cover) and food sources appear adequate in White Mountains, may be lacking or eliminated in Sacramento Mountains<br>• Predation rate is unknown; predation is assumed in areas of overlap with feral hogs<br>• Disease prevalence is unknown; however, plague is assumed present | In each scenario any remaining populations will likely lose some individuals to a variety of factors including changes in food availability resulting from land management, predation and habitat impacts from invasive feral hogs, and disease outbreaks (plague).<br><br>Continuing Conditions: Threats continue on current trajectory.<br>• See Current Condition with continued trajectory<br>• Current lack of resiliency remains unchanged<br>• Extremely low condition or non-viability<br>Optimistic: Feasible Conservation Measures<br>• Slightly elevated densities through captive programs, plague control and management<br>• Habitat conditions could be slightly improved in the Sacramento Mountains<br>• Lack of resiliency remain with slight improvements<br>• Resiliency remains low for long-term viability for the subspecies<br>Increased Stressors:<br>• Resiliency remains lacking and more difficult to improve<br>• High vulnerability to extirpation and non-viability |

| **3Rs** | **Needs** | **Current Condition** | **Future Condition (Viability)<br>Projections based on future scenarios from 2025-2049:** |
|---|---|---|---|
| **Representation: Subspecies (Genetic and ecological diversity to maintain adaptive potential)** | • Genetic variation within and between populations important to maintain adaptive potential<br>• Distribution of populations such that the range of environmental conditions is represented | • Few individuals observed from 2000 to present in the White Mountains; zero individuals have been observed from 1966 to present in the Sacramento Mountains<br>• Genetic variation within extant populations is likely greatly reduced due to low population size<br>• If the Sacramento population is extirpated, genetic and ecological diversity are only represented by the White Mountains population | Continuing Conditions: Threats continue on current trajectory.<br>• See Current Condition with continued trajectory<br>• Current lack of Representation remains unchanged<br>• Extremely low condition or non-viability<br>Optimistic: Feasible Conservation Measures<br>• Genetic Management could improve genetic representation<br>• Representation could be improved, but may still be limited depending on if Sacramento Mts population persistence<br>• A higher level of Resiliency could be attained with concerted efforts, but remains low for long-term viability<br>Increased Stressors:<br>• Representation remains lacking, continues to degrade, and becomes more difficult to improve<br>• Reduced genetic diversity due to contraction in size of populations and loss of unique alleles<br>• Lack of Representation with continued degradation would result in high vulnerability to extirpation and non-viability |
| **Redundancy: Subspecies (Number, distribution, and connectivity of populations to withstand catastrophic events)** | • A large number of populations distributed across the range of the species | • Historically two populations in two mountain ranges<br>• Currently one population in one mountain range | Continuing Conditions: Threats continue on current trajectory.<br>• See Current Condition with continued trajectory<br>• Current lack of Redundancy remains unchanged<br>• Extremely low condition or non-viability |

| 3Rs | Needs | Current Condition | **Future Condition (Viability)**<br>**Projections based on future scenarios from 2025-2049:** |
|---|---|---|---|
| | | | Optimistic: Feasible Conservation Measures<br>• Redundancy could be improved through re-establishing populations<br>• A higher level of Redundancy could be attained with concerted efforts, but remains low for long-term viability<br>Increased Stressors:<br>• Redundancy remains lacking and becomes more difficult to improve<br>• Lack of Redundancy with increased difficulty in improving would result in high vulnerability to extirpation and non-viability |

Table ES-2. Future resiliency conditions of Peñasco least chipmunk populations under three plausible future scenarios.

| | | Demographic Factors | | | | Habitat Factors | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Population** | **Scenario** | **Trap Rate (# Indivs/Trap Hr) Surrogate for Density** | **Population Trends** | **Population Connectivity** | **Subpopulations within Populations** | **Availability of Suitable Habitat to Support Population Persistence** | **Habitat Availability Trends** | **Habitat Condition with Land Use or Management** | **Condition Category** |
| **Sacramento Mountains** | Scenario 1: Continuing Conditions | Very Low | Very Low | Very Low | Very Low | Very Low | Very Low | Very Low | **Very Low** |
| | | -2 | -2 | -2 | -2 | -2 | -2 | -2 | **-2.00** |
| | Scenario 2: Optimistic | Very Low | Low | Moderate | Low | Low | Low | Low | **Low** |
| | | -2 | -1 | 0 | -1 | -1 | -1 | -1 | **-1.00** |
| | Scenario 3: Increased Stressors | Very Low | Very Low | Very Low | Very Low | Very Low | Very Low | Very Low | **Very Low** |
| | | -2 | -2 | -2 | -2 | -2 | -2 | -2 | **-2.00** |
| | | | | | | | | | |
| **White Mountains** | Scenario 1: Continuing Conditions | Very Low / Low | Very Low | Very Low | Very Low | Moderate | Moderate | Low | **Low** |
| | | -1.5 | -2 | -2 | -2 | 0 | 0 | -1 | **-1.21** |
| | Scenario 2: Optimistic | Low | Moderate | Moderate | Low | Moderate | Moderate | Moderate | **Moderate** |
| | | -1 | 0 | 0 | -1 | 0 | 0 | 0 | **-0.29** |
| | Scenario 3: Increased Stressors | Very Low | Very Low | Very Low | Very Low | Low | Low | Low/Very Low | **Very Low** |
| | | -2 | -2 | -2 | -2 | -1 | -1 | -1.5 | **-1.64** |

# CHAPTER 1. INTRODUCTION

The Species Status Assessment (SSA) framework (USFWS 2016, entire; Smith et al. 2018, entire) is an analytical approach to assess a species' needs, stressors, and current and future status using the best available information. The SSA Framework uses the conservation biology principles of resiliency, representation, and redundancy (collectively known as the "3Rs") as a lens to evaluate the current and future condition of a species or subspecies. The result is an SSA Report that characterizes a species' or subspecies' ability to sustain populations in the wild over time, or viability, based on the best scientific understanding of current and future abundance and distribution, and stressors potentially impacting the species or subspecies, within its ecological settings. The intent is for the SSA Report to be updated as new information becomes available and to support all functions of the U.S. Fish and Wildlife Service (Service) Endangered Species Program from Candidate Assessment to Listing to Consultations to Recovery. As such, the SSA Report will be a living document upon which other documents, such as listing rules, recovery plans, and 5–year reviews, will be based if the subspecies warrants listing under the Endangered Species Act (ESA).

The Peñasco least chipmunk (*Neotamias minimus atristriatus*) is currently recognized as one of 17 subspecies of least chipmunk (*Neotamias [=Tamias] minimus*) (Wilson and Reeder 2005, p. 815). Least chipmunks are smaller than most other chipmunk species and belong to the family Sciuridae. The Peñasco least chipmunk occurs as a disjunct subspecies at the most southern distributional extent of all of the subspecies (Verts and Carraway 2001, p. 3). The Peñasco least chipmunk is known from the Sacramento Mountains and White Mountains in Lincoln and Otero Counties in southern New Mexico. In the Sacramento Mountains, the habitat of the Peñasco least chipmunk is described as meadows and grasslands in canyon bottoms, as well as interspersed open meadows and understory of old growth ponderosa pine forests comprised of a park-like understory of native grasses with a low density of trees, at approximately 2,103 to 2,438 meters (m) (6,900 to 8,000 feet [ft]) in elevation (Frey 2018a, p. 15). In the White Mountains, just north of the Sacramento Mountains, the habitat of the Peñasco least chipmunk is described as occurring in Thurber's fescue (*Festuca thurberi*) grassland meadow communities that are associated with rock outcrop areas in high elevation above 3,109 m (10,200 ft; Frey 2018a, p. 20).

Survey efforts by multiple researchers have not yielded any observations of the Peñasco least chipmunk in the Sacramento Mountains since 1966; for this reason, it has been postulated that the Sacramento Mountains population may be or is likely extirpated (Sullivan et al., Undated, p. 21; Hope and Frey 2000 p. 10; Frey and Boykin 2007, pp. 12–18; Frey et al. 2009, p. 5; Frey and Hays 2017 p. i; New Mexico Department of Game and Fish 2016, p. 4). However, we are not aware of any recent surveys on Mescalero Apache tribal land, such that the subspecies may still occur there. Areas of historical observations of the Peñasco least chipmunk in the Sacramento Mountains coincident with more recent survey efforts are limited. The exception is James Canyon, on U.S. Forest Service land, where the most descriptive accounting of chipmunks and habitat has occurred. Recent surveys in James Canyon indicate that the Peñasco least chipmunk is likely extirpated from that area. If the Peñasco least chipmunk still occurs in the Sacramento Mountains, it likely persists there in isolated patches or at extremely low numbers, due primarily to loss of suitable native grassland habitat, but possibly influenced by other factors.

In the White Mountains, recent observational records are limited to the detection of five individuals between 2000 and 2016 as a result of a total of 3,040 trapping-days (= 0.16 Peñasco least chipmunks / 100 trap-days). As is the case in the Sacramento Mountains, we do not have any information within the last 35 years on the status of the subspecies on Mescalero Apache Tribal lands in the White Mountains. Outside of tribal land boundaries, suitable habitat does not appear to be a limiting factor for the Peñasco least chipmunk in the White Mountains. Compared to other least chipmunk subspecies, and relative to early historical records, capture rates for the Peñasco least chipmunk appear to be low to very low in the White Mountains.

On October 5, 2011, the Service received a petition to list the Peñasco least chipmunk under the ESA as endangered or threatened throughout its range. On November 21, 2012, the Service published a substantial 90-day finding and a warranted-but-precluded 12-month finding, stating that listing of the subspecies was warranted due to the present or threatened destruction, modification, or curtailment of its habitat or range and the fragmentation and isolation of small populations. The Service stated that listing of the Peñasco least chipmunk was precluded by higher priority listing actions at that time, and the subspecies was added to the candidate list (77 FR 69994). This SSA Report for the Peñasco least chipmunk is intended to provide the biological support for the decision on whether or not to propose to list the subspecies as threatened or endangered under the ESA and, if so, where to propose designating critical habitat. Importantly, the SSA Report does not represent a decision by the Service on whether this subspecies should be proposed for listing under the ESA. Instead, this SSA Report provides a review of the available information strictly related to the biological status of the Peñasco least chipmunk. The listing decision will be made by the Service after reviewing this document and all relevant laws, regulations, and policies, and the results of a proposed decision will be announced in the *Federal Register* with appropriate opportunities for public input.

For the purposes of this SSA Report, we analyze impacts to both individuals and populations. We define a Peñasco least chipmunk population as one that occurs within the same mountain range, in this case, either the Sacramento Mountains or the White Mountains. A population may consist of one or more subpopulations of Peñasco least chipmunk. In the Sacramento Mountains, historical records (summarized in Frey and Boykin 2007, entire) indicate that there may have been at least four subpopulations of the Peñasco least chipmunk among major drainages; however, we have no information to indicate that chipmunks are currently distributed in any manner that would support subpopulation structure in the Sacramento or White Mountains. Furthermore, low numbers of individuals captured in the White Mountains, representing low population numbers also supports that there is likely low connectivity if subpopulation structure does exist.

This SSA Report provides a thorough assessment of the subspecies' biology and resource needs and assesses demographic risks, stressors, and limiting factors in the context of determining the viability and risk of extinction for the subspecies going forward. For the purposes of this assessment, we generally define viability as the ability of the Peñasco least chipmunk to sustain populations in natural systems over time. Using the SSA framework (Figure 1.1), we consider what the subspecies needs to maintain viability by characterizing its status in terms of its resiliency, representation, and redundancy (Wolf *et al.* 2015, entire; Smith et al. 2018, entire).

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

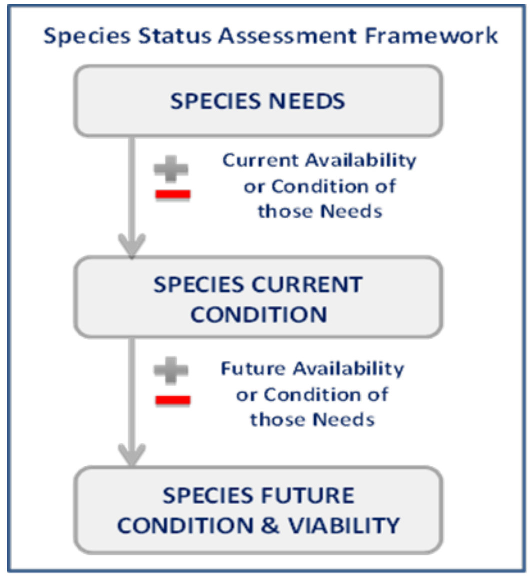



Figure 1.1 Species Status Assessment framework.

- **Representation** describes the ability of a species or subspecies to adapt to changing environmental conditions. Representation can be measured by the breadth of genetic or environmental diversity within and among populations and gauges the probability that a species or subspecies is capable of adapting to environmental changes. The more representation, or diversity, a species or subspecies has, the more it is capable of adapting to changes, natural or human caused, in its environment. In the absence of genetic and ecological diversity information, we evaluate representation based on the extent and variability of habitat characteristics across the geographical range.

- **Redundancy** describes the ability of a species or subspecies to withstand catastrophic events. Measured by the number of populations, their resiliency, and their distribution and connectivity, redundancy gauges the probability that a species or subspecies has a margin of safety to withstand or can bounce back from catastrophic events, such as a rare destructive natural event or episode involving many populations; for example, wildfire.

The format for this SSA Report includes: the life history, biology, and resource needs of individuals (Chapter 2); the historical and current range and distribution of Peñasco least chipmunk, population and subspecies needs, and a framework for determining the distribution of resilient populations needed across its range for viability (Chapter 3); the likely causes of the current and future status of the subspecies and stressors and stressor sources that affect its viability (Chapter 4); current condition of the subspecies, including descriptions of each population (Chapter 5); and a description of subspecies viability in terms of resiliency, representation, and redundancy under various possible future scenarios (Chapter 6).

# CHAPTER 2. INDIVIDUAL NEEDS – LIFE HISTORY AND BIOLOGY

In this chapter we provide basic biological information on the Peñasco least chipmunk, including taxonomic history, genetics, morphological description, and life history traits. For aspects in which we lack subspecies-specific information, we make biological inferences from other, similar western least chipmunk subspecies or generally from chipmunks with similar ecologies. We then outline the resource needs of Peñasco least chipmunk individuals. Here we report those aspects of the life history of the Peñasco least chipmunk that are important to our analysis in determining the viability of the subspecies using resiliency, representation, and redundancy.

## 2.1 Distribution, Taxonomy, and Genetic Diversity

### 2.1.1 Distribution

Least chipmunks have the largest geographic distribution of all North American chipmunks ranging from Central Yukon (Canada) south through the Sierra Nevada and southern New Mexico, and east to Michigan and western Quebec (Canada) (Wilson and Reeder 2005, p. 815). The Peñasco least chipmunk is one of 17 subspecies of the least chipmunk (Wilson and Reeder 2005, p. 815) and occurs as a disjunct subspecies at the most southern distributional extent of all of the subspecies (Verts and Carraway 2001, p. 3). The Peñasco least chipmunk is known from the Sacramento and White Mountains in Lincoln and Otero Counties in southern New Mexico.

Figure 2.1.1 depicts the geology that forms the two mountain ranges in this assessment, the Sacramento Mountains and the White Mountains. The Sacramento Mountains consist of an uplifted fault block composed largely of sedimentary rock, with some bedrock dating from the late Precambrian to Cretaceous, but mostly from the Paleozoic age (Pray 1961, p. 1). Sierra Blanca (= White Mountains) is a separate mountain mass composed largely of igneous rock intruded into strata dating in age from the Permian to Cretaceous (Pray 1961, p. 6). The name "Sacramento Mountains" in New Mexico has been noted as being a confusing term, where some maps denote the Sacramento Mountains as consisting of the entire mountain range from the latitude from Carrizozo, New Mexico, to the northwestern portion of the Guadalupe Mountains, New Mexico (Pray 1961, p. 6). In this depiction, the White Mountains (=Sierra Blanca) would be considered part of the Sacramento Mountains; however, more typically, the name Sacramento Mountains is applied only to the mountain region south of Tularosa Canyon (Pray 1961, p. 6). Thus, Sierra Blanca and other mountain masses in the northern part of the range (north of Tularosa Canyon) are not considered part of the Sacramento Mountains (Pray 1961, p. 6). We follow this depiction, and consider the mountains south of Tularosa Canyon as the Sacramento Mountains, and the mountains north of Tularosa Canyon, specifically, the mountains containing Sierra Blanca Peak, as the White Mountains.

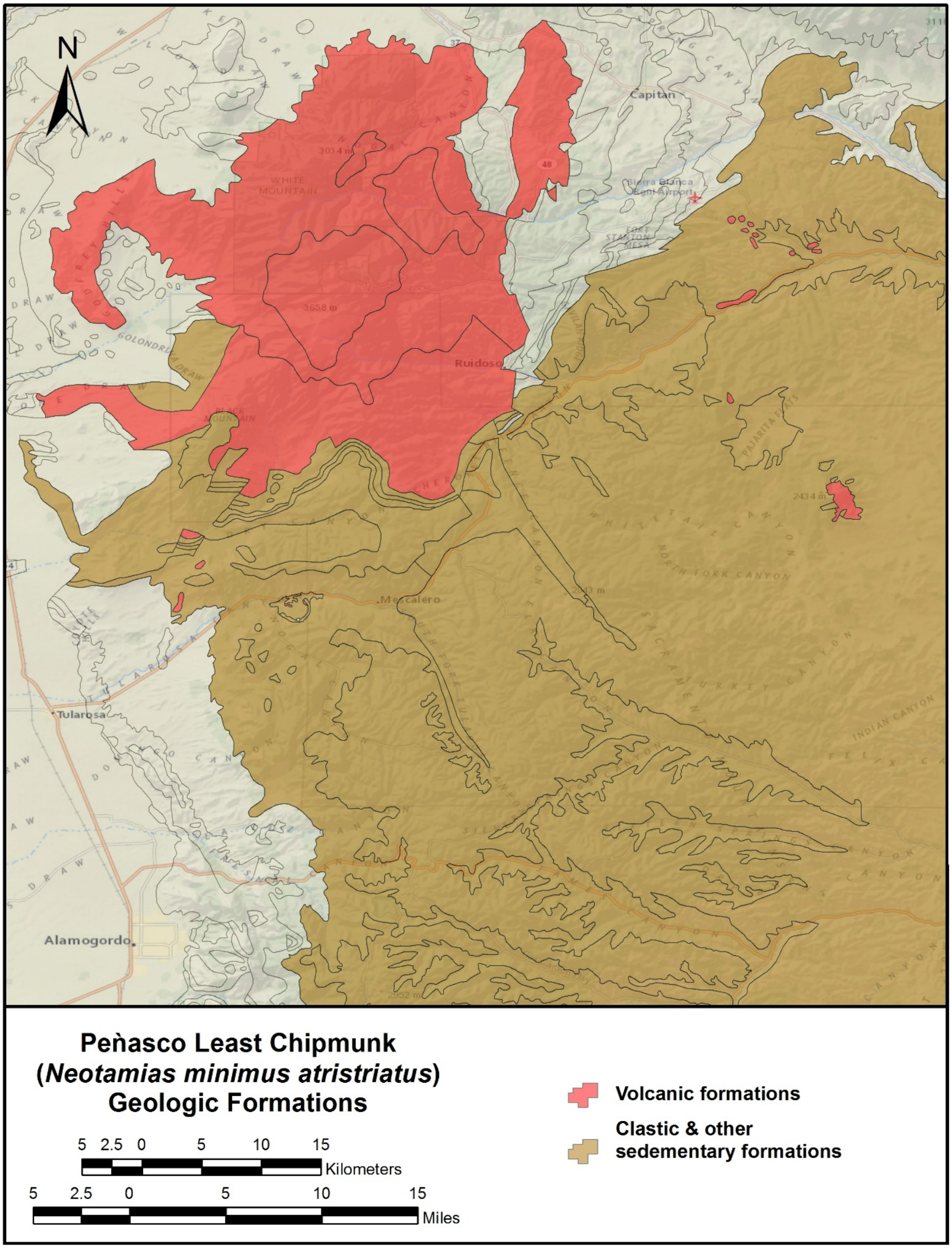



Figure 2.1.1. General depiction of mountain ranges in southeastern New Mexico.

The Peñasco least chipmunk is reported as once having a broad distribution throughout the Sacramento Mountains (Frey 2010, p. 18), and based on early records, it was considered to be abundant and widespread through the early 1930s (Frey and Boykin 2007, pp. 15, 50). Reports suggest that the Peñasco least chipmunk may now be extirpated from the Sacramento Mountains (Hope and Frey 2000, p. 10; Frey and Boykin 2007, pp. 12–18; Frey et al. 2009, p. 5). However, there is uncertainty with these statements that are detailed in Chapter 3, Historical and Current Range. In the White Mountains, the Peñasco least chipmunk was first observed on Sierra Blanca Peak in 1931 and confirmed on Buck Mountain in 2000 (Hope and Frey 2000, p. 2), with the most recent captures in 2016 on Lookout Mountain, in the Sierra Blanca Peak area (Frey and Hays 2017, p. 9).

### 2.1.2 Taxonomy

The Peñasco least chipmunk was first described as a new species, *Eutamias atristriatus,* in 1913 based on 10 specimens collected from ponderosa pine forest in the Sacramento Mountains in 1902 (Bailey 1913, entire). This taxonomy has been revised multiple times as the taxonomy of chipmunks and least chipmunks changed, including use of the synonyms *Eutamias* and *Tamias* for *Neotamias.* Howell (1929, entire) designated the taxon a subspecies of least chipmunk, *Tamias minimus atristriatus*. Conley (1970, entire) purported that the South Sacramento (= Sacramento Mountains) population was the only population of least chipmunks in New Mexico worthy of nomenclatural distinction based on morphological distinctiveness. However, Sullivan and Peterson (1988, p. 21) recommended the retention of *N. m. atristriatus* as a subspecies that included both the New Mexico White Mountains and Sacramento Mountains, based on more in-depth morphological and genetic analyses. Verts and Carraway (2001, entire) and Wilson and Reeder (2005, p. 815) continue to support *N. m. atristriatus* as a recognized subspecies of *N. minimus*. Least chipmunks are currently recognized as belonging to the genus *Neotamias* (Patterson and Norris 2016, p. 248). There is currently no disagreement regarding the distinctiveness of the subspecies from other subspecies of least chipmunk, nor from the sympatric gray-footed chipmunk (*Neotamias canipes*). The Peñasco least chipmunk is thus currently recognized as a valid subspecies, *Neotamias minimus atristriatus* (Wilson and Reeder 2005 p. 815). The Service recognizes the following taxonomic nomenclature:

Kingdom: Animalia

Phylum: Chordata

Class: Mammalia

Order: Rodentia

Family: Sciuridae

Genus: Neotamias

Species: *Neotamias minimus*

Subspecies: *Neotamias minimus atristriatus*

### 2.1.3 Genetic Diversity

Based on the geological differences and the physical separation of the Sacramento Mountains and the White Mountains, the ecological habitat differences of these two mountain ranges (see Section 2.3), and some morphological differentiation between Peñasco least chipmunks in the White Mountains and the Sacramento Mountains (e.g., Sullivan 1985, p. 424), we assume that these two populations have been physically separated over time, with little to no genetic interchange. Using allozymes, Sullivan (1985, pp. 431-433) found that Peñasco least chipmunks in the White Mountains showed the lowest levels of within-population genetic variation out of 9 least chipmunk populations in New Mexico, Arizona, and Colorado, with 1 allele per locus, 4.2% polymorphic loci, and an observed heterozygosity of 0. The low genetic diversity results are likely a result of both the very small sample size as well as evolutionary processes associated with low population sizes with low to very low numbers of individuals. We also assume that if the Peñasco least chipmunk still occurs in the Sacramento Mountains, it is likely that the genetic diversity within that population would also be very low. For this SSA Report, we assume that there are two populations of Peñasco least chipmunk (the Sacramento Mountains population and the White Mountains population), that the genetic diversity within each population is very low, and that each population may have significant genetic differentiation from each other.

## 2.2 Morphology

The Peñasco least chipmunk is grayish-brown mixed with cinnamon-buff on the rump and thighs (Sullivan 1993, p. 1). Its head is blackish with white and cinnamon, with a whitish patch behind each ear; the sides of the body are light brown, and underparts are whitish with buff, with feet that are light pink-cinnamon; the tail is blackish or brown with pinkish-cinnamon; and dark stripes on the back and head are blackish to blackish-brown, edged with tawny along the spine, and bordered with white on the face and sides (Sullivan 1993, pp. 1-2). The Peñasco least chipmunk has pale yellowish orange hindfeet, a light beige, yellowish, or orange belly, and dark underfur (Frey 2010, p. 11).

Specimens of the Peñasco least chipmunk from the Sacramento Mountains had a mean body length of 11.4 centimeters (cm) (4.5 inches [in]), a mean tail length of 9.3 cm (3.7 in), a mean ear length of 1.4 cm (0.6 in), and a mean hindfoot length of 3.0 cm (1.2 in) (Frey 2010, p. 7). An identification key for the subspecies is provided in Frey (2010, pp. 17–21).

When compared among populations of least chipmunks in Arizona, New Mexico, and Colorado, specimens of the Peñasco least chipmunk from the Sacramento Mountains had significantly darker pelage on the hindfeet and rump than specimens from other sites, including adjacent Sierra Blanca Peak (Sullivan 1985, p. 424). The color of the belly in chipmunks from Sierra Blanca Peak and the Sacramento Mountains was distinctly yellowish, compared to other specimens that were more white ventrally. The width of dorsal stripes varied among populations, including between the Sacramento Mountains and the White Mountains (Sullivan 1985, pp. 424-425).

The distribution of the gray-footed chipmunk (*Neotamias canipes*) overlaps with the Peñasco least chipmunk. However, there is some partitioning in habitat use between the species and the subspecies, whereby the gray-footed chipmunk is primarily a forest dwelling species and the Peñasco least chipmunk uses open grasslands and forb habitat. There is some overlap in habitat use at the forest-meadow ecotone. As a result, the two similar taxa can be difficult to distinguish from one another in the field (New Mexico Department of Game and Fish (NMDGF) 2016 p. 1; Figure 2.2.1). Differentiating characters include the following: there is no overlap in ear length, hind foot length (including claws), or weight of adults. However, there can be overlap in these characters when measuring multiple age classes. Other differences in morphology of the gray-footed chipmunk include brown dorsal stripes and predominantly gray body coloration with tawny-orange restricted mainly to the sides of the abdomen (Hope and Frey 2000, p. 8). Because of the similarities and overlap in coarse morphological characters between the Peñasco least chipmunk and the gray-footed chipmunk, it is unlikely, and may not be possible that individuals of the subspecies could be correctly and consistently identified based solely on visual assessment at a distance without capturing animals; however, habitat occurrence could have informed the best judgement of expert mammologists in historical reports.

Figure 2.2.1. Comparison of the Peñasco least chipmunk (top) and gray-footed chipmunk (bottom) specimens collected in 2016 from Lookout Mountain, White Mountains, NM. Figure excerpted from Frey and Hays (2017, p. 43), Figure 23.

## 2.3 Habitat and Natural History

Across their broad North American distribution, least chipmunks (*N. minimus*) occur in a wide variety of habitats that include tundra, shrub-steppes, hot arid sagebrush, sand dunes, pinon-juniper woodlands, ponderosa pine and spruce-fir forests, as well as arid valleys and alpine zones (Sullivan and Nagorsen 1998, p. 54; Verts and Carraway 2001, entire). Throughout this wide range of distribution and habitat use, some subspecies or populations are locally specialized, occurring as disjunct populations that have evolved morphological, physiological, or behavioral adaptations to local environments (Sullivan and Nagorsen 1998, pp. 54-55; Frey and Boykin 2007, p. 10). The southernmost extent of *N. minimus* distribution includes the disjunct populations of the Peñasco least chipmunk (*N. m. atristriatus*) in the Sacramento Mountains and White Mountains in New Mexico (Sullivan and Petersen 1988, entire).

Within this distribution of the Peñasco least chipmunk, the habitat occupied by the subspecies varies by population between these two mountain ranges. In the Sacramento Mountains, Peñasco least chipmunk habitat use has been generally described as mature, open ponderosa pine forest savanna and adjacent valley meadows (Frey and Hays 2017, p. 1). Specimens of the Peñasco least chipmunk from the Sacramento Mountains were originally described from the yellow pine zone (= ponderosa pine) (Bailey 1913, p. 130) and within the transition zone from the juncture of yellow pines and junipers up to the edge of spruce-fir forest (Bailey 1931, p. 91). However, the Peñasco least chipmunk has not been detected in the Sacramento Mountains since 1966, such that our understanding of habitat use and distribution in that area is limited to historical records and reports.

In the White Mountains, the Peñasco least chipmunk is associated with the high-elevation subalpine Thurber's fescue meadow biotic community (Frey and Hays 2017, p. 34). This habitat is distinctly different from the lower elevation, montane meadow grassland communities within mixed conifer and ponderosa pine forest zones (Dyer and Moffett 1999, entire; Dick-Peddie 1993, pp. 101-104), as would be found in the Sacramento Mountains. In the White Mountains, our understanding of subspecies occurrence and habitat use is informed by capture information as recent as 2016, but is still limited by few observational records of the subspecies.

The lack of observations since 1966 in the Sacramento Mountains, and a limited number of recent observations in the White Mountains (5 individual chipmunks from 3 locations from 2000 to present; Frey 2018a, pp. 21-22), limits our understanding of the subspecies' natural history and habitat use in each of these mountain areas. When specific information is not available regarding the natural history, biology, or habitat use of the Peñasco least chipmunk, we rely upon information from other subspecies, inferring that some of the natural history, behavioral ecology, and habitat use of the Peñasco least chipmunk is likely similar to other least chipmunk subspecies, especially those that use similar habitats. However, we also recognize that there may be important subspecies-specific or local adaptations of the Peñasco least chipmunk that may be important in understanding their status or planning for their long-term conservation.

Least chipmunks, in general, often occupy non-forested habitats, which can occur above tree line, in open areas that lack shading, and habitats with recent disturbance, such as logged or burned areas (Verts and Carroway 2001, p. 5). These open areas are often composed of shrubs, rocks, dense herbaceous vegetation, or forests with trees that lack low-hanging limbs (Frey and Boykin 2007, p. 10). The Peñasco least chipmunk has been found in two different and distinctive habitat types in New Mexico: 1) the forested ponderosa pine forest zone with open, grassy understory along drainage bottoms in the Sacramento Mountains; and 2) high-elevation open areas that include talus slopes and grass-forbes meadows surrounded by Engelmann spruce (*Picea engelmanni*), quaking aspen (*Populus tremuloides*), corkbark fir (*Abies lasiocarpa*), and Douglas fir (*Pseudotsuga menziesii*), and areas above treeline in the White Mountains (Sullivan 1993; p. 3; Frey and Boykin 2007, pp. 27–28; Frey and Hays 2017, p. X2.

In the Sacramento Mountains, historic mature ponderosa pine forests have been described as lacking lower limbs and providing an open structure with dense grass cover (U.S. Forest Service 2002, pp. Bii–Biii; Frey and Boykin 2007, p. 51). The Sacramento Mountains population appears to have been nearly exclusively associated with large, open mature stands of ponderosa pine forest along drainage bottoms. In contrast, in the White Mountains, the Peñasco least chipmunk has been associated with patches of rock outcrop and talus above treeline within close proximity of Sierra Blanca Peak (Frey and Boykin 2007, p. 28). Frey and Hays (2017, entire) re-examined previous records and used new records from 2016 for the Peñasco least chipmunk to further inform habitat associations. They postulate that there may be a close reliance on the native subalpine Thurber's fescue (*Festuca thurberi*) meadow biotic community for the Peñasco least chipmunk and suggest the subspecies is associated with these high-elevation fescue meadows where rock outcrops or talus are present (Frey and Hays 2017, p. 34).

Least chipmunks select areas to dig burrows for nesting, hibernation or seasonal torpor, and for escape from predators, that are often under large rocks or other objects (Bihr and Smith, 1998, p. 359). They may also use tree cavities or other natural structures (Verts and Carraway 2001, pp. 6–7). Least chipmunks are described as good climbers, but they are more typically seen on the ground compared to other chipmunk species (Reid 2006 p. 212). Least chipmunks in Oregon were reported to select habitats in which vegetation provides cover, and the cover component in the lowest 15 cm above the surface was sparse to allow for rapid escape and concealment from predators (Verts and Carroway 2001 p. 5). For the Peñasco least chipmunk, the rock component of its habitat in the White Mountains likely serves as areas to establish burrows for nest sites and overwintering, as well as for observation points for predator vigilance (Frey and Hays 2017, p. 36). Bunchgrasses and forbs in subalpine meadows likely also serve as important cover from predators during chipmunk foraging (Frey and Hays 2017, p. 34).

Least chipmunks forage mainly on the ground or in shrubs (Hoffmeister 1986, p. 15). They eat a variety of seeds of shrubs, forbs, and some conifers, and other plant parts and fungi as their main food sources; they also feed on animal foods such arthropods, carrion, and bird eggs (Bailey 1931, p. 91; Vaughn 1974, pp. 770–772; Reid 2006, p. 212). The least chipmunk does not develop additional fat deposits in the fall, but relies primarily on brief periods of activity to consume cached food for survival over the winter (Verts and Carraway 2001, p.7), hibernating (in this case, overwintering with periods of both torpor and activity) in special underground chambers (Reid 2006 p. 212). Peñasco least chipmunks in the White Mountains likely forage primarily on the seeds and flowers of forbs, particularly species of Asteraceae (Frey and Hays 2017, p. 34). Bailey (1931, p. 91) observed the subspecies foraging on sunflower (*Helianthus* spp.) seeds along fencelines and on wheat (*Triticum* sp.) and oats (*Avena sativa*) at the edges of agricultural fields in the Sacramento Mountains. The diet also includes flowers and fruits of gooseberry (*Ribes* spp.) and wild strawberry (*Fragaria* spp.), pinyon (*Pinus edulis*) nuts, Gambel oak (*Quercus gambelii*) acorns, insects, and other items (Sullivan 1993, p. 3). Like other least chipmunks, the Peñasco least chipmunk likely has relatively low water requirements, which may allow it to exploit the drier conditions of open subalpine meadows (Frey and Hays 2017, p. 34). Least chipmunk breeding takes place soon after emergence from the hibernation chambers (Reid 2006, p. 212). In spring, females typically produce one litter of 4-5 pups (Skryja 1974, p. 223), but the size of the litter can range from 3-8, with young being born in May or June (Reid 2006, p. 212). For Peñasco least chipmunks, young are thought to be born in mid- to late-summer, as half-grown juveniles were observed historically in early September in the Sacramento Mountains (Bailey 1931, p. 91). The average life span of least chipmunks overall is 0.7 years (Erlien and Tester 1984, p. 2), but individuals have been seen to live up to 6 years (Reid 2006, p. 212).

**2.4 Life Cycle and Resource Needs**

The annual life cycle of the Peñasco least chipmunk is depicted in Figure 2.4.1 and detailed in Table 2.4.1. Most of our understanding of the Peñasco least chipmunk life cycle and resource needs are based on other least chipmunks as described above. An adult Peñasco least chipmunk will forage and cache food throughout its above ground active season, approximately April through September/October. In the fall, the subspecies prepares for winter by collecting food and caching it in special underground burrows, where it will access it during the winter. As noted, the Peñasco least chipmunk does not store adequate fat to last the winter, and goes into and out of torpor. When it comes out of torpor, it remains in its burrow, and will access its cached food, to maintain its slowed winter metabolism while in torpor. It is therefore important that chipmunks store adequate food to last them the winter and that these stores are free from pilfering from other chipmunk and small mammals.

The Peñasco least chipmunk emerges from its winter torpor after snowmelt in the spring; the exact timing is not known. Winter survival rates for the Peñasco least chipmunk are not known; however, in other least chipmunks, it is estimated that fewer than 1/3 of individuals survive the winter (Bergstrom and Hoffmann 1991, p. 11). In the spring, the Peñasco least chipmunk continues to forage, but also searches for a mate. Pairs mate, followed by nesting by the females. Exact timing of reproduction, nesting activities, and when young leave the nest are not known for the Peñasco least chipmunk. Young least chipmunks are considered to be adults at approximately 100 days post-birth (Conley 1970, p. 695); however, the precise age at sexual maturity can vary considerably from year to year (Nagorsen 2004, p. ). The young-of-year then proceed as adults into the annual life cycle. The average life span of least chipmunks is 0.7 years (Erlien and Tester 1984, p. 2) and maximum known life span is 6 years (Reid 2006, p. 212); we do not know the exact life span for the Peñasco least chipmunk, but presume it is similar to other least chipmunks.

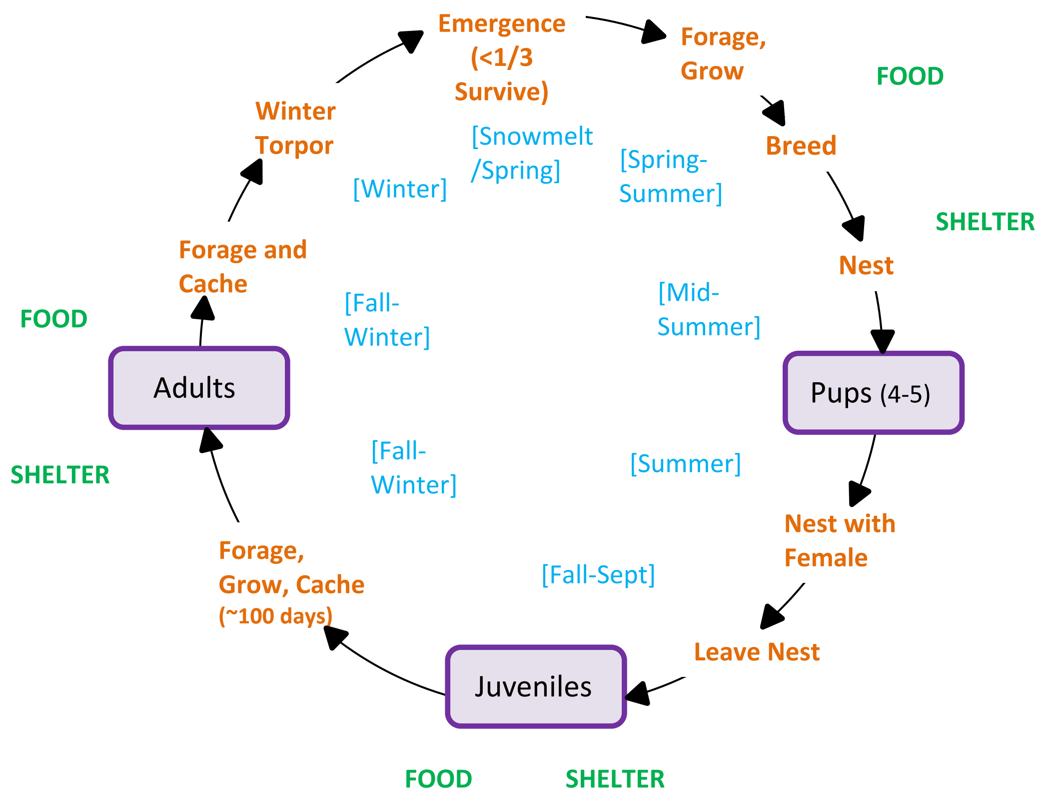



Figure 2.4.1 Key annual life cycle features and resources needed for the Peñasco least chipmunk.

Table 2.4.1. General timeline and necessary resources for the Peñasco least chipmunk life cycle.

| **Life Cycle Activity** | **Life Stage** | **Time of Year** | **Resources Needed** |
|---|---|---|---|
| Foraging and Food Caching | Adult | Summer through start of Winter | Food resources (seeds, berries, nuts, invertebrates); Shelter site protection from predators; Cache sites free of pilfering |
| Winter Torpor | Adult | Winter | Good supply of cached food; Some fat reserves |
| Emergence and Post-winter Plumping | Adult | First Spring | Continued supply of food (cached or new) |
| Breeding | Adult | Late Spring | Non-related mates |
| Nesting | Adult (Females) | Summer | Nesting sites; Some fat reserves |
| Survival and Growth | Pups (4-5 per clutch) | Summer | Mother with adequate health (weight) for reproduction;<br>Nest site protection from elements and predators |
| Foraging, Growth, Survival, Preparing for Winter | Juveniles | Summer, Fall | Food resources (seeds, berries, nuts, invertebrates); Shelter site protection from predators; Cache sites free of pilfering |

# CHAPTER 3 – POPULATION AND SUBSPECIES NEEDS

In this chapter we consider the historical distribution of the Peñasco least chipmunk, its current distribution, and what the subspecies needs for viability. We first review the historical and current information on the range, distribution, ecology, and habitat of the subspecies. We next review the conceptual needs of the subspecies, including population resiliency, representation, and redundancy to support viability and reduce the likelihood of extinction.

## 3.1 Historical and Current Range and Distribution

The historical range of the Peñasco least chipmunk is in the Sacramento and White Mountains, in Lincoln and Otero Counties, New Mexico (Figure 3.1.1). While there are historical locality data points for the Peñasco least chipmunk within the Mescalero Apache Tribal boundaries, the points are not graphically displayed out of courtesy to the Mescalero Apache Tribe and the limited value added the graphical depiction would provide. Specimens, observations, and survey information are summarized in Table 3.1.1. In the Sacramento Mountains, the Peñasco least chipmunk is documented from specimen collections and associated field notes and reports from 1902, when the subspecies was first observed and described from the Sacramento Mountains (Bailey 1913, pp. 129-130), through 1966, when the subspecies was last confirmed in the Sacramento Mountains (Conley 1970, p. 699; Figure 3.1.2). Bailey (1913, pp. 129-130) collected 10 Peñasco least chipmunk specimens in 1902. An additional 56 specimens were collected in the Sacramento Mountains in 1931-1932 by Wharton Huber from the Academy of Natural Sciences in Philadelphia (Frey and Boykin 2007, pp. 13-14). Final collections were made in 1958, when 2 specimens were collected in upper James Canyon, and 1966, when 4 specimens were collected from James Canyon Campground (Frey and Boykin 2007, pp. 15-16). Conley (1970, entire) reports on assessments of specimens of least chipmunks from NM and AZ; and reports that after many hours of trapping and observations over 2 years (1965 and 1966) that efforts were non-productive as compared with similar efforts for another least chipmunk subspecies and for those at Sierra Blanca (Conley 1970, p. 700). Conley (1970, p. 699) further states that specimens assessed were only from James Canyon in the Sacramento Mountains; it is unknown if Conley surveyed or trapped elsewhere in the Sacramento Mountains.

In 1981-1982, surveys were again conducted for Peñasco least chipmunks in the Sacramento Mountains, including efforts in James Canyon (Sullivan et al. Undated, entire; Figure 3.1.2). Sullivan et al. (Undated, p. 23) report that no individuals were captured during their extensive efforts on U.S. Forest Service lands, but that *E. minimus*-like chipmunks (e.g., chipmunks that looked like Peñasco least chipmunks) that appeared to be in good condition were observed off NM Highway 24, in open, roadside ponderosa pine habitat. These observations have not been verified. While these observations would be considered speculative because of the inherent difficulty in identification, and because observations were made from a distance and not by capturing animals, the comments are noteworthy in lending credence to the possibility that the Peñasco least chipmunk may still be extant in the Sacramento Mountains.

There are other unconfirmed reports of the Peñasco least chipmunk in the Sacramento Mountains from 1991-1996 (Ward 2001, p. 234; Frey and Boykin 2007, pp. 16–17). Ward (2001, p. 234) reports 48 possible Peñasco least chipmunks were captured; however, Frey and Boykin (2007, pp. 16-17) note the potential problems associated with the putative Peñasco least chipmunk identifications of Ward (2001, entire). Potential concerns include that the subspecies is very difficult to distinguish from the gray-footed chipmunk, used only morphological characters while in-hand (as taught by R. M. Sullivan) (Ward pers. comm., 2018), and no voucher specimens were collected. Frey and Boykin (2007, pp. 16-17) report that they communicated with Ward to attempt to elucidate whether the chipmunks in Ward (2001, p. 234) were Peñasco least chipmunk or gray-footed chipmunks (Frey and Boykin 2007, pp. 16–17). Using post-hoc data analysis and information provided by Ward, Frey and Boykin (2007, p. 17) assessed capture data for 43 individuals and concluded that 16 were likely gray-footed chipmunks, 15 records did not have enough information to inform a likely identification, and 12 records from 8 locations could not be dismissed as possible Peñasco least chipmunk. Of these records, the largest concentration of possible Peñasco least chipmunk (N=3) from Ward's data was located on James Ridge (Frey and Boykin 2007, p. 17). Finally, Ward (pers. comm. 2018) concedes that because the 2001 study sites were primarily located in forested habitat, which is closely aligned with the preferred habitat use of gray-footed chipmunks, rather than Peñasco least chipmunks, many of the reported Peñasco least chipmunks in the 2001 study may have been young gray-footed chipmunks; however, without a mechanism to verify, the identification of the chipmunks captured in Ward's 2001 study remains unknown.

Surveys were again conducted for Peñasco least chipmunks in the Sacramento Mountains in 2000, 2005-2006, 2007, and 2016 (Figure 3.1.2). With more than 35,000 trap-days, including multiple surveys conducted in James Canyon and at James Ridge, no Peñasco least chipmunks were captured (Frey and Boykin 2007, pp. 17-18; Frey and Hays 2017, pp. 21-29; Frey 2018a, p. 17). Because extensive trapping conducted in the James Canyon area over time has yielded no Peñasco least chipmunk observations, it is likely that this area (the James Canyon area) is no longer occupied by the Peñasco least chipmunk.

Due to lack of confirmed detection since 1966, despite trapping efforts in the 1980s, 2000s, and 2016, combined with currently degraded habitat conditions (see Section 3.2), some have stated that the subspecies may be extirpated in the Sacramento Mountains (Sullivan et al. Undated, p. 21; Hope and Frey 2000, p. 10; Frey and Boykin 2007, pp. 12–18; Frey et al. 2009, p. 5; New Mexico Department of Game and Fish 2016, p.4). However, because there is some anecdotal evidence (Sullivan et al. Undated, p. 23) and unconfirmed reports (Ward 2001, p. 234; Frey and Boykin 2007, p. 17) of the Peñasco least chipmunk in the Sacramento Mountains, it is possible the subspecies still occurs in the Sacramento Mountains in areas that remain un-surveyed or under-surveyed. There is currently not enough evidence to conclude that the subspecies has been extirpated from the Sacramento Mountains, and additional surveys are needed. Therefore, at this time, we conclude that while the subspecies may be extirpated from the Sacramento Mountains, we consider it potentially occupied, most likely as a small isolated remnant population, persisting undetected at extremely low numbers.

In the White Mountains, the Peñasco least chipmunk was first detected in 1931 by Wharton Huber from the Academy of Natural Sciences in Philadelphia, when 29 specimens were collected (Frey and Boykin, 2007; Figure 3.1.3). Conley collected 26 specimens from the White Mountains in 1965, and Sullivan collected 2 specimens in 1982 (Frey 2018a, p. 20). Hope and Frey (2007, p. 7) collected 2 Peñasco least chipmunk specimens from Buck Mountain in the White Mountains in 2000. However, subsequent surveys on Buck Mountain in 2007 and 2015 resulted in no captures of the subspecies (Figure 3.1.3). It is unknown if the Buck Mountain area is no longer occupied by the Peñasco least chipmunk or if the subspecies occurs there at such low numbers or low density that it escapes detection.

In 2016, Frey and Hays (2017, entire) conducted surveys for Peñasco least chipmunks at 4 sites on Lookout Mountain in the White Mountains (Figure 3.1.3). These surveys, over the course of 880 trap-days, resulted in the capture of 3 adult female Peñasco least chipmunks. All were captured in subalpine meadow containing sparse rock (Frey and Hays 2017, pp. 9-20; Frey 2018a, p. 22). The 2016 captures occurred just north of the Mescalero Apache tribal boundary, but in the same connected large meadow habitat of historical records of the Peñasco least chipmunk at Sierra Blanca Peak. The 2016 observations were important in that they documented that the subspecies was still extant at that time.

It is unknown whether the White Mountains distribution of the Peñasco least chipmunk has changed over time. Habitat conditions have likely not significantly changed in this area since the early 1900s (see Section 3.2), but may have undergone some loss due to tree encroachment into meadows. For this reason, we assume the current distribution of the Peñasco least chipmunk in the White Mountains is similar to its historical distribution. While we assume that the distribution of the Peñasco least chipmunk is similar now as it was historically, we do not assume that it occurs now with the same relative density or abundance as it did historically (see Section 3.3).

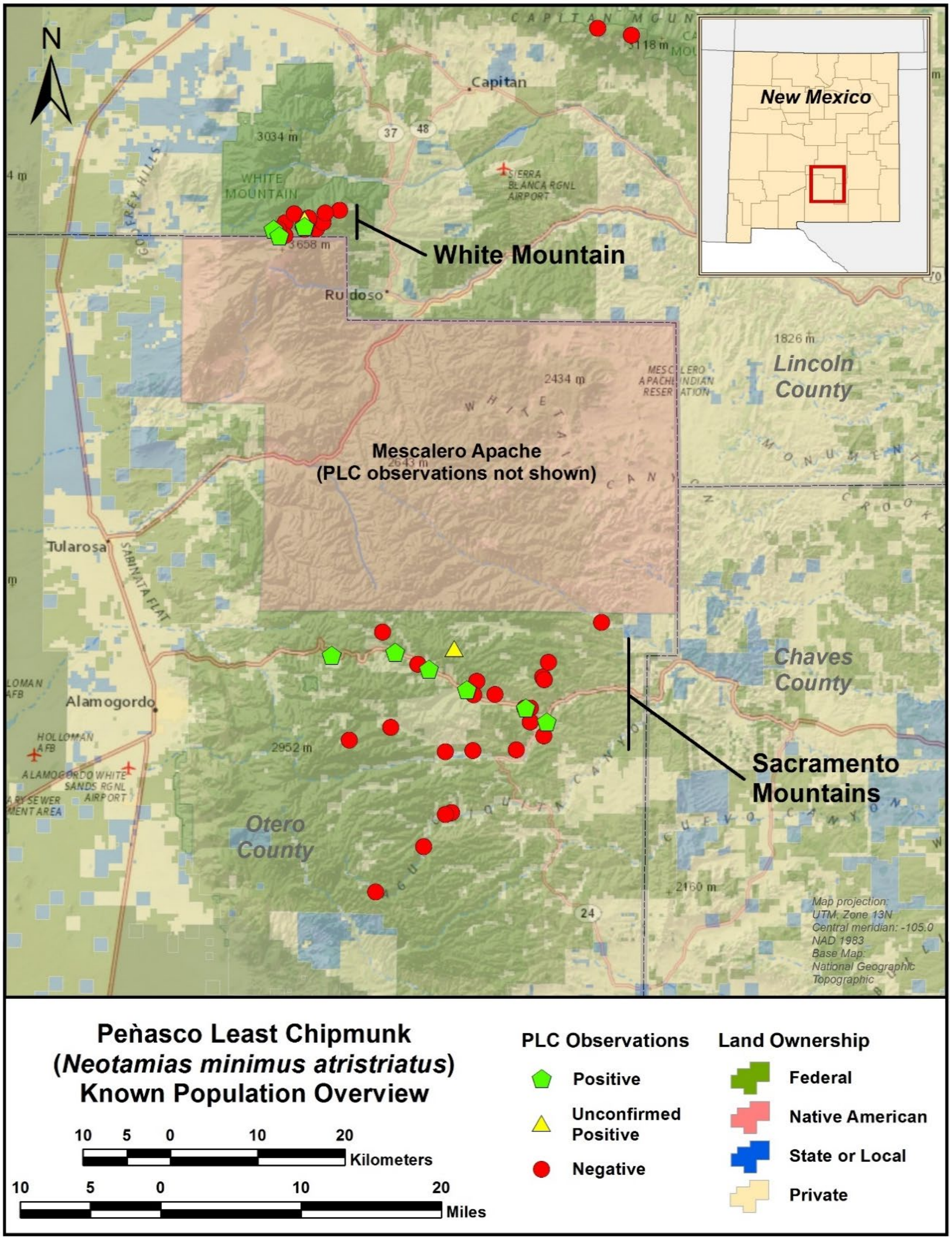



Figure 3.1.1. Sacramento and White mountain ranges, in Lincoln and Otero Counties, New Mexico, containing Peñasco least chipmunk collection locations and known survey locations from 1931 to 2016. Green pentagons indicate positive collection locations, yellow triangles indicate unconfirmed possible positive locations, and red dots show trapping locations for which we no Peñasco least chipmunks were captured. Observation localities on Apache Mescalero Tribal lands are not shown.

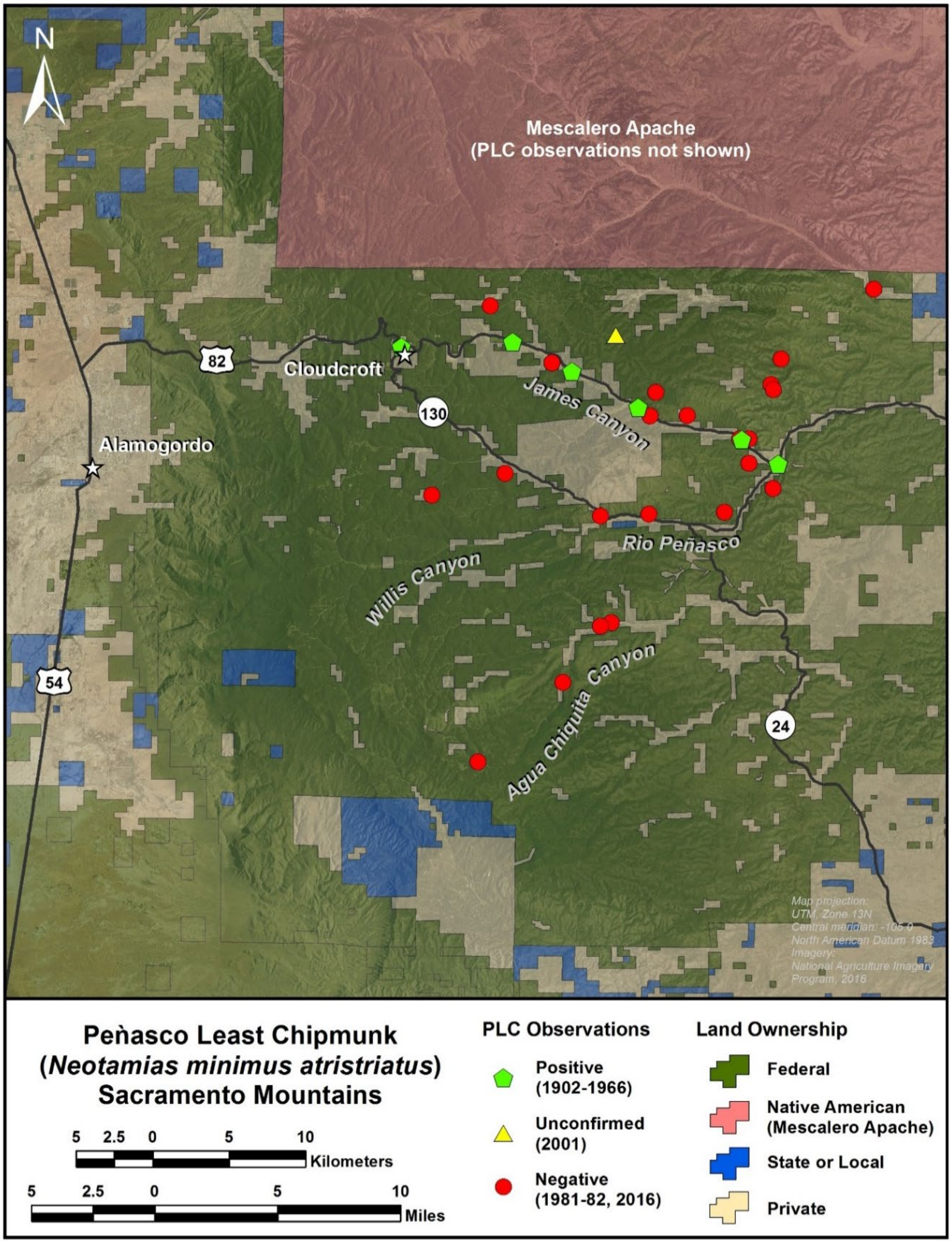



Figure 3.1.2. Peñasco least chipmunk collection locations and known survey locations in the Sacramento Mountains. Green pentagons indicate positive collection locations, yellow triangles indicate unconfirmed possible positive locations, and red dots show trapping locations for which no Peñasco least chipmunks were captured. Observation localities on Apache Mescalero Tribal lands are not shown.

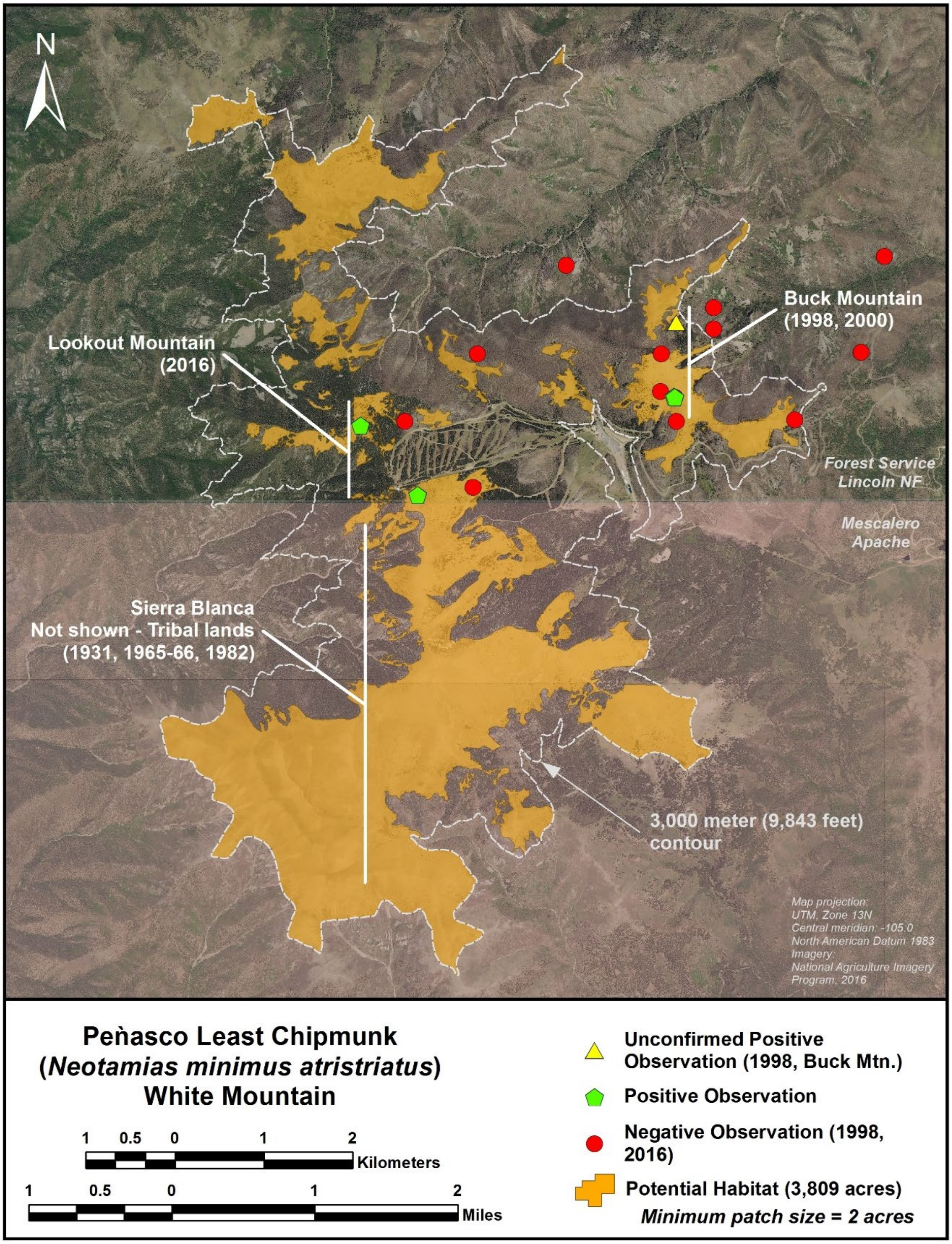



Figure 3.1.3. Peñasco least chipmunk collection locations and known survey locations in the White Mountains from 1931 to 2016. Green pentagons indicate positive collection locations, yellow triangles indicate unconfirmed positive locations, and red dots show trapping locations for which no Peñasco least chipmunks were captured. Observation localities on Apache Mescalero Tribal lands are not shown.

Table 3.1.1. Summary of all known Peñasco least chipmunk specimens, observations, and reported surveys. Specimen data are as reported in Frey and Boykin (2007, pp 12-25; 60-67) and summarized in Frey 2018a (entire). 2018 data are from preliminary data reported in Frey and McKibben 2018 (entire) where the range of individuals are reported because animals are marked; recaptured individuals are not reported here, and some individuals escaped prior to identifying if it was previously captured.

| | **Area Surveyed** | **Year** | **Number of Peñasco Least Chipmunks Collected** | **Reported Comments Regarding Numbers of Peñasco Least Chipmunks** | **Lead Observer/ Author** |
|---|---|---|---|---|---|
| **Sacramento Mountains** | | | | | |
| | Upper Peñasco; Peñasco Creek | 1902 | 2 | Abundant; hundreds seen, often 3 or 4 at a time | Bailey |
| | Cloudcroft t (12 mi E; 6 mi E) (likely=James Canyon) | 1902 | 8 | Abundant; hundreds seen, often 3 or 4 at a time | Bailey |
| | Cloudcroft | 1928 | 1 | Brown collected series of 12 chipmunks from vicinity of Cloudcroft; 1 post-hoc identified as Peñasco least chipmunk | Brown (reviewed by Frey) |
| | Along Tularosa Canyon | 1931 | 19 | Collection Series | Huber |
| | Elk Canyon | 1931 | 2 | Collection Series | Huber |
| | Fence Canyon | 1932 | 1 | Collection Series | Huber |
| | Tularosa Canyon | 1932 | 17 | Collection Series | Huber |
| | Sacramento Mountains | 1932 | 3 | Collection Series | Huber |
| | Elk Canyon | 1932 | 14 | Collection Series | Huber |
| | Cox Canyon | 1957 | 0 | N/A | Fleharty |
| | James Canyon | 1958 | 2 | N/A | Fleharty |
| | James Canyon | 1965-1966 | 4 | Many hours of trapping and observation of 2 years were non-productive; | Conley |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Densities greatly depressed | |
| | 18 locations in Sacramento Mts. | 1981-1982 | 0 | May be extirpated; may still occur in unsurveyed areas | Sullivan |
| | Ward MSO study locations (many) + James Ridge | 1991-1996 | 0 | 48 Reported; data for 43 assessed by Frey: 16 determined not Peñasco least chipmunk; 15 no data; 12 possible with 3 with greatest potential at James Ridge | Ward (data assessed post hoc by Frey) |
| | James Canyon + Sacramento Mts | 2000 | 0 | 0 | Hope and Frey |
| | Pumphouse and Cox Canyons | 2005-2006 | 0 | 0 | Wampler |
| | James Ridge, James Canyon | 2007 | 0 | 0 | Frey and Boykin |
| | James Canyon | 2016 | 0 | 0 | Frey and Hays |
| **White Mountains** | | | | | |
| | Sierra Blanca; Rock Spring | 1931 | 29 | Collection Series | Huber |
| | Sierra Blanca; E. Face, N Ridge | 1965 | 15 | Collection Series | Conley |
| | Sierra Blanca Peak, N Top, N Rise, & E Face | 1966 | 11 | Collection Series | Conley |
| | Sierra Blanca; glacial cirque | 1982 | 2 | | Sullivan |
| | Buck Mountain | 1998 | 1 | 1 captured (Unverified) | Ortiz |

| | | | | | |
|---|---|---|---|---|---|
| | Buck Mountain | 2000 | 1 | 2 captured | Hope and Frey |
| | Buck Mountain | 2007 | 0 | 0 | Frey and Boykin |
| | Lookout Mountain | 2016 | Not reported | 3 captured | Frey and Hays |
| | Ice Springs | 2018 | 6 | 11 camera trap detections too | Frey and McKibben |
| | Lookout Mountain | 2018 | 10 | 8 camera trap detections too | Frey and McKibben |
| | Prospect Ridge | 2018 | 0 | N/A | Frey and McKibben |
| | Crest Trail | 2018 | 0 | N/A | Frey and McKibben |
| | Buck Mountain | 2018 | 0 | N/A | Frey and McKibben |

### 3.2 Historical Habitat Availability and Potential Current Habitat Availability

The Peñasco least chipmunk occupies, and formerly occupied, two distinct habitat types within its overall range as described in Sections 2.1 and 2.3. Here we describe historical habitat and how it relates to current potential habitat for each population of the Peñasco least chipmunk. This discussion pertains only to lands outside of the boundaries of Mescalero Apache tribal lands, as we do not currently have information regarding the state of potential habitat within those boundaries, and there are no recent records for the Peñasco least chipmunk from within those boundaries. However, because we have no other information, we have made the assumption that for each population, current habitat conditions are similar throughout each habitat type for each population across land ownership or management boundaries.

Information regarding the details of habitats used by the Peñasco least chipmunk is limited for both populations, due to limited observations of the subspecies. Information on habitat use in the Sacramento Mountains is particularly limited because the subspecies has not been definitively detected there since 1966, and because the Sacramento Mountains have experienced a much greater intensity of land use and habitat change over the past 75 years than the White Mountains.

Analysis of historical and potential habitat is limited; however, Frey and Boykin (2007, entire) conducted an extensive and thorough review and analysis of all historical records and field notes, and interpreted and described Peñasco least chipmunk historical and potential habitat for both populations. Frey and Hays (2017, entire) and Frey (2018, entire) continue to refine previous assessments. Furthermore, the U.S. Forest Service has conducted various assessments of ecological conditions pertaining to potential Peñasco least chipmunk habitat. We use these studies to inform likely historical and potential current habitat conditions and availability.

### 3.2.1 Sacramento Mountains

The Sacramento Mountains formed via a subsidence of the Tularosa Basin and rising of adjacent blocks. The highest elevation within the range is Sacramento Peak at 2,818 m (9,245 ft). The most extensive habitat type in the Sacramento Mountains is mixed conifer forest, which occurs at elevations greater than 2,195 m (7,200 ft). Lower-elevation forest is ponderosa pine, occurring below mixed conifer forest (Frey and Hays 2017, p. 6).

Unlike much of New Mexico, the Sacramento Mountains were not occupied by humans intensively until the late 1800s (Kaufmann et al. 1998, p. 68). Therefore, settlers and explorers from the 1880s to about 1900 found the ponderosa pine forests open-canopied and park-like, very close to a natural state, as it had likely existed for centuries (U.S. Forest Service 2002, pp. 1.17–1.18). However, after 1900, human settlement and associated logging, grazing, and development quickly altered forests over much of the mountain range (Kaufmann et al. 1998, p. 68; U.S. Forest Service 2002, p. 1.18). Grazing, fire suppression, and timber harvest in the Sacramento Mountains changed forest stand structure and stand composition; meadow grassland composition, size, and connectivity; and natural fire regimes, resulting in a landscape that is now dominated by densely-stocked, small-diameter coniferous trees that have a high potential for insect infestations or stand-replacing fires (U.S. Forest Service 2002, pp. 1.18, 3.22, Bii–Bv). In the Sacramento Mountains, the once widespread and abundant meadow grassland habitats are now in a similar state as other montane grasslands of the southwest, which is degraded and fragmented, composed of non-native grass species, and shrinking in size (Finch 2004, pp. 122-123).

The significant use and management of ponderosa pine forests in the Sacramento Mountains over the last century, including logging, livestock grazing, and fire suppression, has altered vegetation type and structure, such that outside of small, remote, and isolated areas, there remains little to no ponderosa pine forest that resembles the nature of historical mature ponderosa pine forests. Alexander et al. (1984, p. 14) reported that logging removed all mature ponderosa pine trees in the mountain range. Much of the ponderosa pine forests in James

Canyon and other large areas in the Sacramento Mountains were heavily logged between 1900 and 1940, profoundly affecting the Sacramento Mountains (Glover 1984, p. 1; Kaufmann et al. 1998, p. 48). Livestock grazing and fire suppression over the last century have also contributed to changing the ponderosa pine forests of the Sacramento Mountains through the elimination of fine fuels (i.e., grass understory) that formerly carried frequent, low-intensity fire. Fire suppression coupled with the removal of fine fuels allowed ponderosa pine seedlings, that would normally be naturally reduced through fire, to subsequently grow. Fire suppression also allowed less fire-tolerant species of trees to establish, such as Douglas fir and white fir. This land use and management over the past century has resulted in a current ponderosa pine forest that is significantly departed from natural and historical conditions (U.S. Forest Service 2002, entire).

Currently, the ponderosa pine forests of the Sacramento Mountains consist of high-density small-diameter ponderosa pine, with encroaching Douglas fir and white fir. These changes in both vegetation composition (Douglas fir and white fir) and structure (high-density, small-diameter trees with many low branches) not only alter the suitability of the habitat for Peñasco least chipmunk, but also have altered the natural fire regime from frequent low-severity fire to the occurrence of large-scale, high-intensity wildfire. The same factors that have allowed forest vegetation shifts to take place have also allowed trees to encroach into montane meadow habitat over time, thus reducing the size and connectivity of meadows. The U.S. Forest Service (Frost et al. 2007, p. 1) reports that many of the meadows in the Sacramento Mountains have been significantly reduced or eliminated due to tree and woody species encroachment.

The U.S. Forest Service (Finch 2004, entire) provides a complete assessment of grassland ecosystem conditions in the southwestern United States, and assesses historical and current conditions in southwestern grasslands. The authors of this report state that pre-Euro-American settlement grasslands are difficult to describe accurately, and the current challenge of identifying what an ecologically sustainable southwestern grassland community consists of, in terms of plant diversity, composition, size, and fire regimes, is extremely difficult due to the complexity of these systems (Finch 2004, p. 121). However, the U.S. Forest Service concludes that in pre-Euro-American settlement times, most montane grasslands would have been less fragmented with a greater degree of connectivity, and their total acreage would have been greater (Finch 2004, p. 122). Almost all of these grasslands, either large or small, have either yielded acreage to forest or disappeared altogether (Finch 2004, p. 122).

This assessment (Finch 2004, pp. 122-123) indicates that some ponderosa pine forests of the southwest were historically described as “pure park-like stands made up of 2 to 20 trees, usually connected by scattering individuals. Openings are frequent, and vary greatly in size. Within the type are open parks of large extent…” The report authors describe how historical montane meadows had a mixture of grass species that had a natural ebb and flow in composition that was in step with periodic variations in seasonal precipitation. The report continues to describe the decrease in some types of native grasses in ponderosa pine forest ecosystems, as well as the replacement of most wet meadow plant diversity with Kentucky bluegrass (*Poa pratensis*). Wet meadows were typical for all but the narrowest and steepest drainages in Southwestern forested communities (Finch 2004, pp. 122-123). This native meadow replacement and conversion was made possible by heavy livestock use (Finch 2004, pp. 122-123).

A study conducted in the late 1990s provides information on plant communities in the Sacramento Mountains that may have contained suitable habitat for the Peñasco least chipmunk. In his study assessing Mexican spotted owl (*Strix occidentalis*) prey in the Sacramento Mountains, Ward (2001, pp. 18-19) lists the common plants (trees, shrubs, and herbs) of the four major vegetation communities used by the Mexican spotted owl. The two communities reported by Ward (2001, pp. 18-19) that would also be considered potential Peñasco least chipmunk habitat in the Sacramento Mountains are the Lower Montane Conifer Forest and Montane Grassland. The Lower Montane Conifer Forest is described as occurring between 2,070 m (6,617 ft) and 2,590 m (8,497 ft) elevation and is dominated by ponderosa pine, with fewer and less diverse shrubs and more abundant grasses than in the Upper Montane Conifer Forests, which is a mixed conifer forest type (Ward 2001, p. 7). Montane Grassland vegetation communities were found in valley bottoms above 2,130 m (6,988 ft) and could grade into wet meadows (Ward 2001, pp. 7-8). Plant species identified by Ward (2001, pp. 18-19) are listed in Table 3.2.1. Kentucky bluegrass and other non-native grasses were documented by Ward (2001, pp. 18-19) and fit the general description of grassland conversions described by the U.S. Forest Service in southwestern Montane grasslands (Finch 2004, pp. 121-123).

Table 3.2.1. Plants identified by Ward (2001, pp. 18-19) in areas of potential Peñasco least chipmunk habitat in Lower Montane Conifer Forest and Montane Grassland vegetation communities in the Sacramento Mountains during a study assessing small mammal prey for the Mexican Spotted Owl. Asterisks denote non-native species.

| | **Trees** | **Shrubs** | **Herbs** |
|---|---|---|---|
| **Lower Montane Conifer Forest** | | | |
| | Ponderosa Pine (*Pinus ponderosa*) | True Mountain Mahogany (*Cercocarpus montanus*) | Hairy Goldenaster (*Heterotheca villosa*) |
| | Two Needle Pinyon (*P. edulis*) | Skunkbush Sumac (*Rhus trilobata*) | Blue Grama (*Bouteloua gracilis*) |
| | Gambel Oak (*Quercus gambelii*) | Small Soapweed (*Yucca glauca*) | Little Bluestem (*Shizachyrium scoparium*) |
| | Alligator Juniper (*Juniperus deppeana*) | Fendler Ceanothus (*Ceanothus fendleri*) | Mountain Muhly (*Muhlenbergiea montana*) |
| | | | Lousiana Sagewort (*Artemisia ludoviciana*) |
| **Montane Grassland** | | | |
| | | | Creeping Bentgrass (*Agrostis stolonifera*)* |
| | | | Fringed Brome (*Bromus ciliates*)* |
| | | | Kentucky Bluegrass (*Poa pratensis*)* |
| | | | Orchardgrass (*Dachtylis glomerata*)* |
| | | | Western Yarrow (*Achillea millefolium var. lanulosa*) |
| | | | Yellow Thistle (*Cirsium pallidum*) |
| | | | Virginia Strawberry (*Fragaria virginiana*) |

In addition to changes in grass species composition of meadow habitat in the Sacramento Mountains, meadow habitat has also decreased in size due to the encroachment of trees from the forest edge in all areas of the Sacramento Mountains (Frost et al. 2007, p. 17). The U.S. Forest Service (Frost et al. 2007, p. 17) states that the pre-settlement period small openings of 1-20 acres that existed in the Sacramento Mountains are often not identifiable today—they have been significantly reduced or completely eliminated—and that the larger parks and glades greater than 100 acres are decreasing in size due to encroachment.

Peñasco least chipmunk habitat in the Sacramento Mountains has experienced significant change from historical and natural conditions, that has resulted in an overall paucity of what is considered to be suitable Peñasco least chipmunk habitat. Historical reports on the Peñasco least chipmunk indicate that the subspecies was associated with mature ponderosa pine forest, from the lower ecotone with piñon-juniper woodland to the upper ecotone with mixed conifer, from approximately 2,103 m to 2,438 m (6,900 to 8,000 ft) in elevation (Frey 2018a, p. 15). Reports on Peñasco least chipmunk from the early 1900s mentioned exceptionally high densities of the subspecies on rail fences adjacent to agricultural fields and in open ponderosa pine forests (Bailey 1913, pp. 129-130; Bailey 1931, p. 91). It is presumed that the chipmunks associated with the agricultural fields were taking advantage of both the open nature of agricultural fields, as well as the abundant food source, but that the natural habitat of the Peñasco least chipmunk consisted of the open, uncut park-like ponderosa pine forests consisting of an herbaceous understory and interspersed with montane meadows of diverse native grass and forb species that provided abundant, connected habitat and an ample food supply. The ponderosa pine forests consisted of large-diameter ponderosa pine trees, with variable patches of small diameter trees or open grass and forb areas, all of which experienced a high-frequency of low-severity fires that naturally maintained ecosystem function. The general lack of low limbs and high grass content in these stands likely provided ideal habitat for the Peñasco least chipmunk.

In summary, there is currently an overall lack of suitable Peñasco least chipmunk habitat in the Sacramento Mountains. This conclusion aligns with analyses and conclusions of Frey and Hays (2017, pp. 21, 38-39).

### 3.2.2 White Mountains

Unlike the Sacramento Mountains, the White Mountains are volcanic in origin, and they contain the highest elevations in southern New Mexico. Sierra Blanca is the highest peak at 3,649 m (11,973 ft). Sierra Blanca was the southernmost mountain in the United States to hold a glacier during the Wisconsin glacial period, and this glacier carved a cirque on the northeastern face of the mountain. The White Mountains also contain the southernmost subalpine biotic communities in the United States, including spruce-fir forest and meadow/grassland. Subalpine Thurber's fescue (*Festuca thurberi*) meadow/grassland community occurs within openings in high-elevation spruce-fir forest and above tree line in the glacial cirque. These Thurber's fescue grasslands contain tall bunchgrasses, including Thurber's fescue, sedges, flowering forbs, and shrubs (Frey and Hays 2017, pp. 2-3). The Thurber's fescue meadows are distinct from the lower-elevation montane meadows and are considered to be climax subalpine communities (Frey and Hays 2017, pp. 2-3).

All observations and habitat descriptions for the Peñasco least chipmunk in the White Mountains from 1998 to present have been described as open, rocky areas, with more recent reports describing the interspersed subalpine Thurber's fescue meadow component of habitat. All observations have occurred between 3,109 and 3,597 m (10,200 and 11,800 ft) in elevation (Frey 2018a, p. 20). The Peñasco least chipmunk has been recorded from one broad area in the White Mountains, with three general locality descriptions used: Sierra Blanca Peak, Lookout Mountain, and Buck Mountain. However, there are no physical or biological demarcations that separate or would otherwise delimit these localized areas (Figures 3.1.3 and 3.2.1). While it is useful to use the three localized area names for discussion purposes, we consider the White Mountains to support a single Peñasco least chipmunk population.

Peñasco least chipmunk habitat in the White Mountains includes talus slopes and Thurber's fescue meadow communities surrounded by Engelmann spruce, quaking aspen, corkbark fir, and Douglas fir, as well as areas above treeline (Sullivan 1993; p. 3; Frey and Boykin 2007, pp. 27–28; Frey and Hays 2017, p. 9). The fescue meadow communities are diverse and include other bunchgrass species, sedges, flowering forbs, and shrubs such as orange gooseberry (*Ribes pinetorum*) and mountain snowberry (*Symphoricarpos oreophilus*). Thurber's fescue meadow is a subalpine climax community, differing from lower elevation, montane meadow grasslands within mixed conifer and ponderosa pine forest (Frey and Hays 2017, pp. 2-3). Intact Thurber's fescue montane meadows in the southwest are often in excess of a meter in height (Finch 2004, p. 122). The subalpine Thurber's fescue meadow habitat in this area of the White Mountains is apparently unaltered from that found historically (Frey and Boykin 2007, p. 40), but may be reduced in size as a result of tree encroachment into the meadows (Figure 3.2.1).

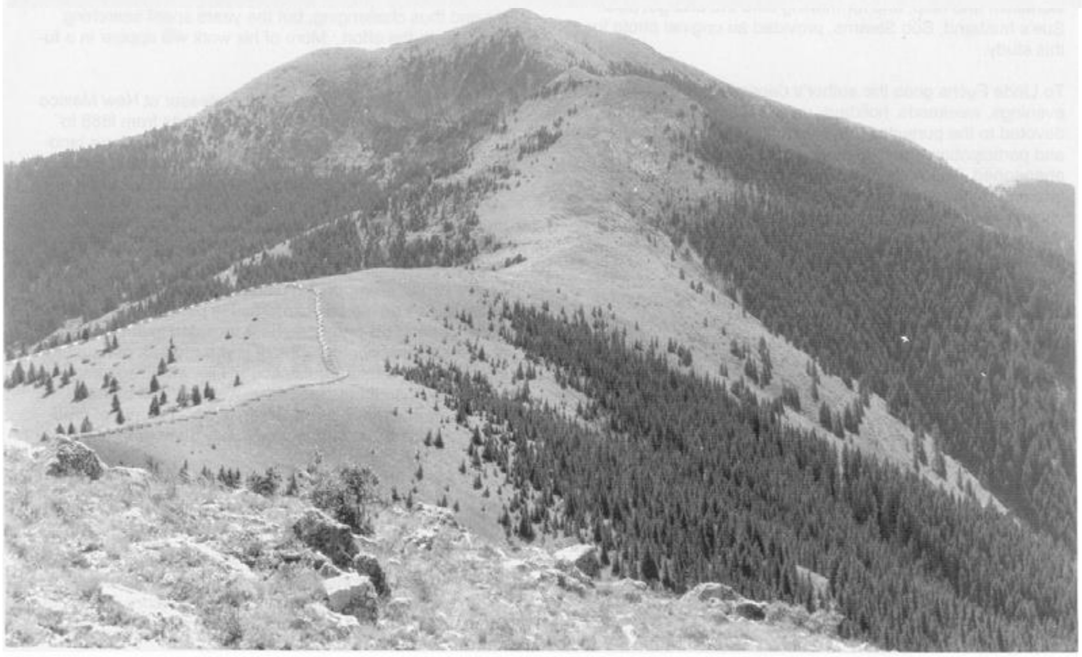
There are two exceptions to the general statement that the habitat appears to be relatively unaltered in the White Mountains; these include the development of the Ski Apache Resort and encroachment of trees into meadows. The Ski Apache Resort, associated infrastructure, and associated impacted areas total approximately 450 acres (see Section 4.1.2 below). It is not known if the Peñasco least chipmunk uses the open areas between the ski runs of Ski Apache Resort. Tree encroachment has also been documented in the White Mountains (Figure 3.2.1 (Frey and Hays 2017, p. 40; Dyer and Moffett 1999, entire) and has likely been mediated by climate change (Dyer and Moffett 1999, p. 444-445) and positive feedback, where the presence of encroaching trees allows additional tree establishment nearby (Halpern et al. 2012, p. 425). Tree encroachment in the White Mountains was documented from 1936-1994 (Dyer and Moffett 1999, p. 445). Encroachment into montane meadows is an ongoing factor that incrementally reduces meadow habitat in the White Mountains, but we are not aware of any assessment that estimates the amount or rate of encroachment.

Using all available capture data, we modeled current potential Peñasco least chipmunk habitat in the White Mountains (Figure 3.2.2). This model is a coarse estimate of potential habitat. We do not have information on habitat conditions on Mescalero Apache Tribal land. However, because land ownership does not change our assumption that Thurber's fescue meadow vegetation communities in the White Mountains appear relatively unaltered, and 2 of the 3 observations in 2016 were in the same Sierra Blanca meadow as historical records, we modeled potential habitat throughout the White Mountains, regardless of ownership.

To develop the model, we used 13 Peñasco least chipmunk locality records (based on capture data) and U.S. Forest Service vegetation raster data maps to identify predominant vegetation classifications for these records. The positive locality records (with the number of data points in parentheses) fell into the following vegetation classifications: Grassland Forbes Meadows (N= 7); Gamble Oak (N=4); and Shade Intolerant (N=2). The potential habitat model was then bounded with a lower elevation of 3,000 m (9,843 ft), which is approximately the lowest elevation of the White Mountains records (3,051 m (10,010 ft). The resulting vegetation polygons were then overlaid with 2016 National Agriculture Imagery Program (NAIP), and the boundaries were corrected based on meadow and forest edge boundaries, to capture open meadows within the elevational limits.

Editing of the resulting polygons was based on photo interpretation of the NAIP imagery, habitat descriptions, and vegetation classification. The refinement of the potential habitat polygons resulted in the elimination of the Shade Intolerant classification from the model (the 2 data points were on the edge of the Meadow classification, and that category as a potential habitat type was the result of the coarser data). We also eliminated any significantly disturbed or developed areas (ski runs, parking areas, etc.). Finally, we removed very small, isolated patches less than 2 acres in size that occurred at a distance of approximately more than 200 m from another open, potential habitat patch. This modeling effort resulted in a coarse estimate of approximately 3,809 acres of potential Peñasco least chipmunk habitat in the White Mountains (Figure 3.2.2).


**45A**. Date: **1914**. Credit: Rio Grande Historical Collections.
Taken from Lookout Mountain, the highest point in Lincoln County, facing south, with White Mountain or Sierra Blanca (12,000 feet) in the background, on Mescalero Apache lands in Otero County. Trees appear to be covered with frost.



**45B**. Date: July, **1998**. Credit: E. Hollis Fuchs, location found with help from Rick Hall and Roy Parker of Ski Apache.
Compared to 1914, less area is covered with grass, while more area is covered by Mixed Conifers. Elevation of the photo point is about 11,600 feet.

Figure 3.2.1. Frey and Hays (2017, p. 40) "Figure 22 View from Lookout Mountain facing south to Sierra Blanca in 1914 (top) and 1998 (bottom) (Photos taken from UHWC 2004). Note expansion of coniferous forest and loss of herbaceous communities above tree line…"

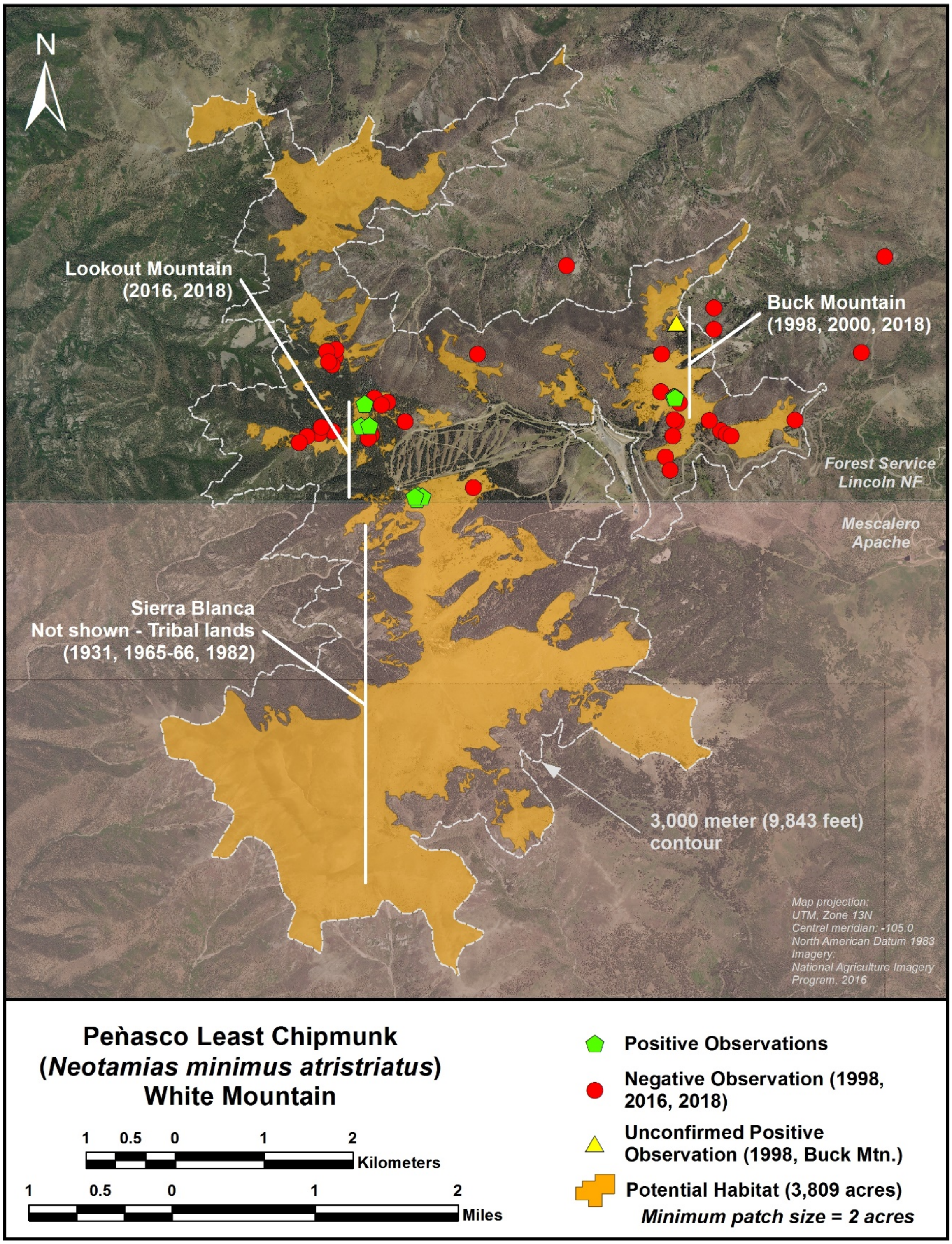



Figure 3.2.2. Map of modeled potential Peñasco least chipmunk habitat in the White Mountains, New Mexico. Predicted potential Peñasco least chipmunk habitat represents potential habitat from 3,000 m (9,843 feet) elevation and higher.

# CHAPTER 4 – STRESSORS ON VIABILITY

In this chapter, we evaluate the past, current, and future stressors and stressor sources that affect Peñasco least chipmunk needs for long-term viability. Current and potential future stressors, along with current and future expected distribution and abundance, determine viability and, therefore, vulnerability to extinction. Below we discuss: 1) known stressor sources; 2) potential stressor sources that would have important impacts on chipmunk viability; and 3) potential stressor sources that were not carried forward into our analysis because of lack of evidence or because the stressor source is predicted to have low impact on Peñasco least chipmunk viability.

## 4.1 Stressor Sources Considered and Included in Long-term Viability Analysis

### 4.1.1 Vegetation Shifts, Wildfire, and Forest Encroachment

Section 3.2.1 describes the habitat needs for the Peñasco least chipmunk and forest changes in the ponderosa pine forests of the Sacramento Mountains, occurring outside of Mescalero Apache Tribal boundaries. Over the last ~150 years, historical land management practices have shifted the vegetative components of Peñasco least chipmunk habitat in the Sacramento Mountains, resulting in an overall lack of suitable habitat for the subspecies. The historically open, park-like stands of ponderosa pine forest that comprised Peñasco least chipmunk habitat have been replaced with high-density, small-diameter ponderosa pine, with encroaching Douglas fir and white fir, and a lack of native grass meadow habitat.

These forest changes in vegetation composition (inclusion of less fire tolerant species of trees such as Douglas fir and white fir) and structure (from low density, large diameter trees, with few low branches to high-density, small diameter trees, and many low branches), coupled with the loss and conversion of native to non-native grass meadows, alter the suitability of the habitat for the Peñasco least chipmunk in the Sacramento Mountains. Effective fire exclusion and suppression actions by land managers have also contributed to the changes in forest composition and structure and have resulted in the additional stressor source of altered fire regimes.

Since the late 1800s, the exclusion and suppression of high-frequency, low-intensity fires in the Sacramento Mountains has altered natural fire behavior (Allen 2013, p. 1; Alexander et al. 1984, pp. 14–15). Historically, natural low-intensity ground fires occurred every 4 to 5 years and shaped and perpetuated the vegetative communities of the mountain range (U.S. Forest Service 2002, pp. 1.18, 3.17). The loss of herbaceous vegetation in the understory of ponderosa pine forests resulted in a lack of fine fuels to carry high-frequency, low-intensity fires that naturally killed seedlings and maintained open savannahs. Pre-settlement period small openings of 1-20 acres are often not identifiable today (Frost et al. 2007, p. 7) and there is an apparent overall lack of suitable habitat for the Peñasco least chipmunk in the Sacramento Mountains (Frey and Hays, 2017 p. 21).

In the Sacramento Mountains, fire exclusion and the resulting altered forests have also significantly increased the potential for high-intensity, destructive crown fires (Covington and Moore 1992, p. 94; Allen et al. 2002, p. 1420). In the last 20 years, there have been six wildfires of over 1,000 acres in size and totaling approximately 75,000 acres, a portion of which historically contained habitat of the Peñasco least chipmunk (U.S. Forest Service 2002, p. 3.18). For example, the Peñasco fire burned 15,020 acres in 2002, burning in Peñasco and James Canyons, which were historically occupied by the Peñasco least chipmunk. As of 2002, the U.S. Forest Service (2002, p. 3.20) reported that 94 percent of the area of watersheds that historically supported the Peñasco least chipmunk in the Sacramento Mountains was highly susceptible to stand-replacing fires. However, the U.S. Forest Service continues to work to reduce fuel loads and restore landscapes to be more fire resilient (U.S. Forest Service 2017, p. 1). The Lincoln National Forest reports having treated over 100,000 acres in the last 20 years to meet this goal (U.S. Forest Service 2017, p. 1).

Despite these efforts, substantial areas remain in the Sacramento Mountains that are at high risk of wildfire. In the southwest, stand-replacing fires that occur in ponderosa pine forests that are departed from their natural vegetation type and structure, as well as their fire regimes, often regenerate as dense grasslands or shrublands (Allen 2013 p. 2). Frey and Hays (2017, p. 21) identified areas in the Sacramento Mountains that burned with high-severity wildfire that converted to dense thickets of Gambel oak or dense monotypic stands of weeping lovegrass (*Eragrostis curvula*) that was seeded during post-fire erosion control efforts. We are not aware of any areas that have burned in wildfire in the Sacramento Mountains where Peñasco least chipmunk habitat has been improved or created from the effects of wildfire. If the subspecies is persisting in unsurveyed areas in the Sacramento Mountains, stand-replacing wildfire and altered natural fire regimes will continue to be a stressor source through impacts to habitat by limiting important natural habitat elements, such as native montane grassland meadow and open ponderosa pine forest with grass understory habitat.

Changes to forest and meadow habitats resulting from the complex interrelated interactions of over a hundred years of land management activities including logging, livestock grazing, and fire suppression have significantly decreased the availability of suitable habitat for the Peñasco least chipmunk in the Sacramento Mountains. For this reason, these changes in habitat are considered a significant stressor source to the Peñasco least chipmunk in the Sacramento Mountains.

In the White Mountains, there is some evidence of historical land use practices, such as intensive livestock grazing early in the 20th century, but it is reported to have occurred at the base of Buck Mountain, and likely did not influence current conditions of Peñasco least chipmunk high-elevation meadow habitat. Dyer and Moffett (1999, p. 451) report multiple lines of evidence that fire has been an important disturbance agent affecting subalpine forest dynamics on Buck Mountain. The Buck Mountain area likely has had a pattern of stand-destroying fire that also mediated tree encroachment into meadows (Dyer and Moffett 1999, p. 451). Furthermore, Thurber's fescue communities are well-adapted to fire; and fire and climate are suspected to be behind creation and maintenance of these high-elevation montane grasslands (Finch 2004, pp. 121-122).

While there are historical records of fire as a natural process in the spruce-fir forests on Buck Mountain, and southwestern Thurber's fescue grassland communities are well-adapted to fire, it is possible that there has been a shift in the frequency, timing, or scale of wildfire in the White

Mountains that has resulted in wildfires today that are different than those that historically occurred. In the White Mountains, there have been three fires in the last 10 years that were over 1,000 acres in size, totaling approximately 60,000 acres. In June 2012, the Little Bear Fire burned 17,806 ha (44,000 ac) within the White Mountains, including Buck Mountain and adjacent areas (U.S. Forest Service 2012, pp. 1, 4, 10). It is unknown whether the Peñasco least chipmunk was affected by the Little Bear Fire. The chipmunk was observed on Buck Mountain in 2000 (with an unconfirmed observation in 1998), but was not detected on Buck Mountain during 2007 and 2015 surveys (Frey 2018a, pp. 20-21). Frey and Hays (2017, p. 36) note that while some may posit that wildfire could create Peñasco least chipmunk habitat in the White Mountains, subalpine meadow is not a seral stage of subalpine coniferous forest in the White Mountains. In addition, following fire, the spruce-fir forest in this region usually regenerates through an herbaceous and shrub-thicket stage, ultimately transitioning to a mature forest.

Overall, because fire in the forested areas around Peñasco least chipmunk meadow habitat in the White Mountains was a historically naturally occurring process, and Thurber's fescue meadow communities are fire-adapted to historical naturally occurring fire regimes, it is unlikely that wildfire is a source of concern for the Peñasco least chipmunk in the White Mountains. While both the short-term and long-term impacts to the Peñasco least chipmunk from wildfire in the White Mountains remain relatively uncertain, regeneration of forested areas burned by wildfire is unlikely to provide suitable habitat for the Peñasco least chipmunk because Peñasco least chipmunks do not use forested habitat.

Finally, as described in Chapter 3, forest encroachment into grasslands is occurring in both the Sacramento Mountains and in the White Mountains, although the causes for each are likely different. The causes for tree encroachment into meadows in the Sacramento Mountains is likely related to land use and land management practices; while the White Mountains are influenced by climatic events and successional encroachment processes. While some landscape restoration projects (i.e., the South Sacramento Forest Restoration Project, 82 FR 16989) may address some areas of meadow encroachment, there are currently no proposed projects within the historical distribution of the Peñasco least chipmunk either in the Sacramento Mountains or the White Mountains to control or limit tree encroachment into meadow habitat.

Given the changes in habitat from: 1) historical land management practices in the Sacramento Mountains; 2) altered fire regimes and patterns, with the potential for impacts to the subspecies from unnatural high-severity wildfire; and 3) tree encroachment into meadow habitat in both populations, this stressor including forest shifts, wildfire, and forest encroachment is considered in our analysis of future viability of the subspecies.

### 4.1.2 Recreation, Development, Land Use, and Land Management

Many of the historical records of Peñasco least chipmunks in the Sacramento Mountains are from James Canyon. We assessed development and changes in land use along the drainage bottom in James Canyon by looking for change in new buildings and structures and in agricultural fields through time by visually comparing imagery from 1942, 1976, and 2018 (Figure 4.1.2). Development in the Sacramento Mountains would have most likely occurred along drainage bottoms where private lands occur. While we were not able to quantify the amount of development using the imagery, from our visual assessment, the scale or impact from the change in buildings and structures does not appear to be significant between 1942 to present.

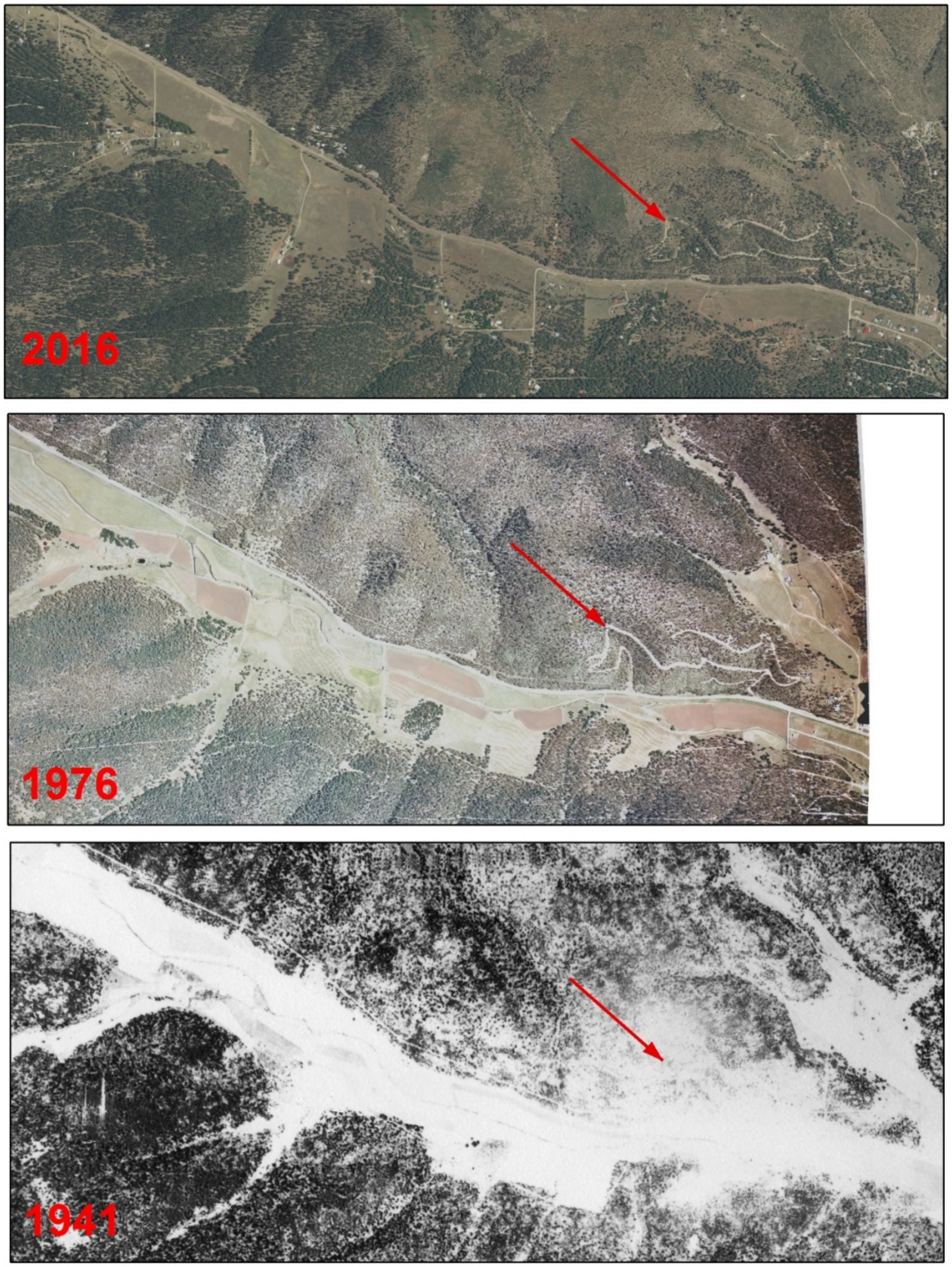



Figure 4.1.2.1 Aerial photographs from 1941, 1976, and 2016 of the same area in James Canyon, in the Sacramento Mountains. Note what appears to be agriculturally farmed areas in 1976 compared to 2016. Red arrows indicate the same reference location in each photograph of the time series.

We noted from this imagery and historical written descriptions, however, that land use of the bottom of James Canyon appears to have shifted from what was agricultural farming in the early part of the 20th century to pasture use. This conversion likely affected a potentially significant food resource (i.e., crops) for Peñasco least chipmunks in this canyon. It is likely that the high-quality, abundant food resource of wheat and oat fields drew Peñasco least chipmunks to the fields and road where the animals were easily observable, as early records noted that Peñasco least chipmunks were especially abundant along rail fences, eating oats and wheat at field edges (Bailey 1931; p. 91). However, Bailey (1931; p. 91) also states that Peñasco least chipmunks were abundant in the open, mature ponderosa pine forests. Peñasco least chipmunks were noted as abundant throughout the Sacramento Mountains during the early 1900s, in both natural open habitat and near agricultural fields. The change in land use from crop fields to pasture for livestock likely impacted Peñasco least chipmunks by decreasing the availability of an abundant, high-quality food source. Grasslands in the bottom of canyons that are currently used for pasture or livestock are likely not usable by the Peñasco least chipmunk because the grasses are likely not tall enough to provide shelter and cover.

U.S. Forest Service lands are managed for multiple uses. In the Sacramento Mountains, these uses currently include recreation, livestock grazing, and special use permits for a variety of actions. Activities also formerly included timber sales. Recreational use includes camping, hiking, biking, and motorized vehicle use, among other activities. The historical role of livestock grazing and timber harvest are described in sections 3.1 and 4.1.1 in terms of altering forest composition, structure, and fire regimes.

Current forest management strategies include applying a wide variety of restoration actions to move the forest closer to a natural state by reducing the risk of large, high-severity wildfire, managing for lower density of trees, and to promote openings and an herbaceous understory (for example, the U.S. Forest Service's South Sacramento Forest Restoration Project; 82 FR 16989). While this landscape-level restoration project is outside of the recorded range for the Peñasco least chipmunk in the Sacramento Mountains, we are not aware of anyone ever having surveyed for the subspecies in this portion of the Sacramento Mountains. Because suitable habitat once occurred in the area, it is reasonable that the Peñasco least chipmunk may have also occurred there. Regardless, habitat suitability assessments for the subspecies have been made throughout the Sacramento Mountains, and there is currently little to no suitable habitat within the Sacramento Mountains, including the South Sacramento Mountains (Section 3.2). The ongoing land management projects on U.S. Forest Service lands should alleviate some of the issues created by historical land management and provide future opportunities for restoring Peñasco least chipmunk habitat.

Habitat restoration efforts may ultimately restore some important ecological processes to Peñasco least chipmunk habitat in the Sacramento Mountains; however, there is uncertainty regarding whether the subspecies would be able to use the restored areas because of the required native grass component of the habitat. It is unlikely that native grass species will return with restoration activities. Landscape restoration projects such as the South Sacramento Forest Restoration Project manage only for creating and maintaining openings with herbaceous cover; the restoration of native grass species is not part of restoration at this time.

Additionally, native grass restoration that would be suitable for restoring Peñasco least chipmunk habitat in the Sacramento Mountains is confounded with land management that includes livestock grazing.  Managing numbers of livestock could allow for suitable grass height to provide cover for Peñasco least chipmunk needs; however, in montane grasslands, grazing-induced reduction in cover resulted in decreases in total small mammal biomass and changes in species composition and a decrease in mammal species diversity (Finch 2005, p. 36). Additionally, livestock use can determine the species of grass present (Finch 2004, pp. 121-123, U.S. Forest Service 2005, pg. 34).  By affecting plant species diversity and vegetation structure, livestock grazing can influence rodent species diversity.  The effects of grazing on rodents can vary by habitat, but small mammal communities are changed significantly by a reduction in cover caused by grazing, particularly in montane grasslands (U.S. Forest Service 2005 (pt. 2) pp. 36-37).  The non-native grasses often associated with livestock grazing are not likely suitable Peñasco least chipmunk habitat.  Furthermore, Peñasco least chipmunks utilize the seeds of grasses and forbes for food and food storage, which may not be compatible with livestock grazing regimes.  Because livestock grazing may have had significant impacts to Peñasco least chipmunk habitat in the past, and may be a limiting factor now and into the future on the subspecies' viability, livestock grazing as a stressor source will be carried forward in our analysis.

Other recreational activities, and activities authorized under special use permits by the Forest Service, occur in the Sacramento Mountains.  These other activities are dispersed or relatively small in scale.  We are not aware of any additional permitted activities in the Sacramento Mountains that have impacted or could influence the long-term viability of the Peñasco least chipmunk.

In the White Mountains, on Forest Service lands, development and land use is likely constrained to areas outside of the White Mountains Wilderness boundary.  Recreation likely occurs throughout the White Mountains, but it is limited by rough terrain and access, and is also likely to be primarily constrained to outside of the White Mountains Wilderness boundary.  We have no information regarding land use, development, or recreation within the Mescalero Apache Tribal boundary in the White Mountains.

The most significant recreational, development, and land use activities likely to affect the Peñasco least chipmunk in the White Mountains are related to the opening, operating, and maintaining of the Ski Apache Resort on Lookout Mountain.  Access roads to Ski Apache and the adjacent Buck Mountain were constructed in 1960 (Dyer and Moffett 1999, p. 451).  In 1961, Ski Apache opened under the name "Sierra Blanca Ski Resort," and the Resort has since been owned and operated by the Mescalero Apache Tribe (Ski Apache Resort, 2018).  Ski Apache hosts both winter and summer recreation and occurs mostly on Forest Service land, operating under a Special Use permit issued by the Forest Service.  Some of the activities also occur on Mescalero Apache Tribal lands.  We address impacts and use of the area regardless of ownership.  Summer use of Ski Apache Resort includes gondola rides, mountain biking, hiking, and zip-lining (4.2.1.2).

In 2016, three Peñasco least chipmunks were observed on two survey trap lines on Lookout Mountain. Lookout Mountain was selected to survey for several reasons, the main one being that it is located in the same large patch of subalpine meadow/tundra as that of Sierra Blanca Peak (Frey and Hays 2017, p. 9), where many historical records for the Peñasco least chipmunk are located. Two of the three Peñasco least chipmunk observations in 2016 were located just off the access road that leads to, and is in close proximity to, the Ski Apache zip line infrastructure. Vehicle use on the access road and human use for the zip line have the potential to be a stressor to the Peñasco least chipmunk due to vehicle strikes and disturbance from human presence.

Based on the Ski Apache Mountains Bike Trail Map, it appears that mountain bike trails also cross open meadow habitat (Blue Mountain bike trail on map, 4.2.1.2). Peñasco least chipmunks could be hit by fast-moving mountain bikes descending the mountain through Peñasco least chipmunk meadow habitat. Because recreational activities may have impacts currently and into the future, including some lethal impacts in the only location in which the subspecies my still be extant, recreation, development, and land use as stressor sources are carried forward in our analysis.

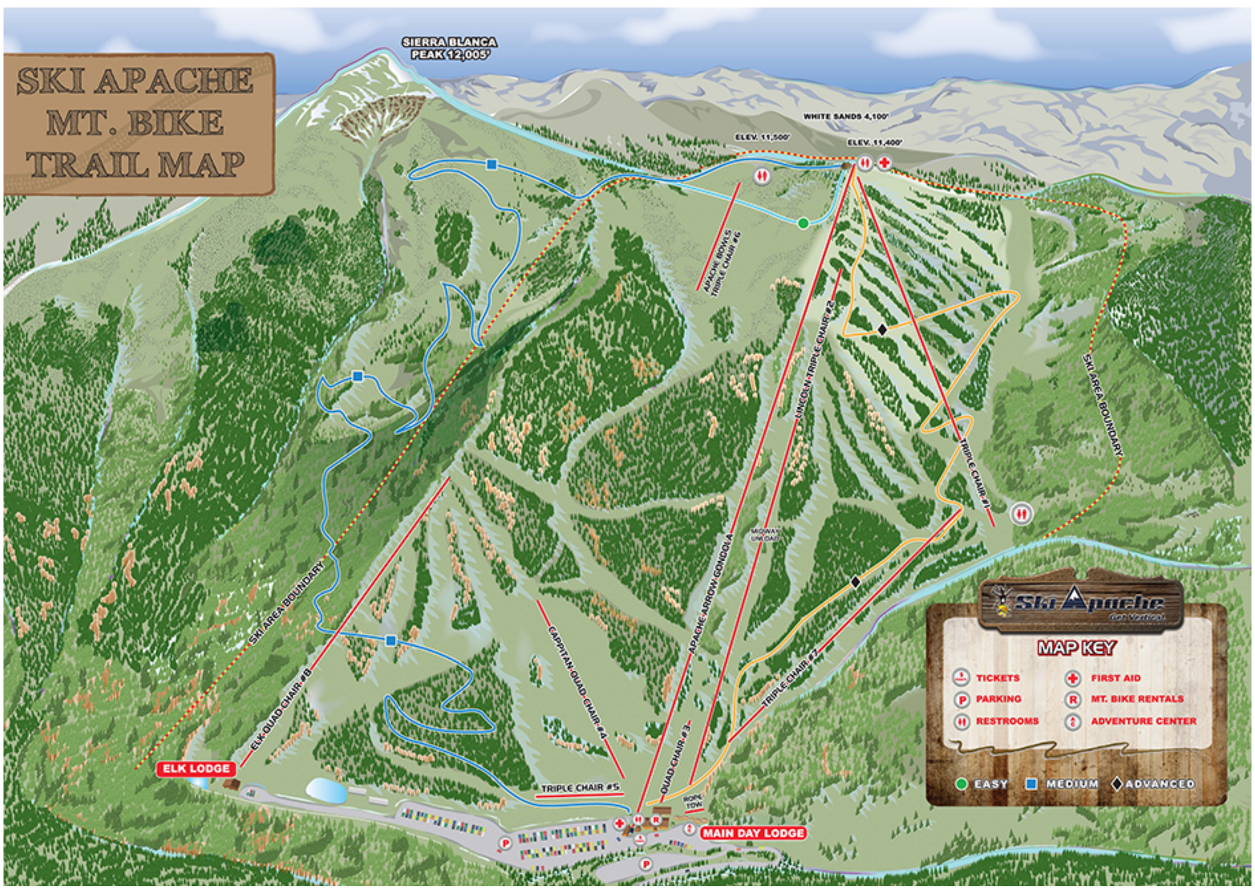


Figure 4.2.1.2. Ski Apache Mountain Bike Trail showing recreational use on Lookout Mountain and in the vicinity of Sierra Blanca Peak (Ski Apache website (www.skiapache.com) 2018). Frey and Hays (2007, p. 8) report that three Peñasco least chipmunk were observed in 2016 on Lookout Mountain in the area at the top of the ski runs**.**

### 4.1.3 Disease

A variety of pathogens and diseases have the potential to affect or have affected the Peñasco least chipmunk. Of these, the plague has the greatest likelihood of being a stressor to the subspecies. The plague is caused by the bacteria *Yersinia pestis*, a highly virulent organism that can quickly cause lethal disease in susceptible mammals (Abbott and Rocke 2012, p. 7). Transmission of *Y. pestis* typically occurs through fleas, whereby fleas feed on infected hosts and move to new hosts. In humans, the plague is most commonly transmitted through fleas, but can also be transferred through inhalation, eating of infected animals, or through bites, scratches, or direct contact with infected animals, tissues, or fluids (Abbott and Rocke 2012, p. 18). Modes of transmission of *Y. pestis* in wildlife are likely similar, whereby flea transmission is most common, but other avenues may also occur.

Different species of mammals demonstrate varied susceptibility to the plague, where some species experience dramatic die-off events and other hosts may survive with only mild illness (Abbott and Rocke 2012, p. 18). There can also be variation within the same host species in different geographical areas. Rodents are the major group of animals infected by *Y. pestis*, and some species may act as a reservoir or as an "amplifying host" for the organism (Abbott and Rocke 2012, p. 18). Generally, an amplifying host is a host in which disease agents, such as viruses or bacteria, increase in number (Abbott and Rocke 2012, p. 71); in this case, "amplifying hosts " also applies to hosts that are more uniformly susceptible to plague and undergo dramatic die-offs during epizootics of plague (Abbott and Rocke 2012, p, 17). Prairie dogs (*Cynomys spp.*) are commonly known to be highly susceptible to *Y. pestis*, and would be considered an amplifying host. Occasional epizootics have been observed in chipmunks, wood rats, ground squirrels, deer mice, and voles, some of which may also be amplifying hosts.

*Y. pestis* is not native to North America and was first introduced to the western coast of the United States in the early 1900s, spreading eastward and becoming established in wild rodent populations in several western states (Adjemian et al. 2007, p. 365; Figure 4.3.1). Adjemian et al. (2007, p. 368) report two records of *Y. pestis* in south-central New Mexico, one from 1951-1960 and one from 1961-1966. *Y. pestis* is presently known to occur in Lincoln and Otero Counties, among others in New Mexico.

It is unknown if the plague has affected the Peñasco least chipmunk in the past, is currently affecting the subspecies now, or will in the future. However, there is supporting evidence that suggests that the plague could be a significant stressor to the viability of Peñasco least chipmunk. The *Y. pestis* organism likely arrived into New Mexico at a time that is approximately coincident with observed declines of Peñasco least chipmunk populations (that is, beginning in the early 1950s through the 1960s; Figure 4.3.1). Chipmunks, in general, and least chipmunks more specifically, have been tested in the laboratory and are susceptible to the plague (Quan and Karman 1962, p. 128). Some epizootics caused by the plague have been observed in chipmunks and other ground squirrels (Smith et al. 2010, entire). Because the plague may be a significantly important stressor, we consider it in our analysis of future viability of the subspecies.

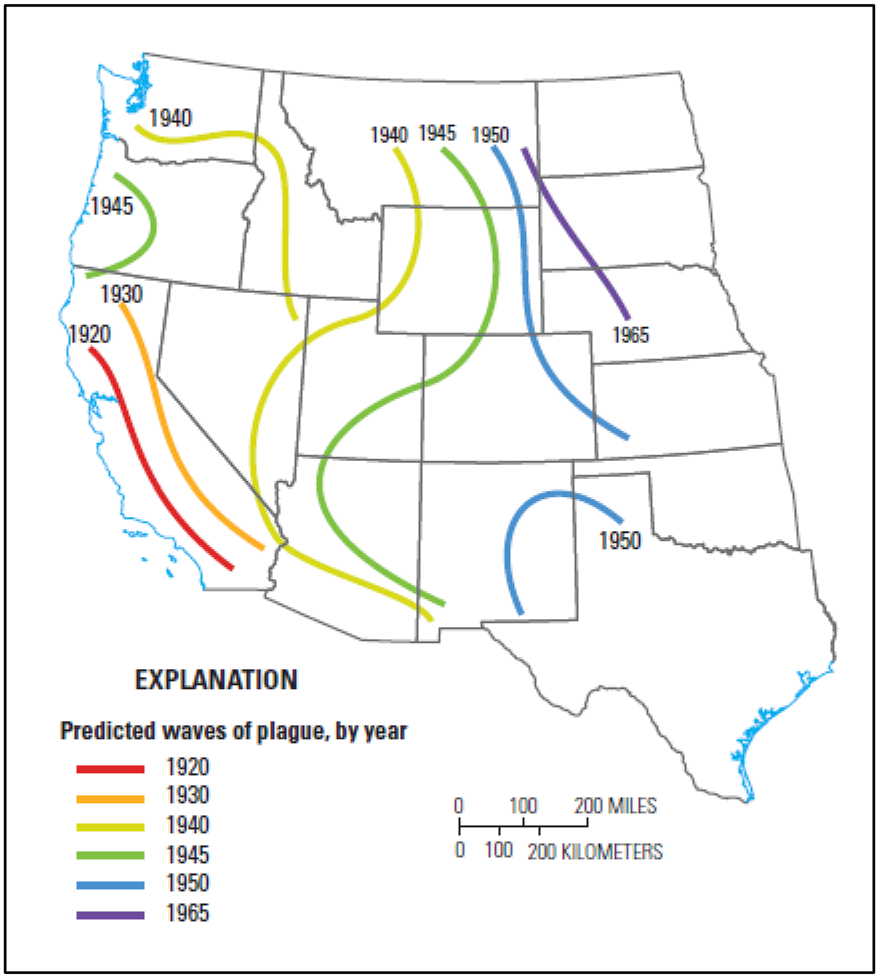


Figure 4.1.3. Map from Abbott and Rocke (2012, p. 17) "Figure 6 Predicted waves of plague movement from the west coast of the United States eastward into the Great Plains. (Based on Adjemian et al., 2007)." The timing of the predicted wave of plague through New Mexico supports the hypothesis that plague may have played a role or caused the enigmatic declines observed in populations of Peñasco least chipmunk in the 1950s through the 1960s.

### 4.1.4 Non-native Species

Feral hogs have become established as a nuisance species in New Mexico and elsewhere in the United States (USDA Wildlife Services New Mexico 2010, entire). In New Mexico, feral hogs occur within Lincoln and Otero Counties. As of 2011, feral hogs occurred in areas east of Cloudcroft in the Sacramento Mountains (U.S. Forest Service 2011, map). Unpublished data from USDA Wildlife Services indicate that feral hogs have been removed from an area north of Peñasco least chipmunk habitat in the White Mountains. We lack specific data demonstrating overlap of feral hog occurrence with Peñasco least chipmunk occurrence; however, feral hogs are known to occur in the vicinity of Peñasco least chipmunk habitat or areas formerly known to be occupied by the Peñasco least chipmunk. Feral hogs are voracious, flexible, and opportunistic omnivores (USDA Wildlife Services New Mexico 2010, p. 6) and will persistently root in an area until the resources are depleted (USDA Wildlife Services New Mexico, 2010, p. 7).

Rooting can be extremely destructive to habitat (Figure 4.1.4). Feral hogs cause long-term degradation of native ecosystems and plant communities and have been associated with spread of invasive weeds through their rooting behavior (USDA Wildlife Services New Mexico 2010, p. 10-12, 19-20). In addition to impacting habitat, feral hogs have been documented consuming a multitude of vertebrate and invertebrate species (USDA Wildlife Services New Mexico 2010, p. 13). As of 2010, USDA Wildlife Services New Mexico (2010, p. 14) reports that 90% of the small mammal species listed under the Endangered Species Act were in areas of expanding feral hog populations and impacted by feral hog predation, and document how feral hogs could influence small mammal populations through heavy and persistent predatory activities. In addition to direct predation, feral hogs can strip an area of food resources and are competitors with native species for food and water resources (USDA Wildlife Services New Mexico 2010 p. 12-13).

According to USDA Wildlife Services New Mexico (2010, p. 15), feral hogs are susceptible to at least 30 viral and bacteriological diseases, 20 of which are zoonotic, and at least 37 parasites have been identified. Among the many diseases, pathogens, and parasites that feral hogs carry, in New Mexico feral hogs have tested positive for swine brucellosis and pseudorabies. While the ability of feral hogs to transfer disease to wildlife is not well-studied, pseudorabies virus is highly contagious, and rodents are reported as being susceptible (USDA Wildlife Services New Mexico 2010, p. 15). Additionally, the prevalence of antibodies of *Y. pestis* was reported for 17 species of mammals from the western U.S. (Abbott and Rocke 2012, p. 26); of those, wild boar (=feral hog) was reported to have the highest prevalence rate at 74%. Although the sample size for this assessment was relatively low (18 out of 23 were positive), these data demonstrate that feral hogs in both the Sacramento Mountains and White Mountains could contribute to disease dynamics in the small mammal communities in these mountain ranges.

Impacts from feral hogs thus include rooting, predation, spreading diseases and parasites, spreading invasive weed species, and competition with native species for water and food resources. Within Peñasco least chipmunk habitat, feral hogs are more likely to have had, or possibly continue to have, impacts to the Peñasco least chipmunk in the Sacramento Mountains, but could have impacts in the future to both populations. Because of the potentially significant impact non-native feral hogs may have had, and may continue to have in the Sacramento Mountains population, as well as future potential impacts to the White Mountains population, this stressor is considered in our analysis of future viability of the subspecies.

Feral horse grazing in the White Mountains has been reported as a potential concern for effects to Thurber's fescue meadows (Frey and Hays 2017 p. 42). Frey 2018b (p. 4) reports observing feral horses or feral horse sign in the mixed conifer forests along the Ski Run Road, in the White Mountains, and indicates that if feral horses populations were to grow and utilize Peñasco least chipmunk habitat, they could become a stressor to the Peñasco least chipmunk from impacts to habitat. We are not aware of any information regarding the current or likely future impacts of feral horses to Peñasco least chipmunk habitat in the White Mountains, and are not considering this specific non-native species further in our analysis of future viability of the subspecies.

Figure 4.1.4. Example of rooting in Ponderosa Pine forest, Lincoln National Forest (photo excerpted from USDA Wildlife Services New Mexico 2010, p. 21).

### 4.1.5 Small Population Size and Lack of Connectivity

Compared to large populations, small populations are more vulnerable to extirpation from environmental, demographic, and genetic stochasticity (random natural occurrences), and unforeseen natural or unnatural catastrophes (Shaffer 1981, p. 131). Small populations are less able to recover from losses caused by random environmental changes (Shaffer and Stein 2000, pp. 308–310), such as fluctuations in reproduction (demographic stochasticity), sweeping losses from disease events, or changes in the frequency or severity of wildfires (environmental stochasticity).

Another type of random fluctuation, genetic stochasticity, results from: 1) changes in gene frequencies due to the founder effect, which is the loss of genetic variation that occurs when a new population is established by a small number of individuals (Hedrick 2000, p. 226); 2) random fixation, or the complete loss of all but one allele at a locus (Hedrick 2000, p. 258); or 3) inbreeding depression, which is the loss of fitness or vigor due to mating among relatives (Hedrick 2000, p. 208). Additionally, small populations generally have an increased chance of genetic drift, or random changes in gene frequencies from generation to generation that can lead to a loss of variation, and inbreeding (Ellstrand and Elam 1993, p. 225). Allee effects, when there is a positive relationship between any component of individual fitness and either numbers or density of conspecifics (Stephens et al. 1999, p. 186) may also occur when a population is in decline (Dennis 1989, pp. 481– 538). In a declining population, an extinction threshold or ‘‘Allee threshold’’ (Berec et al. 2007, pp. 185–191) may be crossed, in which adults in the population either cease to breed or the population becomes so compromised that breeding does not contribute to population growth. Allee effects typically fall into three broad categories (Courchamp et al. 1999, pp. 405–410): lack of facilitation (including low mate detection and loss of breeding cues), demographic stochasticity, and loss of heterozygosity. Environmental stochasticity amplifies Allee effects (Dennis 1989, pp. 481–538; Dennis 2002, pp, 389–401). In Peñasco least chipmunks, random fixation and loss of heterozygosity have been observed. Sullivan (1985, pp. 431-433) found that Peñasco least chipmunks in the White Mountains had 1 allele per locus at 14 of 15 loci examined, and an observed heterozygosity of 0. The extinction risk for a subspecies represented by few small populations is magnified when those populations are isolated from one another, as is the case for the White Mountains and the Sacramento Mountains.

Although it is suspected that the White Mountains and Sacramento Mountains populations may have been physically separated over a long time period with little to no genetic interchange (based on morphometric differences in collected specimens; Sullivan 1985, pp. 424-425), connectivity could play an important role as it relates to the overall viability to the subspecies if present. Connectivity between these populations would contribute to the number of reproductively active individuals in a population; mitigate the genetic, demographic, and environmental effects of small population size; and recolonize extirpated areas. Additionally, the fewer the populations a species or subspecies has, the greater the risk of extinction. The combination of a very small population in the White Mountains, a possibly extirpated population in the Sacramento Mountains, and no population connectivity between the mountain ranges, layered with the other stressors and potential stressors described above, greatly increases extinction risk for the Peñasco least chipmunk. Because of this, the stressor of small population size is included in our analysis of future subspecies viability.

## 4.2 Stressors Considered and Not Included in Viability Analysis

### 4.2.1 Interspecific Competition

Interspecific competition with the gray-footed chipmunk could be a stressor to Peñasco least chipmunk, particularly as it may relate to changes in forest composition and structure and encroachment into meadows. However, we do not consider this factor in our analysis of future viability as competition with gray-footed chipmunks, but rather as changes in forest composition and structure that make the habitat more suitable for a forest-dwelling chipmunk species than an open, grass meadow subspecies. While populations of the gray-footed chipmunk may have expanded in response to the increase of densely-stocked mixed conifer forests (Frey and Boykin 2007, Table 4), we are not aware of any evidence that suggests that direct competition with the gray-footed chipmunk has been, currently is, or will be a stressor to the Peñasco least chipmunk. For this reason, we do not further consider this factor in our viability analysis.

4.2.2 Scientific Collection

Collection of individuals of Peñasco least chipmunk for scientific museum collections has occurred since the subspecies was first discovered in 1902 (Bailey 1913, pp. 129-130). Based on a query of 36 museum collections, a total of 130 Peñasco least chipmunk specimens was found in 6 collections (Frey and Boykin 2007, pp. 6, 12). Early collection numbers had the potential to impact a population, but reports from those field trips indicate that the subspecies was abundant at the times of collection. While it is unknown if these early collections impacted the viability of the populations, it not likely since populations were reported to be abundant, and collections were conducted as single points in time, not constant applied collection pressure. Modern day specimen collection for the Peñasco least chipmunk is conducted to verify subspecies identification through time and to add value to scientific museum collections for future scientific endeavors. It is reported that recent collections of the Peñasco least chipmunk were made only for one specimen per survey and only for new observation locations (Hope and Frey 2000, p. 6).

Typically, the collection of 1-2 specimens would be inconsequential to a population; however, because numbers of individuals remaining in the wild is likely extremely small, even small collections can be impactful to some degree. A variety of stressors such as wildfire, changes in habitat, or disease play or may play a relatively much more significant role influencing Peñasco least chipmunk viability going forward. While collection for scientific purposes may have an impact on small populations, for the Peñasco least chipmunk it has been confined primarily to past survey efforts, and it is not likely to be a significant stressor for the subspecies going forward. For these reasons, scientific collection is not carried forward as a stressor in this analysis.

4.2.3 Climate Change

To assess whether climate change may be a stressor to the Peñasco least chipmunk, we considered how changes in precipitation and temperature could affect the resources of the subspecies, the life history characteristics of the subspecies, and stressors affecting the subspecies. Of those, climate change could potentially affect food resources, over-wintering environment and behavior, and disease dynamics. We used the National Climate Change Viewer (NCCV) established by the U.S. Geological Survey, Climate Research and Development Program, for the assessment (USGS 2016: entire). The NCCV includes future climate projections relative to the historical climate normal (1981-2010) and contains statistically down-sampled output (800 m grid) for 30 General Circulation Models contained in the 5th Climate Model Intercomparison Program (CMIP5) for two of the Intergovernmental Panel on Climate Change Representative Concentration Pathways (RCPs) (IPCC 2014, p. 8). RCP4.5 is one of the intermediate emission scenarios, in which global greenhouse gas concentrations are generally stabilized via climate mitigations and do not exceed a radiative forcing of 4.5 $Wm^{-2}$ after 2100, which is roughly equivalent to 650 parts/million (ppm) $CO_2$. RCP8.5 is the most aggressive and uncompromising climate change scenario, in which 8.5 $Wm^{-2}$ radiative forcing is equivalent to approximately 1,370 ppm $CO_2$. As of September 2017, the current global mean $CO_2$ concentration is 402.50 ppm (National Oceanic and Atmospheric Administration [NOAA] 2017, entire). For all models, we assessed the evaluation interval 2025 through 2049.

The parameters we selected for the NCCV output are based on the ways in which climate change could affect Peñasco least chipmunk food resources or over-wintering behavior, and are as follows:

- **Region Type = State/Counties/Watershed (NM/Lincoln, Otero/Rio Hondo Watershed).**
- **Model = Mean Model (the ensemble model for all 30 CMIP5 models);**
- **Variable = Precipitation (mm/month):**
    - Annual Mean Precipitation
    - Average of Monthly Precipitation for Spring/Summer (April, May, June, July, Aug)
    - Average of Monthly Snow Precipitation for Winter (Nov, Dec, Jan, Feb)
- **Variable = Temperature (Degrees Celsius) (°C)**
    - Average of Monthly Maximum Temperature for Winter (Nov, Dec, Jan, Feb)
    - Average of Monthly Minimum Temperature for Winter (Nov, Dec, Jan, Feb)

The Time Period parameter in the NCCV allows for the selection of either an annual mean or a monthly timestep. Because some of the factors we were interested in were seasonal for the chipmunk, we averaged the NCCV monthly output for the spring-summer (April-Aug) and winter (Nov-Feb) periods. The results for the selected parameters are provided in Table 4.2.1.

Table 4.2.1. Modeled change in precipitation and temperature variables relevant to Peñasco least chipmunk life history traits, using RCP 4.5 and RCP 8.5 climate scenarios under the evaluation interval 2025-2049. Negative values indicate a decrease in precipitation.

| | Annual Mean Precipitation Change mm (in) | Average Monthly Precipitation Change for Summer Months mm (in) | Average Monthly Snow Precipitation Change for Winter Months mm (in) | Change in Average Monthly Maximum Temperature for Winter Month °C (°F) | Change in Average Monthly Minimum Temperature for Winter Months °C (°F) |
|---|---|---|---|---|---|
| **RCP 4.5** | -0.7 (0.0) | -0.8 (0.0) | -1.7 (-0.1) | 1.5 (2.8) | 1.3 (2.2) |
| **RCP 8.5** | -0.4 (0.0) | -1.0 (0.0) | -1.9 (-0.1) | 1.4 (2.5) | 1.4 (2.5) |

We framed our climate change analysis to how changes in precipitation or temperature would most likely affect the biological or natural history needs of the subspecies, by assessing changes in air temperature and snow pack in the winter, that could impact the overwintering of the Peñasco least chipmunk (less snow could impact temperature stability in underground burrows over winter), summer precipitation and temperature that could affect food resources for the Peñasco least chipmunk, as well as how changes to summer precipitation and temperatures could potentially influence disease dynamics and outbreaks. We found that for the evaluation interval 2025 through 2049, predicted changes in precipitation and temperature from climate change in the Sacramento and White Mountains of New Mexico that could relate to Peñasco least chipmunk resources or stressors appeared to be mild. Model output indicated a less than one millimeter (mm) change in annual precipitation, less than 2 mm change in snow precipitation in winter months, and less than 1.5 °C change in temperature minimums and maximums. In addition, climate model output did not vary significantly even under the most extreme (RCP 8.5) climate scenario. While there may be climate mediated processes than influence other ecological processes and community dynamics that could affect the subspecies, we do not have the ability to predict such impacts, and consider them as stochastic events, to which, if well represented, populations could persist. For these reasons, climate change is not considered to be a factor to significantly affect the viability of the Peñasco least chipmunk over the next 30 years and is not carried forward in this analysis.

### 4.3 Summary

Our analysis of the past, current, and future stressors on the Peñasco least chipmunk revealed that there are likely several stressors affecting this subspecies. These include forest shifts, wildfire, forest encroachment, recreation, development, and land use. Additional potentially significant factors that may be affecting the subspecies include disease (particularly plague) and non-native feral hogs. However, small population size poses the greatest risk to the subspecies' future viability, as it greatly compounds the impacts of these other stressors. The impact of all other stressors is amplified by the extremely small population size, contributing more to the deterioration of long-term viability of the Peñasco least chipmunk than those stressors would in the presence of large populations. Because these stressors may significantly affect the viability of the Peñasco least chipmunk going forward, we include changes in habitat from forest shifts, wildfire, and forest encroachment; increased recreational use; disease outbreaks; non-native feral hogs; and small population size in our assessment of the current and future resiliency of Peñasco least chipmunk populations and the viability of the subspecies overall.

# CHAPTER 5 – CURRENT CONDITIONS

## 5.1 Introduction

The available information indicates that one of two populations of the Peñasco least chipmunk —the Sacramento Mountains population—is either very nearly extirpated or is extirpated, and the remaining White Mountains population is extant, but with a total of only a few individuals observed during four survey efforts conducted in 2000, 2007, 2016 and 2018. Because surveys are labor-intensive in remote, difficult terrain, data do not indicate the extent of occupied habitat. However, data collected from the early 1900s through present indicate that the White Mountains population is not as abundant now as historically.

## 5.2. Current Population Resiliency

*Methodology*

In Chapter 4, we described the stressors affecting populations of Peñasco least chipmunk. We also discussed the needs of a resilient population and identified and described the demographic and habitat factors needed for a resilient Peñasco least chipmunk population. In this section, we describe our methodology for assessing the resiliency of each population. We first define our understanding of what the various overall population resiliency levels (i.e., High, Moderate, Low, and Very Low/Extirpated; Table 5.2.1) would look like for this subspecies. To then rate the population resiliency levels for the Peñasco least chipmunk, we used the demographic and habitat factors identified above on Population Resiliency. Here, we provide the current conditions of the demographic and habitat factors analyzed. The demographic factors we analyzed include: trap rate, population trends, connectivity between populations, and number of subpopulations within populations. The habitat factors we analyzed include: suitable habitat size to support population persistence, habitat availability trends, and habitat.

For each of these demographic and habitat factors, we developed condition categories (High, Moderate, Low, and Very Low/Extirpated) to assess the condition of each factor for each population (Table 5.2.2) in order to rate overall population resiliency. Some factors rely on qualitative metrics, while for others, where more data are available, we were able to develop quantitative metrics. We assigned a numerical value to the condition categories, with High = 1, Moderate = 0, Low = -1, and Very Low/Extirpated = -2, to assign scores to each demographic and habitat factor, and to calculate an overall score for each population. We averaged all of the demographic and habitat condition category scores for each population to determine the overall resiliency score for that population.

Table 5.2.1. Population resiliency category definitions for Peñasco least chipmunk.

| High (1) | Moderate (0) | Low (-1) | Very Low/Extirpated (-2) |
|---|---|---|---|
| Density or relative abundance is high; the population is increasing over time; there is connectivity between the populations; and the number of subpopulations is high, spatially dispersed, and able to withstand or recover from stochastic events; with large, contiguous areas of increasing availability of suitable habitat with no detectable impacts from land use or management. | Density or relative abundance is moderate; the population is stable over time; populations are adjacent to each other, but unsuitable habitat precludes dispersal; multiple subpopulations, allowing for some ability to withstand or recover from stochastic events; with areas of moderately sized habitat with some isolated habitat patches; and in which land use or management occurs but does not significantly limit chipmunk resources. | Density or relative abundance is low; population is decreasing over time but still extant; populations are extremely isolated from one another; two subpopulations allow for some, but limited, ability to withstand or recover from stochastic events; habitat occurs as small isolated patches; and land use or management reduces chipmunk resources. | Abundance decreases over time, such that population may be extirpated completely; no connectivity with other populations exists; if extant, no subpopulation structure occurs; little to no suitable habitat is available; if patches exist, they are small and isolated and will lead or have led to high probability of extirpation; and land use or management removes chipmunk resources. |

Table 5.2.2. Condition categories (with condition category scores in parentheses) for population factors and habitat factors used to rate population resiliency for the Peñasco least chipmunk. Habitat availability trends are assessed over the last approximate 75 years to reflect the time when the subspecies and habitat conditions were first described to present.

| Condition Categories | Demographic Factors | | | | Habitat Factors | | |
|---|---|---|---|---|---|---|---|
| | **Trap Rate (# Indivs/Trap Hr) Surrogate for Density** | **Population Trends** | **Connectivity Between Populations** | **Subpopulations Within Populations** | **Suitable Habitat Size to Support Population Persistence** | **Habitat Availability Trends** | **Habitat Condition** |
| **High (1)** | > 10 captures per 100 trap-days | Increasing over time | Adjacent to another population with intervening suitable habitat | 4 or more subpopulations | Area of large, contiguous habitat allowing for a self-sustaining population with low risk of extirpation | >25% increase in habitat availability in last 75 years | Remote area with no detectable impacts from land use or management, with abundant chipmunk resources |
| **Moderate (0)** | 1 to 10 captures per 100 trap-days | Stable over time | Adjacent to another population with intervening habitat unsuitable for dispersal | 3 subpopulations | Area of moderately sized habitat, with some isolated habitat patches and some risk of localized extirpation. | 0-25% change in habitat availability in last 75 years | Land use or management occurs but does not significantly limit chipmunk resources |
| **Low (-1)** | 0.1 to 1 captures per 100 trap-days | Decreasing over time | Extremely isolated from other populations | 2 subpopulations | Small, isolated habitat patches that do not support a self-sustaining population, with high probability of extirpation | >25% decrease in habitat availability in last 75 years | Land use or management reduces or limits chipmunk resources |
| **Very Low or Extirpated (-2)** | 0 to 0.1 captures per 100 trap-days | Decreasing over time and now possibly or likely extirpated | No connectivity with other populations | 0-1 subpopulations | Little to no suitable habitat; if patches exist, they are small and isolated and will lead or have led to high probability of extirpation | Apparently no remaining habitat | Land use or management removes chipmunk resources |

*Trap Rate.* We used the trap rate of Peñasco least chipmunks as a surrogate to assess population density. To develop a relative scale by which to assess Peñasco least chipmunk trap rates, we examined trap rate data from other subspecies of least chipmunks. We attempted to use published data on trap rate for other subspecies from research in which trapping methods were similar to the Peñasco least chipmunk to develop a relative scale of capture rates (Table 5.2.3). However, it is noteworthy that capture results can vary by how the traps set and for what purpose the traps are set. For example, there can be differences between traps that are set for general small mammal captures and those targeting certain species, in this case, trapping for the Peñasco least chipmunk. In theory, when traps are set for the Peñasco least chipmunk, they are done in a manner that would increase the likelihood for capturing the subspecies if present that if the traps were set for general small mammal assessment in Peñasco least chipmunk habitat. Presumably, trapping for general small mammal assessment would result in a lower capture rate for the Peñasco least chipmunk. However, we do not have data to test this presumption; therefore, this assessment is our best attempt to provide a context for the what the trapping results for the Peñasco least chipmunk may represent, and may be an over-estimation relative to the data for other least chipmunk subspecies.

For high- and mid-range capture rates, a study assessing small mammals in Custer State Park, South Dakota reported a capture rate of 33.3 least chipmunk captures per 100 trap-nights in post-fire grassland habitat (Ellis et al 2008, pp. 169). Ellis et al. (2008, pp. 172) also report a trap rate of 7.3-10 least chipmunks per 100 trap-nights (Ellis et al 2008, pp. 169, 172) in a single year (2002) in five other habitat types. Proulx et al (1997, p. 447) reported mid-range capture rates of 1.8 capture of least chipmunks per 100 trap-nights in areas that had been clear-cut. In the low range, a long-term mark-recapture study using two permanent trapping webs at one location reported capturing 116 least chipmunks over a period of from 1995-2006 with a total 47,850 trap-nights that equates to 0.24 least chipmunks per 100 trap-nights (Doty et al. 2009, p. 2). These other studies provide a context of rates at which least chipmunks have been captured in other studies.

The trap rate data for the Peñasco least chipmunk is limited to reports that specify trapping rate. We are aware of data from 1981 (Sullivan et al, Undated) to present in both the Sacramento Mountains and White Mountains. In the Sacramento Mountains, no Peñasco least chipmunks were captured with at least 38,271 trap-days. The copy of Sullivan et al. (Undated) that we have is missing part of Table 17, where trapping efforts are reported. Because the table is organized chronologically and geographically, it appears as though some trapping efforts for the Peñasco least chipmunk from 1981 may be missing; therefore, we report on only the available information, noting the minimum effort that was reported, because additional trapping from 1981 likely occurred, for which we do not have the data. However, the text of the report states that no Peñasco least chipmunks were captured in the Sacramento Mountains. In total, 38,271 trap-days have been reported in the Sacramento Mountains since 1981, over 40 sites (Sullivan et al. undated; Frey 2018a, p. 17) without capturing or detecting any Peñasco least chipmunks. Therefore, the Sacramento Mountains Trap Rate (labeled: "Trap Rate (# Indivs/Trap Hr) Surrogate for Density" in Table 5.2.4) has a condition category of Very Low (-2).

In the White Mountains, 2 Peñasco least chipmunks were captured in 1982 with 153 trap-days and 5 Peñasco least chipmunks were captured from 2000 to present with 4,193 trap-days. We did not include trapping data or the unconfirmed but likely Peñasco least chipmunk from the 1998 U.S. Forest Service data reported in Frey and Boykin (2007, p. 24) because of the great level of uncertainty regarding identification from field personnel. The trap rate from 1981 to present ranged from 0 to 1.3 Peñasco least chipmunks/100 trap days, and averaged 0.17 chipmunks/100 trap days. While we assigned condition categories based on the best available information regarding trap rates for other least chipmunk subspecies, the cut-off between categories is relative among potential rates. Because the trap rate for the White Mountains is at the lower end of the Low Category, and the trap rate data are heavily weighted by the relatively old 1981 captures (the 1981 capture rate was the maximum at 1.3, and the overall White Mountains trap rate excluding these early 1980s data is 0.11), we have assigned a Trap Rate condition category of Very Low / Low (-1.5) for the White Mountains population.

Table 5.2.3 Trap rate information from least chipmunk subspecies.

| Trap Rate (Number Least Chipmunks/100 trap-days) | Habitat | Location | Citation | Notes |
|---|---|---|---|---|
| **Other Least Chipmunk Subspecies** | | | | |
| 33.3 | Post-Fire Grasslands | Black Hills, SD | Ellis et al 2008, pp. 169 | |
| 7.3-10.0 | Five Habitat Types | Black Hills, SD | Ellis et al 2008, pp. 172 | |
| 2.6 | Clear-cut | Uinta Mtns, northern UT | Proulx et al. 1997, p 447) | |
| 0.93 | Sagebrush | WY | Hanser et al. 2011, p. 340. | |
| 0.24 | Pine-juniper | Western CO | Doty et al. 2009, p. 2 | 12 year study capturing 116 least chipmunks |
| **Peñasco Least Chipmunk** | | | | |
| **Sacramento Mountains** | | | | |
| 0 | | Sacramento Mountains, at least 11 locations | Sullivan et al., Undated (Table 17 incomplete) | 2,197 trap days in 1982; at least 160 trap days in 1981. An additional 217 person hours were spent actively searching/hunting for chipmunks. |
| 0 | Ponderosa Pine Forest | Sacramento Mountains, NM | Frey and Hays 2017 | 2,894 trap days in 2016 |
| 0 | Ponderosa Pine Forest | Sacramento Mountains, NM | Frey 2018a, p. 17 | 4,091 trap days in 2000 |
| 0 | Ponderosa Pine Forest | Sacramento Mountains, NM | Frey 2018a, p. 17 | 27,440 trap days in 2005-2006 |
| 0 | Ponderosa Pine Forest | Sacramento Mountains, NM | Frey 2018a, p. 17 | 1,694 trap days in 2007 |

| | | | | |
|---|---|---|---|---|
| **White Mountains** | | | | |
| 1.3 | High-elevation Meadow | White Mountains, NM: Sierra Blanca Peak, | Sullivan et al., Undated, Table 17 | Sullivan reports capturing 2 PLC during 153 trap-days over a 2 day trapping session in 1982 |
| 0.35 | High-elevation Meadow | White Mountains, NM: Buck Mountain | Frey and Hope 2000 | 2 Peñasco least chipmunks in 560 trap-days in 2000 |
| 0.08 | High-elevation Meadow | White Mountains, NM: Carlton Canyon, Johnson Canyon, Buck Mountain, Lookout Mountain | Frey and Boykin 2007, p. 24 | 1998 U.S. Forest Service Data Compiled by J. Frey. 1 unconfirmed, but likely Peñasco least chipmunk captured at Buck Mountain with 1,260 trap-days. |
| 0 | High-elevation Meadow | White Mountains, NM: Buck Mountain | Frey and Boykin 2007 | 1,600 trap days in 2007 |
| 0 | High-elevation Meadow | White Mountains, NM: Buck Mountain | Frey 2018a, p. 21 | 1,000 trap days in 2015 |
| 0.34 | High-elevation Meadow | White Mountains, NM: Lookout Mountain | Frey and Hays 2017 | 3 Peñasco least chipmunks in 880 trap days in 2016 |
| 0.84-1.26 | High-elevation Meadow | White Mountains, NM: Ice Springs | Frey and McKibben 2018, entire | 4-6 Peñasco least chipmunks in 476 trap days within site 2018 |
| 7.8-10.8 | High-elevation Meadow | White Mountains, NM: Lookout Mountain | Frey and McKibben 2018, entire | 8-11 Peñasco least chipmunks in 102 trap days within site 2018 |
| 0 | High-elevation Meadow | White Mountains, NM: Prospect Ridge | Frey and McKibben 2018, entire | 0 Peñasco least chipmunks in 255 trap days within site 2018 |
| 0 | High-elevation Meadow | White Mountains, NM: Crest Trail | Frey and McKibben 2018, entire | 0 Peñasco least chipmunks in 340 trap days within site 2018 |
| 0 | High-elevation Meadow | White Mountains, NM: Buck Mountain | Frey and McKibben 2018, entire | 0 Peñasco least chipmunks in 510 trap days within site 2018 |

*Population Trends.* Specimen records of the Peñasco least chipmunk are displayed in Table 3.1.1. Specimen records with some historical field note information coupled with more recent specific observational data allow us to assess relative population trends. The Peñasco least chipmunk in the Sacramento Mountains was once reported as abundant; this is reflected in the high numbers of specimens collected from 1902 through 1932. The last observation of the subspecies in the Sacramento Mountains occurred in 1966. At that time, it was also reported to have greatly reduced densities, and the four specimens collected took great efforts (Conley 1970, p. 700). Extensive surveying and trapping efforts have not detected the Peñasco least chipmunk in the Sacramento Mountains since 1966, indicating that this population may be extirpated (Frey and Hays 2017, p. i; Frey 2018a, p. 17). The Sacramento Mountains population of the Peñasco least chipmunk has a clearly declining trend through time, with no individuals detected during surveys in appropriate habitat, and thus has a Population Trend condition category of Very Low / Extirpated (-2).

For the White Mountains, we do not have detailed accounts of observed abundance of Peñasco least chipmunks from early specimen collections. However, based on the numbers of specimens collected (Table 3.1.1), the subspecies was likely to be more abundant than it is today. Extensive trapping efforts between 2000 and 2016 (Table 5.2.3) resulted in the capture of a total of 5 individual Peñasco least chipmunks. Of these 5 captures, 2 individuals were observed in 2000 at Buck Mountain, and subsequent surveys in the Buck Mountain area in 2007, 2015, 2016, and 2018 did not detect the subspecies (Frey 2018a, p. 21; Frey 2018b p. 1). While the subspecies may still occur in the vicinity of Buck Mountain, if it does, it is at such a low density such that it is not detected via extensive trapping effort. Frey and Hays (2017, p. 9) suspect that the Peñasco least chipmunk has a core population at Sierra Blanca Peak, including the Lookout Mountain area. Preliminary results from a new study in 2018 (McKibben and Frey 2018, entire) have detected 8-11 individual Peñasco least chipmunks from Lookout Mountain and another 4-6 individuals from an adjacent meadow called Ice Springs (Table 5.2.3). The Frey and McKibben (2018, entire) study is assessing the efficacy of using camera traps to detect and identify Peñasco least chipmunks that includes individual marking and recapture techniques. It is our understanding that some individuals escaped prior to being identified whether it was a recapture, thus resulting in a range of potential individuals observed. Regardless, these are the greatest numbers of captures of Peñasco least chipmunks than for any other sampling effort since the early collections. However, the observations are in the same area as previously observed Peñasco least chipmunks and may be the result of a variety of influence that include natural variation in the number of chipmunks present (more chipmunks were available for detection than in other sampled years) or variation in sampling strategy or technique (we do not yet have detailed sampling protocols). While these preliminary data offer hope, we do not yet have information whether these individuals were young of year (thus resulting in relatively higher capture rates), or reflecting a year when greater numbers of individuals were present at the site. We are not aware of any surveys conducted after 1982 on Mescalero Apache tribal land on Sierra Blanca Peak. Overall, capture rates are relatively low, the number of very few detections relative to very high survey effort on Sierra Blanca Peak in 1982, 2016, and even 2018 (a high capture-rate year) compared to numbers of detections in those same meadows in 1931 and 1965-66 indicate a long-term declining trend in abundance. Therefore, the White Mountains has a Population Trend condition category of Low (-1).

*Population Connectivity.* The two populations of Peñasco least chipmunk are geographically separated by low-elevation areas not suitable for the subspecies to traverse. There is some genetic and morphological evidence that the two populations have been separated over time with little connectivity (Sullivan 1985, pp. 424-425). Population connectivity is important for the subspecies to maintain genetic diversity and to allow for recolonization events. If the Sacramento Mountains population is already extirpated or becomes extirpated, it is extremely unlikely that the Sacramento Mountains will be recolonized by chipmunks from the White Mountains. Similarly, if the Sacramento Mountains population is still extant, it would be extremely unlikely that chipmunks would ever move to and find the White Mountains population. Therefore, both the Sacramento and White Mountains populations have a Connectivity condition category of Very Low (-2).

*Subpopulations within Populations.* The Sacramento Mountains population of the Peñasco least chipmunk may be extirpated. If it persists undetected, then it is likely at very low numbers and lacking any subpopulation structure. The White Mountains population is currently known only from meadows at and around Sierra Blanca Peak. The open meadow habitat of Buck Mountain appears to be physically connected to the meadow habitat of Sierra Blanca Peak, and there is no evidence of any subpopulation structure for the White Mountains population. Therefore, both the Sacramento and White Mountains populations have a condition category of Very Low (-2) for Subpopulation structure.

*Availability of Suitable Habitat.* Current conditions of suitable habitat for both populations of Peñasco least chipmunk are presented in section 3.2. In the Sacramento Mountains, data indicate that there is currently an overall lack of suitable Peñasco least chipmunk habitat. The Sacramento Mountains thus have a condition category of Very Low (-2) for Availability of Suitable Habitat. We modeled available habitat in the White Mountains (Section 3.2) based on habitat characteristics of all known Peñasco least chipmunk occurrences in the White Mountains. This modeling resulted in an estimate of approximately 3,809 acres of available habitat. Much of the modeled habitat consists of large contiguous areas, with some isolated patches (Figure 3.2.2). Therefore, the White Mountains population has a condition category of Moderate (0) for Availability of Suitable Habitat.

*Habitat Availability Trends*. As described in Section 3.2., there is currently an overall lack of suitable Peñasco least chipmunk habitat in the Sacramento Mountains. Historical reports on the subspecies indicate that it was associated with mature ponderosa pine forest from approximately 6,900 to 8,000 feet in elevation (Frey 2018a, p. 15). This forest was described as "open, park-like stands within a grassland matrix" consisting of large-diameter ponderosa pine trees, with variable patches of small-diameter trees or open grass areas. Reports on Peñasco least chipmunks from the early 1900s also mentioned exceptionally high densities of the subspecies on rail fences adjacent to agricultural fields (Bailey 1913, pp. 129-130; Bailey 1931, p. 91). Current ponderosa pine forests and potential chipmunk habitat in the Sacramento Mountains have been described as significantly departed from the historical condition (82 FR 16989). Over the last century, ponderosa pine forests in the Sacramento Mountains have undergone significant use and management, such that outside of small, remote, and isolated areas, there remains little to none that resembles the historical mature ponderosa pine forests. Currently, these forests consist of high-density small-diameter ponderosa pine, with encroaching Douglas fir and white fir. Because of this removal of suitable habitat, the Sacramento Mountains population of the Peñasco least chipmunk has a Habitat Availability Trend condition category of Very Low (-2).

In the White Mountains, approximately 450 acres have been modified as a result of the development of the Ski Apache Resort and associated infrastructure. Of the total of a maximum historical 4,358 acres of potential habitat (3,908 + 450 Ski Acreage), alteration from development is approximately 10 percent. Habitat availability has also decreased by a small, but unmeasured amount from tree encroachment. Thus, the change in Peñasco least chipmunk habitat availability in the White Mountains is 0-25%. This population therefore has a Habitat Availability Trend condition category of Moderate (0).

*Habitat Condition*. Here, we combine our assessment of habitat condition described in section 3.2 with the land use and management described in section 4.1.1 to determine the condition category for habitat condition with land use or land management for each population. The Sacramento Mountains, where there is an overall lack of suitable Peñasco least chipmunk habitat due to historical uses and management, is further limited currently by continued livestock grazing and other factors, such as shifted forest vegetation and shifted fire regimes. Because these land use and management activities remove chipmunk resources, the Sacramento Mountain population has a current Habitat Condition category of Very Low (-2).

In the White Mountains, the most significant land use activities likely to affect Peñasco least chipmunk resources are related to the Ski Apache Resort on Lookout Mountain. Winter use of the area includes skiing and snowboarding, and summer use includes gondola rides, mountain biking, hiking, and zip lining. In 2016, three Peñasco least chipmunks were observed on two survey trap lines on Lookout Mountain. Two of these three observations were located just off of the access road that leads to and is in close proximity to the zip-line infrastructure. Even given these recreational activities on Lookout Mountain, this type of land use has not been observed to significantly decrease Peñasco least chipmunk resources in the area. For this reason, the White Mountains population has a Habitat Condition category of Moderate (0).

*Current Resiliency Condition of Peñasco Least Chipmunk Populations*. The current condition of each demographic and habitat factor and the overall condition of each population of the Peñasco least chipmunk is displayed in Table 5.2.4. Based on the demographic and habitat factors discussed, the Sacramento Mountains population is considered to be in Very Low (-2) overall condition. There have been no detections of Peñasco least chipmunk in the Sacramento Mountains since 1966, despite extensive survey effort, indicating that this population may be extirpated. Even if it is still extant, it has no connectivity with other populations and likely no subpopulation structure. The Sacramento Mountains have little to no remaining suitable habitat, and land use and management have severely decreased Peñasco least chipmunk resources.

For the White Mountains population, in terms of habitat factors, there is a moderate level of habitat availability and moderate habitat availability trends, and land use or management is not known to significantly reduce Peñasco least chipmunk resources. However, in terms of demographic factors, the White Mountains population has a low density and decreasing population trend. The population is extremely isolated (i.e., there would be no connectivity with the Sacramento Mountains population if it were extant), and the White Mountains population has no known subpopulation structure.  Given these Low and Very Low condition demographic factors, the White Mountains population is in Low (-1) overall condition.

Table 5.2.4. Current resiliency of the 2 populations of Peñasco least chipmunk in New Mexico.

| Population | Demographic Factors | | | | Habitat Factors | | | Condition Category |
|---|---|---|---|---|---|---|---|---|
| | Trap Rate (# Indivs/Trap Hr) Surrogate for Density | Population Trends | Population Connectivity | Subpopulations within Populations | Available Suitable Habitat to Support Population Persistence | Habitat Availability Trends | Habitat Condition with Land Use or Management | |
| **White Mountains** | Low | Low | Very Low | Very Low | Moderate | Moderate | Moderate | Low |
| | -1.5 | -1 | -2 | -2 | 0 | 0 | 0 | -1 |
| **Sacramento Mountains** | Very Low | Very Low | Very Low | Very Low | Very Low | Very Low | Very Low | Very Low |
| | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -2 |

## 5.3 Current Subspecies Representation

Maintaining representation in the form of genetic or ecological diversity is important to maintain the capacity of the Peñasco least chipmunk to adapt to future environmental changes. Because one of the two populations of Peñasco least chipmunk may be extirpated, and the extant population persists in extremely low numbers, genetic diversity is likely extremely low. Sullivan (1985, pp. 431-433) found that Peñasco least chipmunks in the White Mountains showed the lowest levels of within-population genetic variation out of nine least chipmunk populations in New Mexico, Arizona, and Colorado, with 1 allele per locus, 4.2% polymorphic loci, and an observed heterozygosity of 0. In addition, the subspecies has a historical distribution in two very different ecological settings: one in a high-elevation subalpine meadow zone in the White Mountains, and one in a lower-elevation ponderosa pine zone in the Sacramento Mountains. Because the Sacramento Mountains may no longer support the subspecies, the Peñasco least chipmunk has already lost ecological representation across its range.

## 5.4 Current Subspecies Redundancy

The Peñasco least chipmunk needs to have at least two resilient populations distributed throughout its range to provide for redundancy. Generally, the more populations a subspecies has, and the wider the distribution of those populations, the more redundancy the subspecies will exhibit. Redundancy reduces the risk that a large portion of the subspecies' range will be negatively affected by a catastrophic natural or anthropogenic event at a given point in time. Subspecies that are well-distributed across their historical ranges are considered less susceptible to extinction and more likely to be viable than subspecies confined to small portions of their ranges (Carroll et al. 2010, entire). Because one of the two populations of Peñasco least chipmunk may be extirpated, the Peñasco least chipmunk currently lacks any redundancy.

# CHAPTER 6 – VIABILITY

We have reviewed the individual, population, and subspecies needs of the Peñasco least chipmunk (Chapters 2 and 3), we reviewed the stressors that are driving the historical, current, and future conditions of the subspecies (Chapter 4), and we have considered what the Peñasco least chipmunk needs for viability, as well as the current condition of those needed resources (Chapter 5). We now consider the subspecies' likely future conditions given a breadth of future scenarios. We apply our future forecasts to the concepts of resiliency, redundancy, and representation to assess the future viability of the Peñasco least chipmunk.

### 6.1 Scenarios Assessment

We developed three future scenarios to consider the range of potential future conditions against which to assess the future viability of the Peñasco least chipmunk. The three scenarios are:

- Scenario 1 – Continuing Conditions;
- Scenario 2 – Optimistic; and
- Scenario 3 – Increased Stressors.

These future scenarios forecast the conditions of the Peñasco least chipmunk over the next approximate 30 years. This time frame was selected as it was a reasonable time period for a short-lived subspecies (average life span of 0.7 years (Erlien and Tester 1984, p. 2) and maximum known life span of 6 years (Reid 2006, p. 212); existing stressors and potential conservation actions are large-scale and long-term and would be forecasted to occur or need approximately 20-30 years to demonstrate change over time; and this period of time was in alignment with modeled local climate projections.

While we have data to inform us of the stressors that are impacting and are likely to impact Peñasco least chipmunk populations in the future, and we understand how the stressors can impact Peñasco least chipmunk, there is uncertainty regarding the exact risk of the stressors to each population because of limitations of the data. Consequently, we made the following assumptions about stressors in each of the mountain ranges supporting or potentially supporting populations of the Peñasco least chipmunk:

- There is little to no suitable habitat remaining on Forest Service Lands in the Sacramento Mountains. Restoration of habitat is limited by the resources and ability of the Forest Service to implement large-scale landscape restoration. However, there is a lack of data in the Sacramento Mountains regarding existing grass and forb species compared to historical native species of grasses and forbs that were suitable for food and cover for the Peñasco least chipmunk.
- Suitable, quality habitat does not currently appear to be a limiting factor for the Peñasco least chipmunk in the White Mountains.
- Because we have no information regarding habitat conditions or stressors for the Peñasco least chipmunk on Mescalero Apache Tribal lands for either population, we assume that conditions in each population are similar to the conditions and stressors that are present in areas on neighboring Forest Service lands (within the same population). We recognize

that conditions may be different, but have no information upon which to make other assumptions.

- The probability of detecting the subspecies when present is imperfect and less than one, meaning the more rare an organism is, the lower the probability of detection when present. This means there is some uncertainty as to whether the subspecies is still extant in areas where surveyed multiple times without detection. Because of this uncertainty, it is possible that the Peñasco least chipmunk is still extant in the Sacramento Mountains, despite not being detected since 1966. Similarly, the Peñasco least chipmunk may still occupy the specific area of Buck Mountain, in the White Mountains, despite it not being detected since 2000 (i.e., during 2007 or 2015 surveys).
- The number of individuals detected and available for collection during the first part of the 1900s reflects the relatively high abundance of Peñasco least chipmunks that occurred at that time in the Sacramento and White mountains, and the very low detection rates with high survey efforts from the 1960s to present reflect a relatively low abundance of the Peñasco least chipmunk. We assume that these changes over time (approximately 120 years) demonstrate a significant declining population trend in both populations of the Peñasco least chipmunk.
- Detection of any number of Peñasco least chipmunks equates to persistence of the subspecies in the surveyed population; continued lack of detection supports the possibility of extirpation of a population.

We developed three scenarios incorporating the stressors that are ongoing or will occur in the future to consider the range of possible future conditions. For each scenario, we describe the likely impact from the identified stressors that would occur in each population. All of the scenarios involve some degree of uncertainty; however, they present a range of realistic and plausible future conditions. Table 6.1.1 below summarizes the three scenarios and Table 6.1.2 summarizes the future resiliency condition category for each population of the Peñasco least chipmunk for each of the three future scenarios.

*Scenario 1 – Continuing Conditions*. Within Scenario 1, we assume that no conservation actions are implemented, as none are currently being implemented, and effects from stressors continue at the same rate as observed currently. Under this scenario, we assessed the viability of the Peñasco least chipmunk with no changes in conservation interventions, strategies, or ongoing actions or practices that are affecting the current status of the subspecies. Without any change in conservation actions or the rate of existing or ongoing stressors, we expect the viability of Peñasco least chipmunk to be characterized by a continued loss of resiliency, representation, and redundancy at the level that is currently occurring.

*Scenario 2 – Optimistic*. Under Scenario 2, we considered the viability of the Peñasco least chipmunk with the implementation of reasonable and practicable, but significant and expensive, conservation measures. Potential conservation measures under consideration are only those that are feasible; these actions are not known to be under way, under consideration for action, or funded in any way. The potential conservation measures included in this Optimistic scenario include an effective captive propagation program that incorporates a genetic and management plan; habitat restoration and reintroduction of animals from a captive program into the Sacramento Mountains and augmentation into the White Mountains; plague control; and forest and range management specifically for the conservation of the Peñasco least chipmunk.

*Scenario 3 –Increased Stressors*. Under Scenario 3, we considered the viability of the Peñasco least chipmunk with either an increase in stressors, an increase in the effects of stressors, or a decrease in conservation actions. However, we are not aware of any current conservation actions that could be decreased for this scenario. Potential new stressors included in this scenario are the initiation of livestock grazing in Peñasco least chipmunk habitat in the White Mountains; changes in habitat or food sources resulting from new development; new encroachment of feral hogs; and novel disease impacts. Increases in current stressors include increasing tree encroachment into open meadows. The stressor of low population abundance and lack of connectivity to another population are maintained at the same rate as seen under current conditions.

Table 6.1.1 Future Scenario Descriptions. The State of Stressors describes stressor conditions for each future scenario for each population. Change in Conservation Actions describes how future conservations actions would increase or decrease for each scenario; however, there are currently no ongoing or planned future conservation actions for the Peñasco least chipmunk; therefore, conservation actions cannot be continued under Scenario 1 or decreased under Scenario 3. Resulting Stressor Effects describes how the state of the stressors and change in conservation actions would most likely affect the Peñasco least chipmunk.

| | **State of Stressors** | **Change in Conservation Actions** | **Resulting Stressor Effects** |
|---|---|---|---|
| **Sacramento Mountains** | | | |
| Scenario 1: No Interventions | • Ongoing forest restoration efforts could change portions of what may have been historical habitat by reducing fuel loads and creating openings in forest stands.<br>• Wildfire continues with shifted fire regimes that result in relatively large-scale and high-severity wildfire.<br>• No change in land use practices, including livestock grazing.<br>• Tree encroachment continues at similar rate, or reduced in some areas through restoration activities.<br>• Exposure and risk to disease pathogens continues.<br>• Impacts from feral hogs continue at same rate.<br>• Low numbers and lack of connectivity limit the ability of the subspecies to persist or grow to greater abundance. | • No chipmunk conservation actions are underway; therefore, no change in conservation actions. | • Some areas of possible historical habitat may be improved with thinning and restoration treatments in the South Sacramento Mountains, but these are outside of the known historical distribution of the subspecies.<br>• Land use practices will continue to limit the availability of suitable habitat.<br>• Tree encroachment will continue at the same rate in some areas, and will be reduced in some areas, with the objective of re-establishing open areas for other land use practices (i.e., livestock grazing).<br>• Pathogens may limit populations.<br>• Feral hogs will continue to impact habitat, continue to prey upon small mammals, and be a vector for pathogens.<br>• Low number of individuals in population (if still extant) will likely remain low or decrease to extirpation due to low numbers and lack of connectivity. |

| | State of Stressors | Change in Conservation Actions | Resulting Stressor Effects |
|---|---|---|---|
| Scenario 2: Optimistic | | • Habitat restoration includes actions to provide needed resources for the Peñasco least chipmunk.<br>• Encroaching trees are removed from native grass meadow habitat.<br>• Land use and management, including livestock grazing, are implemented in ways compatible with the resource needs for the Peñasco least chipmunk.<br>• Effective feral hog eradication is implemented and maintained.<br>• Plague management actions are implemented in mammal communities within the range of Peñasco least chipmunk.<br>• Successful captive breeding and release program is instituted.<br>• Genetic management is implemented and maintained. | • Restoration of habitat specifically to meet the needs of the Peñasco least chipmunk will occur within the historical range of the subspecies, providing suitable habitat.<br>• Removal of encroaching trees will expand available habitat.<br>• Livestock use will not be a limiting factor in habitat suitability or use for the Peñasco least chipmunk.<br>• Impacts from feral hogs will be reduced or removed.<br>• Chipmunk population may have opportunity to recover if plague is a factor in population losses.<br>• Population will be supported and have the opportunity to expand with a captive breeding and reintroduction program.<br>• Genetics will be managed to maximize diversity. |
| Scenario 3: Increased Stressors | • Restoration actions do not consider Peñasco least chipmunk resource needs, and habitat conditions become less suitable or more difficult to restore.<br>• Wildfire continues with shifted fire regimes that result in relatively large-scale and high-severity wildfire.<br>• No change or slight increase in intensity of land use practices, including livestock grazing. | • No chipmunk conservation actions are underway; therefore, no change in conservation actions. | • Forest restoration activities will contribute to limiting the availability of suitable chipmunk habitat.<br>• Land use practices will continue to limit the availability of suitable habitat.<br>• Tree encroachment will continue at the same rate in some areas, and will be reduced in some areas, with the objective of re-establishing open areas for other land use practices (i.e., livestock grazing).<br>• Pathogens may limit populations. |

| | State of Stressors | Change in Conservation Actions | Resulting Stressor Effects |
|---|---|---|---|
| | • Tree encroachment continues at a similar rate.<br>• Exposure and risk from pathogens remains the same or similar.<br>• Impacts from feral hogs continue at a similar or an increased rate.<br>• Low numbers and lack of connectivity limit the ability of the subspecies to persist or grow to greater abundance. | | • Feral hogs will continue to impact habitat, continue to prey upon small mammals, and be a vector for pathogens.<br>• Low number of individuals in population (if still extant) will likely remain low or decrease to extirpation due to low numbers and lack of connectivity. |
| **White Mountains** | | | |
| Scenario 1<br>No Interventions | • Wildfire patterns continue that result in relatively large-scale and high-severity wildfire.<br>• No change in land use practices.<br>• Development of the area around Ski Apache Resort continues at same rate.<br>• Tree encroachment continues at similar rate.<br>• Exposure and risk to pathogens continues.<br>• Low numbers and lack of connectivity limit the ability of the subspecies to persist or grow to greater abundance. | No chipmunk conservation are underway; therefore, no change in conservation actions. | • Continued development will result in small incremental impacts of loss of habitat, and possibly some direct mortality.<br>• Tree encroachment will continue at the same rate, resulting in shrinking the amount of suitable habitat.<br>• Pathogens may limit populations.<br>• Feral hogs may move into occupied habitat, resulting in predation and increasing the risk of exposure to pathogens.<br>• Low number of individuals in population will likely remain low or decrease due to low numbers and lack of connectivity. |
| Scenario 2<br>Optimistic | | • Encroaching trees are removed from native grass meadow habitat.<br>• Land use continues to maintain non-grazing status.<br>• Development is restricted to no new development or infrastructure. | • Removal of encroaching trees will expand available habitat.<br>• Availability or quality of suitable habitat will not be impacted from livestock or other land use actions. |

| | State of Stressors | Change in Conservation Actions | Resulting Stressor Effects |
| --- | --- | --- | --- |
| | | • Effective feral hog eradication is implemented and maintained.<br>• Plague management actions are implemented in mammal communities within the range of Peñasco least chipmunk.<br>• Successful captive breeding and release program is instituted.<br>• Genetic management is implemented and maintained. | • Suitable habitat availability will not be reduced or removed by development actions.<br>• Impacts from feral hogs will be reduced or removed.<br>• Population may have opportunity to recover if plague is a factor in population losses.<br>• Population will be supported and have the opportunity to expand with a captive breeding and reintroduction program.<br>• Genetics will be managed to maximize diversity. |
| Scenario 3 Increased Stressors | • Wildfire patterns continue that result in relatively large-scale and high-severity wildfire.<br>• Land use practices change and allow livestock grazing.<br>• Tree encroachment continues at a similar rate.<br>• Exposure and risk to pathogens continues.<br>• Feral hogs move into occupied Peñasco least chipmunk habitat.<br>• Low numbers and lack of connectivity continue to limit population growth and contribute to the continued decreasing trend. | No chipmunk conservation are underway; therefore, no change in conservation actions. | • Land use practices will decrease the quality or availability of suitable habitat.<br>• Tree encroachment will continue at the same rate.<br>• Pathogens may limit populations.<br>• Feral hogs will impact habitat, prey upon small mammals, and be a vector for pathogens.<br>• Low number of individuals in population will likely remain low or decrease to extirpation due to low numbers and lack of connectivity. |

Table 6.1.2 Future resiliency condition category for each population of the Peñasco least chipmunk for each of the three future scenarios.

| | | Demographic Factors | | | | Habitat Factors | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Population** | **Scenario** | **Trap Rate (Surrogate for Density)** | **Population Trends** | **Population Connectivity** | **Subpopulations within Populations** | **Availability of Suitable Habitat** | **Habitat Availability Trends** | **Habitat Condition** | **Condition Category** |
| **Sacramento Mountains** | Scenario 1: Continuing Conditions | Very Low/ Extirpated | Very Low/ Extirpated | Very Low/ Extirpated | Very Low/ Extirpated | Very Low/ Extirpated | Very Low/ Extirpated | Very Low/ Extirpated | **Very Low/ Extirpated** |
| | | -2 | -2 | -2 | -2 | -2 | -2 | -2 | **-2.00** |
| | Scenario 2: Optimistic | Very Low/ Extirpated | Low | Moderate | Low | Low | Low | Low | **Low** |
| | | -2 | -1 | 0 | -1 | -1 | -1 | -1 | **-1.00** |
| | Scenario 3: Increased Stressors | Very Low/ Extirpated | Very Low/ Extirpated | Very Low/ Extirpated | Very Low /Extirpated | Very Low/ Extirpated | Very Low/ Extirpated | Very Low/ Extirpated | **Very Low/ Extirpated** |
| | | -2 | -2 | -2 | -2 | -2 | -2 | -2 | **-2.00** |
| | | | | | | | | | |
| **White Mountains** | Scenario 1: Continuing Conditions | Very Low/Low | Very Low/ Extirpated | Very Low/ Extirpated | Very Low/ Extirpated | Moderate | Moderate | Low | **Low** |
| | | -1.5 | -2 | -2 | -2 | 0 | 0 | -1 | **-1.21** |
| | Scenario 2: Optimistic | Low | Moderate | Moderate | Low | Moderate | Moderate | Moderate | **Moderate** |
| | | -1 | 0 | 0 | -1 | 0 | 0 | 0 | **-0.29** |
| | Scenario 3: Increased Stressors | Very Low/ Extirpated | Very Low/ Extirpated | Very Low/ Extirpated | Very Low/ Extirpated | Low | Low | Low/Very Low | **Very Low/ Extirpated** |
| | | -2 | -2 | -2 | -2 | -1 | -1 | -1.5 | **-1.64** |

*Results*

As we did with the current condition assessment (Table 5.2.3), we averaged all of the condition category scores for each population for each scenario to assess the population resiliency for the Peñasco least chipmunk for each future scenario (Table 6.1.2). We examined the resiliency, representation, and redundancy of the Peñasco least chipmunk under each of three scenarios (Table 6.1.1). Only under the optimistic Scenario 2, with the initiation and implementation of long-term and resource-intensive conservation actions could the resiliency, representation, and redundancy of the Peñasco least chipmunk be improved from the current very low and low conditions to low and moderate conditions, respectively, for the Sacramento and White Mountains populations.

Scenario 1: Continuing Conditions:

The Continuing Conditions scenario represents the continuation of risks that contribute to the current condition, and projects those risks into the future at the same rates as are currently occurring, and without any addition of conservation measures (Table 6.1.1). Because there are no conservation measures currently in place or known to be planned for the Peñasco least chipmunk, there were no conservation measures to continue into the future. Under this Continuing Conditions scenario, we anticipate that the Sacramento Mountains population would remain in Very Low overall condition, with all demographic and habitat factors in Very Low condition, as is seen under current conditions. The White Mountains population would remain in Low overall condition, but with a decrease in the Population Trends and Habitat Condition with Land Use or Management factors relative to current conditions. Because the Peñasco least chipmunk currently lacks resiliency, representation, and redundancy, any further loss as projected under the Continuing Conditions scenario would result in low and continued decreasing viability for the subspecies.

Scenario 2: Optimistic:

The Optimistic scenario provides an idea of the best possible conditions for populations over the next 30 years. Under the Optimistic scenario, those stressors that are having a negative influence on populations of Peñasco least chipmunk continue at current rates or are decreased (Table 6.1.1). In this scenario, the following risks remain probable: limited suitable habitat within the Sacramento Mountains; if disease is an issue, it will likely continue to be a long-term issue; small population size and relatively low density; and lack of connectivity within and between populations. However, conservation measures, including restoring habitat in the Sacramento Mountains, managing encroaching trees into open habitat, aligning land use practices and management that are compatible with Peñasco least chipmunk habitat needs, effective feral hog control, plague management and control, and the implementation of a successful captive breeding and release program that also incorporates genetic management would allow the populations to recover from low densities and isolation and become reestablished across the landscape in both the Sacramento Mountains and the White Mountains, contributing to bolstering the resiliency of the subspecies. Under this Optimistic scenario, we anticipate that the Sacramento Mountains population would improve to a Low overall condition, with increases in population trends, connectivity, and number of subpopulations due to a captive breeding and release program, creation of suitable habitat, and implementation of other conservation measures. Under this scenario, the White Mountains population would improve to a Moderate overall condition, with, again, increases in population trends, connectivity, and number of subpopulations.  Under this scenario, we expect the viability of the Peñasco least chipmunk to be characterized by higher levels of resiliency, representation, and redundancy than it exhibits under current conditions, but to remain low over the assessed time period relative to levels needed for long-term viability of the subspecies.

Scenario 3: Increased Stressors

The Increased Stressors scenario provides an example of a future in which the Peñasco least chipmunk is subject to an increase in stressors and risk (Table 6.1.1).  Under this scenario, we anticipate that the Sacramento Mountains population would remain in Very Low overall condition, with all demographic and habitat factors remaining in Very Low condition.  The White Mountains population would decline to Very Low condition from its current Low condition.  This is due to decreases in density, population trends, availability of suitable habitat, and habitat condition in the White Mountains under this scenario.  Overall, increases in stressors or effects of stressors would decrease the viability of the Peñasco least chipmunk, with a reduction in resiliency, representation, and redundancy.  As with the Continuing Conditions scenario, because the Peñasco least chipmunk currently lacks resiliency, representation, and redundancy, any further loss as projected under this Increased Stressors scenario would result in high vulnerability to extirpation.

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