Nevada Bat Conservation Plan

Original art by Hanna Muntz

Prepared By:
The Nevada Bat Working Group
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Nevada Bat Conservation Plan Authors

The Nevada Bat Conservation Plan was developed by a small subgroup of professionals within the Nevada Bat Working Group. These dedicated individuals participated in the drafting, editing, and review of this document, which is intended to guide bat survey, research, and conservation efforts within the state.

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The Nevada Bat Conservation Plan was released to members of the Nevada Bat Working Group for review in July 2024. Several authors, as well as the reviewers listed below, participated in the final editing process.

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Cover Art:

The cover of this document contains original watercolor artwork by Hanna Muntz.

Additional Acknowledgements

A revision of the 2006 Nevada Bat Conservation Plan was attempted approximately 10 years prior to this version of the document. Authors of the 2024 Plan used materials written or compiled by the previous revision team, which was also a subset of the Nevada Bat Working Group.

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The Nevada Bat Working Group (NBWG). 2024. Nevada Bat Conservation Plan.

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ACRONYMS AND ABBREVIATIONS

ac	acre(s)
AML	Abandoned Mine Land
AMP	Assess-Modify-Protect
BACI	before after-control impact
BAER	burned area emergency response
BAR	burned area rehabilitation
BCC	bat-compatible closure
BLM	Bureau of Land Management
BMP	Best Management Practice
BSG	Bat Special Group
cm	centimeter(s)
CS	Concentrated Solar
dbh	diameter at breast height
EPA	U.S. Environmental Protection Agency
ft	foot(feet)
g	gram(s)
ha	hectare(s)
HRIG	human rabies immune globulin
ITIS	Integrated Taxonomic Information System
IUCN	International Union for Conservation of Nature
km	kilometer(s)
km^2	square kilometer(s)
kV	kilovolt(s)
lb	pound(s)
m	meter(s)
mi	miles(s)
mi^2	square mile(s)
mm	millimeter(s)
mph	mile(s) per hour
mps	meter(s) per second
MW	megawatt(s)
MWh	megawatt hr(s)
mya	million years ago
NBCP	Nevada Bat Conservation Plan
NBWG	Nevada Bat Working Group
NDNH	Nevada Division of Natural Heritage
NDOM	Nevada Division of Minerals
NDOT	Nevada Department of Transportation
NDOW	Nevada Department of Wildlife

NPS	National Park Service
NV	Nevada
oz	ounce(s)
PIT	passive integrated transponder
PPE	personal protective equipment
PV	photovoltaic
ROW	right(s)-of-way
SEZ	Solar Energy Zone
SSC	Species Survival Commission
USFS	United States Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
U.S.	United States
WNS	White-nose syndrome

1. INTRODUCTION

1.1. Purpose and Need

Approximately 15% of Nevada's mammal species are bats. The Nevada Bat Conservation Plan (NBCP) covers the 23 bat species known to regularly occur in the state. Since at least 1998, the Nevada Bat Working Group (NBWG) has been dedicated to bat conservation in the state. The first Nevada Bat Conservation Plan was completed by the NBWG in 2002, and a revision was completed in 2006. The purpose of this revision of the NBCP is to provide a comprehensive document addressing the current state of knowledge and recommendations for bat conservation within the state.

The NBCP provides:

1. Updated information about bats in Nevada.
2. Identified threats to bats and their habitats in Nevada.
3. Conservation Strategies that can be implemented to protect, conserve, and reduce threats to bat populations and their habitats.
4. Helpful references and resources (including existing Best Management Practices (BMPs)) to improve knowledge about bats in Nevada and promote bat conservation.
5. Ways to promote healthy bat habitats and stable or increasing bat populations throughout the state precluding the need for federal Endangered Species Act protection.

1.2. Bat Species Protection in Nevada

In the state of Nevada, "all bats in the order Chirpotera", which includes all Nevada bat species, are designated as protected mammals under state regulation (Adopted Regulations, NAC 503.030, and Agenda Item VI A-1) as of 2022.

To be classified as "protected", one or more of the following criteria exists (NAC 503.103):

1. The wildlife is found only in Nevada and its population, distribution, or habitat is limited.
2. The wildlife has a limited population or distribution within Nevada that is likely to decline as a result of human or natural causes.
3. The population of the wildlife is threatened as a result of the deterioration or loss of its habitat.
4. The wildlife has ecological, scientific, educational or other value that justifies its classification as protected.
5. The available data are not adequate to determine the exact status of the population of the wildlife, but indicate a limited population, distribution, or habitat.
6. The wildlife is listed by the United States Fish and Wildlife Service (USFWS) in the Federal Register as a candidate species, or it is classified as threatened or endangered in the Endangered Species Act of 1973, as amended, 16 U.S.C. §§ 1531 et seq.
7. Other evidence exists to justify classifying the wildlife as protected.

1.3. Conservation Strategies

Conservation Strategies (Section 6) in the NBCP were developed to conserve important bat habitat (see Sections 6.1 Natural Habitat and 6.2 Urban Habitat) and address threats to bats (see Sections: 6.3 Habitat Loss Degradation, 6.4 Energy Development, 6.5 Mining and Mineral Exploration, 6.6 Historical and Renewed Mining, and 6.7 White-nose Syndrome). Each Conservation Strategy provides background concerning current threats and guidance intended to reduce impacts on Nevada bat populations and their habitats. Conservation Strategies are supported by scientific research, peer-reviewed literature, and conservation plans developed for other states.

1.4. Future Nevada Bat Conservation Plan Updates

The NBCP is a living document. A small team from the NBWG will actively update resources and guidance annually or as needed.

Updates may include:

- New BMPs regarding bats in Nevada
- Changes in species status
- New research on how to mitigate for impacts to bats
- Development of additional conservation strategies as issues arise
- Changes to the status of White-nose syndrome (WNS) in Nevada

Feedback or information that may be used in the NBCP can be directed to:

NevadaBWG@gmail.com OR
The current NV Bat Working Group Co-Chairs (https://www.pacwestbats.org/nbwg-about)

Responses to inquiries may be made annually or 'as-needed'.

2. NATURAL HISTORY

2.1. Evolutionary History of Bats

Bats are one of the most abundant and diverse groups of living mammals; however, they have one of the poorest fossil records (Taylor and Tuttle 2019). Bats are in the taxonomic order Chiroptera, which translates to "hand wings." The bones of the hand are significantly elongated and attached by a vascular membrane to form the wings of this only true flying mammal. When in the evolutionary history of bats these traits began to occur is not known. The earliest known fossils of true bats in North America date back approximately 52 million years ago (mya). Over 1,000 fossil bats have been collected over the years and all specimens were fully formed, capable of powered flapping flight and echolocation (Werner and Werner 2008). Evolution suggests that there should be fossils of "precursor" bats, maybe as ground-dwelling mammals with partially developed wings not yet capable of flight, but with climbing abilities; or maybe as nocturnal, insectivorous, tree-dwellers (Speakman 2001). However, the fossil record is lacking in these types of specimens. Therefore, what we know about bats today relies largely on extant species, a relatively small number of fossils of fully formed bats, and several hypotheses about their evolution.

The fossil record is lacking in bat specimens in part due to the rarity of bats in situations where fossil preservation occurs (e.g., sedimentary deposits) and in the difficulty of identifying the specimens that are recovered, namely isolated teeth (Czaplewski 1993). If early bat ancestors were mostly tree dwelling, then they would rarely, if ever, be in situations that would create fossil records (Czaplewski 1993, Speakman 2001). Therefore, many species may have lived and died with no telltale signs they ever existed.

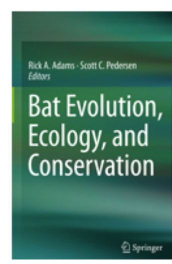
Although the bat fossil record is poor, there are important fossil sites in the U.S. where bat specimens have been found. The oldest known fossil bats include *Onychonycteris finneyi* (52 mya) and *Icaronycteris index* (50 mya), both found in the Green River Formation in Wyoming (Werner and Werner 2008, MacDonald 2009, Jepsen 1966). The Gray Fossil Site, which was discovered in 2000 in the Appalachian Mountains of northeast Tennessee, is dated from the late Miocene to the early Pliocene and contains a highly diverse paleobiota including specimens of big brown bat (*Eptesicus fuscus*), a species that still occurs today throughout the U.S. (Czaplewski 2017). In fact, big brown bats are represented in the fossil record more than any other bat in North America. This species has been recorded at more than 30 sites in North and South America including the West Indies (Kurta and Baker 1990). Interestingly, the Reddick Cave in central Florida is known for the recovery of vampire bat (*Desmodus stocki*) fossil specimens that date between 120,000-5,000 years ago. Vampire bats do not occur in North America today, but fossilized vampire bats have been recovered in Virginia, Florida, Texas, New Mexico, Arizona, and California (Gut 1959, FMNH 2021).

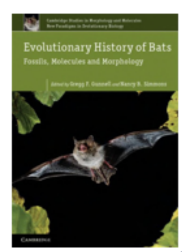
Additional Fossil Record Information

This section presents a summary and is not meant to be an exhaustive account of the bat fossil record. Refer to the following resources and the literature cited to delve further into the topic of bat evolution.

- Adams, R. A., and S. C. Pedersen (eds.). 2013. Bat Evolution, Ecology, and Conservation. Springer, New York, 547 pp.

- Gunnell, G. F., and N. B. Simmons (eds.). 2012. Evolutionary History of Bats: Fossils, Molecules, and Morphology. Cambridge University Press, Cambridge, United Kingdom, 572 pp.





The genus *Lasiurus* (hairy-tailed bats or red bats) is known from the Pliocene (5.3 to 2.6 mya) in North America and the pallid bat (*Antrozous pallidus*) is known from the late Miocene (11.6 to 5.3 mya) to the late Pleistocene (2.6 to 1.8 mya) from fossils in the U.S. (Czaplewski 1993). The hoary bat (*Lasiurus* *cinereus*) and the pallid bat were both found at the La Brea Tar Pits in Los Angeles, California, which date to approximately 50,000 years ago (Pleistocene) (La Brea Tar Pits and Museum 2021).

Due to the poor fossil record, there are many hypotheses about how bats first evolved and who their early ancestors are. Hypotheses include "ground-up", "tree-down", echolocation first, flight first, and co-evolution of echolocation and flight. Whichever is correct, we will never be able to fully prove them without fossils older than the oldest known today. Scientists suggest that fossils 50-66 million years old will help continue to tell the story of bat evolution (Black 2020).

2.2. Ecological Importance

Globally, bats provide a wide variety of ecosystem services. The most notable are pest control, pollination, and seed dispersal. Bats are also important cultural icons, provide inspiration for the medical industry and engineering, and in some areas support ecotourism. Following is a summary of the ecosystem services bats are known to provide in Nevada.

Insect Control

All Nevada bat species are insectivorous. Insectivorous bats consume a large variety of insects including many that are considered agricultural pests, pests that annoy, or transmit pathogens to humans. Prior to the use of molecular techniques, the identification of pests consumed by bats occurred through fecal dissection and the evaluation of stomach contents, which only resulted in high-level identification of the invertebrate prey item (e.g., order or family). DNA studies of bat guano can now identify the prey item to species (Kunz et al. 2011), which provides a much better understanding of which invertebrates are being consumed. Quantifying the impact of bat insect consumption within an ecosystem or agricultural area is difficult, however. These types of studies have many variables and many assumptions, and although the conclusion can be made that bats are beneficial, the economic value is more difficult to determine (Kunz et al. 2011).

Studies have shown that insectivorous bats consume more than 25% of their body mass in insects each night. Species specific studies concluded that during peak lactation a little brown myotis (*Myotis lucifugus*) female needs to consume more than 100% of her body mass in insects each night, and Mexican free-tailed bat (*Tadarida brasiliensis*) females consume up to 70% of their body mass in insects each night (Kasso and Balakrishnan 2013). Mexican free-tailed bats also tend to increase foraging efficiency by only consuming the nutrient-rich abdomen of moths and discarding less nutritional parts (head, wings, and appendages). Using this information, it is estimated that a maternity colony of one million Mexican free-tailed bats weighing 12 g (0.4 oz) each could consume up to 8.4 metric tons of insects each night (Kasso and Balakrishnan 2013). That's more than 18,500 pounds of insects removed from the ecosystem every night!

Support of Cave Communities

Insectivorous bats in cave ecosystems provide nutrients like nitrogen and phosphorus through their guano. These nutrients are important to invertebrate cave dwellers such as mites, pseudoscorpions, beetles, thrips, moths, and flies (Kunz et al. 2011, Kasso and Balakrishnan 2013, NPS 2021).

Prey for Other Wildlife

Although a small proportion of their diets, bats are prey for a number of predators including hawks, falcons, owls, snakes, raccoons, ringtails, and opossums (Kasso and Balakrishnan 2013).

Bioindicators of Healthy Ecosystems

Bioindicators are organisms in an ecosystem that may be used to understand the health of that ecosystem. Based on a review of scientific articles researching the potential of bats as bioindicators, Russo et al. (2021) concluded that bats may be promising bioindicators in riverine systems and can also be used (humanely through fur samples) as indicators of the presence of contaminants.

Contributors to Ecosystem Stability

Bats contribute to "nutrient redistribution over the landscape via the 'pepper-shaker effect.' Because insectivorous bats consume energy rich prey, experience rapid digestion during flight, and forage significant distances over heterogeneous habitat types, it is expected that guano is sprinkled over the landscape throughout the night. Thus, bats contribute to nutrient redistribution from nutrient-rich sources (e.g., lakes and rivers) to nutrient-poor regions (e.g., arid or upland landscapes)" (Kunz et al. 2011).

2.3. Economic Importance

Agriculture Pest Control

Insectivorous bats save the United States (U.S.) agriculture industry billions of dollars each year in pest control. Boyles et al. (2011) estimated bats' pest control "service" to be valued between $3.7 billion and $53 billion per year for the continental U.S. and between $3.5 million and $50.5 million per year for Nevada (see Section 6.3.1 Agriculture). This valuation does not include benefits provided by bats outside of an agricultural landscape. Bats also provide pest control in forest ecosystems, potentially benefitting the lumber industry. It also doesn't include costs of pesticides used in the absence of bats, nor does the estimate include potential for reducing evolved resistance of insects to pesticides and genetically modified crops. Therefore, the actual monetary value of bats in the U.S. may be much greater than Boyles et al. (2011) estimated.

2.4. Movement and Seasonality

2.4.1. Torpor and Hibernation

Most insectivorous bat species cope with cold weather and disappearance of insect food supply during the winter through torpor, hibernation, or migration. Non-migratory bats use torpor and hibernation to survive the winter. Torpor is an involuntary, physiological strategy that is used during the cold season. It is a deep state of metabolic suppression, lowered body temperature, and decreased heart rate that some animals (mostly birds and mammals) use to conserve energy during extreme weather conditions, limited food resources, or other periods of inactivity (Besler and Broders 2019, van Breukelen and Martin 2015). Torpor can be expressed in a number of different patterns (van Breukelen and Martin 2015). It can last for several hours to endure a cold day or severe storm, or can extend for weeks or months during winter, at which point it is known as hibernation. The use of torpor for several hours on a daily basis prior to the hibernation period allows bats to expend less energy and increase fat stores necessary for the upcoming cold season (Speakman and Rowland 1999). In a state of torpor, a bat's heart rate can decrease to 10 beats per minute (from 200 - 300 beats per minute) and its body temperature can drop to near freezing (NPS 2020). Some hibernating bats may form dense clusters for protection against drastic temperature changes and dehydration (Taylor and Tuttle 2019).


Hibernating myotis near Jarbidge, Nevada - Almeta Helmig

The use of torpor and torpor patterns vary amongst species and individuals. Many environmental variables including weather conditions, food availability, geography, reproductive status, and roosting location affect the frequency, duration, and depth of an individual's use of torpor (Besler and Broders 2019, Rintoul and Brigham 2014). For instance, long-eared myotis are known to take advantage of rock crevices as roost sites while pregnant, optimizing the use of torpor to maximize energy reserves during this energetically demanding period (see Section 6.1.1 Caves, Rock Crevices, and Talus Slopes).

Information on winter roosts used for hibernation or torpor in Nevada is limited due to challenges in detection and accessibility. Bats roosting singly, outside of caves and mines (e.g. rock crevices, trees, leaf litter), and at high elevations are poorly understood.

2.4.2. Migration Strategies

Nevada is the seventh largest state in the U.S., covering 110,540 square miles. It is the driest and most mountainous states in the country, providing a wide range of habitat and appropriate seasonal conditions for bats at different elevations and climates. Some Nevada bat species make short latitudinal or elevational movements in search of prey, appropriate roosts, or water, while others take on long distance migrations for a complete change in climactic condition.

Resident bat species often migrate locally, taking advantage of changes in temperatures at different altitudes in Nevada mountain ranges and valleys. Insect hatching periods likely start earlier at low-elevation sites, while higher-elevation caves provide the low temperatures required for bouts of torpor in poor conditions. Bats use short-range seasonal movements to help balance the cost of foraging activity with the need for food. Residency status is not confirmed for all Nevada bat species. More research is required to determine if Nevada bats migrate, hibernate, or remain active year-round.

Table 1: Known bat residency in Nevada

Common Name(s)	**Scientific Name**	**Resident**	**Migrant***
Allen's big-eared bat	*Idionycteris phyllotis*	Yes	
Big brown bat	*Eptuscus fuscus*	Yes	
Big free-tailed bat	*Nyctinomops macrotis*		Yes
California leaf-nosed bat	*Macrotus californicus*	Yes	
California myotis	*Myotis californicus*	Yes	
Canyon bat, western pipistrelle	*Parastrellus Hesperus*	Yes	
Cave myotis	*Myotis velifer*	Yes	
Fringed myotis	*Myotis thysanodes*	Yes	
Hoary bat	*Lasiurus cinereus*		Yes
Little brown myotis, little brown bat	*Myotis lucifugus*	Yes	
Long-eared myotis	*Myotis evotis*	Probable	
Long-legged myotis	*Myotis volans*	Yes	
Mexican free-tailed bat, Brazilian free-tailed bat	*Tadarida brasiliensis*	Yes	Yes
Pallid bat	*Antrozous pallidus*	Yes	
Pocket free-tailed bat	*Nyctinomops femorosaccus*	Unknown	Unknown
Silver-haired bat	*Lasionycteris noctivagans*	Yes	Yes
Spotted bat	*Euderma maculatum*	Yes	
Western big-eared bat, Townsends big-eared bat	*Corynorhinus townsendii*	Yes	
Western mastiff bat, greater bonneted bat	*Eumops perotis*	Yes	
Western red bat	*Lasiurus frantzii*	Yes	Yes
Western small-footed myotis	*Myotis ciliolabrum*	Yes	
Western yellow bat	*Lasiurus xanthinus*	Yes	Yes
Yuma myotis	*Yuma myotis*	Unknown	Unknown

*For the purposes of this table, ‘migrant’ refers to bats known to migrate long distances outside of Nevada. Some ‘migrant’ populations may also travel shorter distances within the state to find suitable seasonal habitat, these populations are considered both ‘migrant’ and ‘resident.’

Species such as the hoary bat, western red bat, and Mexican free-tailed bat are known to migrate long distances at high altitude. The Mexican free-tailed bat is the best-known migratory bat species and can travel thousands of miles from their breeding grounds in the U.S. to wintering grounds from Mexico to Brazil, sometimes covering more than 500 km (300 mi) in one night. During their long migration they will travel at altitudes as high as 3,000 m (10,000 ft) and at an average speed of 97 kmh (60 mph); however, with the appropriate wind conditions they can reach speeds of 160 kmh (100 mph) (Taylor and Tuttle 2019). Within Nevada, colonies of Mexican free-tailed bats are also known to migrate locally to find preferred conditions during maternity season.

2.5. Public Health

2.5.1. Rabies

Rabies is a fatal but preventable viral disease transmitted through the bite or saliva of an infected animal. Rabies infection causes encephalitis (inflammation of the brain) and a wide range of symptoms in humans from flu-like symptoms at the onset to delirium and hallucinations as the disease progresses. Once clinical signs appear, the disease is nearly always fatal. However, the disease is preventable if treated quickly and adequately through post-exposure prophylaxis, which consists of a single injection of human rabies immune globulin (HRIG) and a series of four doses of the rabies vaccine (Franka et al. 2009, CDC 2021). Bat bites can be very subtle; the CDC recommends that if a person awakens to a bat in their home or if a bat is found in the presence of someone who cannot verbalize if a bite occurred (e.g., a child or those with diminished mental capacity), and the bat cannot be submitted for testing, the person should contact their doctor to receive the post-exposure prophylaxis vaccine (CDC 2021). Symptoms in animals are similar to humans, from early, non-specific symptoms to neurological symptoms and death (CDC 2021). In addition to bats, other wildlife known to commonly become infected with the rabies virus include raccoons, foxes, and skunks (Ma et al. 2021, CDC 2021).

The rabies virus is in the family Rhabdoviridae and genus *Lyssavirus* and only affects mammals (CDC 2021, Kuzmin et al. 2011). The family of Rhabdoviruses is so named because Rhabdos is Greek for rod, and the rabies virus is rod-shaped. The genus *Lyssavirus* is named for the Greek word, Lyssa, which means frenzy and describes the state of the victim if infected and untreated (Ryan 2020). Some bats have a symbiotic (commensal—the virus does not affect the bat) relationship with the rabies virus, hence infected bats may show no signs of disease (Ryan 2020). Research shows that bats have been harboring the rabies virus for at least 7,000-12,000 years (Wasik and Murphy 2013).

Symbiosis

Symbiosis is a term used to describe any association between two species that live together, regardless of whether the species benefit, harm, or have no effect on each other.

There are three types of symbiosis

1. Mutualism - both species benefit (e.g., the plant/pollinator relationship)
2. Commensalism - one species benefits but does not benefit or harm the other species (e.g., bats and the rabies virus)
3. Parasitism - one species benefits at the expense of the other (e.g., ticks in the truest sense or cuckoos and cowbirds in the case of brood parasitism)

References: https://en.wikipedia.org/wiki/Symbiosis and https://www.britannica.com/science/symbiosis.

Although some bat species (e.g., big brown bats and little brown myotis) are known to have a commensal relationship with the rabies virus (Davis et al. 2016), others do not and are affected. Bat species in the U.S. that have died from rabies infection include western big-eared bat, spotted bat, western mastiff bat, California leaf-nosed bat, western small-footed myotis, long-eared myotis, fringed myotis, cave myotis, long-legged myotis, Yuma myotis, and big free-tailed bat. Regardless, individual bat deaths from rabies infections are not widespread enough that it is considered a threat to these species (O'Shea et al. 2018). However, this list does highlight the fact that all species of bats in Nevada are potential rabies vectors.

Rabies in insectivorous bats was first documented in the U.S. in 1953 in Florida (Kuzmin 2011), and rabies-carrying bats are found in all states except Hawaii (Wasik and Murphy 2013). Maintenance of the rabies virus in natural populations is likely influenced by the species ecology and sociality (Klug et al. 2011). Wide-ranging bat species such as the Mexican free-tailed bat (*Tadarida brasiliensis*) and big brown bat (*Eptesicus fuscus*), and migratory species such as *Lasiurus* species and silver-haired bat (*Lasionycteris noctivagans*), maintain the rabies virus throughout their ranges (Kuzmin 2011, Kuzmin and Rupprecht 2007). Individuals that roost in large colonies (e.g., Mexican free-tailed bat) do so in close proximity to each other, which increases the opportunity for the rabies virus to spread from bat to bat. Conversely, species with small colony sizes, or a solitary lifestyle (e.g., hoary bat) have less opportunity for transfer of rabies between individuals (Klug et al. 2011).

Bats became one of the most significant sources of rabies in the U.S. after an effective vaccination program eliminated canine rabies in 2007 (Kuzmin 2011, CDC 2021). Nonetheless, human rabies cases in the U.S. are rare. Between 2003 and 2018, 24 cases of rabies contracted directly from bats were reported, only two of which survived their infection, solidifying the fact that human cases are rare, but most do not recover from the disease once clinical symptoms occur (Rohde 2020). No human rabies cases were reported in the U.S. in 2019 (Ma et al. 2021) or 2020 (CDC 2022); however, five cases were reported in 2021 (CDC 2022) transmitted by unspecified rabies vector species.

U.S. Human Rabies Cases

For current data on human rabies cases in the US, Search "rabies surveillance in the United States" at https://pubmed.ncbi.nlm.nih.gov/.

In the 11 years spanning 2010-2020, 1,109 Nevada bat specimens were submitted to the Nevada Department of Agriculture for rabies testing. Of those, 175 (16%) specimens representing at least 10 species tested positive (Nevada Department of Agriculture 2021). It should be noted that specimens submitted for testing are often found dead or are exhibiting unusual behavior, creating a sampling bias and likely overestimation when trying to determine the percentage of bats carrying rabies. Studies suggest that rabies prevalence in natural populations is around or below 1% across all bat species (Klug et al. 2011). Bats appearing healthy with no unusual behavior are not typically tested; therefore, the true percentage of bats carrying the rabies virus in general bat populations is unknown and difficult to measure because rabies testing requires euthanizing the bat. In addition, the roosting ecology of the species may influence the number of specimens submitted for testing, thus impacting the degree of rabies prevalence estimated in the bat population. For example, species that roost in large numbers near humans (e.g., big brown bats) are likely to encounter the public more often and be submitted for testing, whereas solitary or migratory, or tree-roosting species are less likely to encounter the public when sick (Klug et al. 2011). It should be noted, however, the solitary silver-haired bat is most commonly associated with human rabies cases in the US (Davis et al. 2016), and this may be because of the silver-haired bat's susceptibility to the specific rabies strain infecting them.

The public often only hear about bats when a rabid bat is found in the community and a positive rabies test makes the news. This type of news typically presents bats in a negative light as rabies carriers and does not include information on the biodiversity of bats in the state, the ecosystem services they provide, and the rarity of rabies in bats. Public health officials, the news media, and natural resource/wildlife managers should work together to dispel the stigma of bats being highly diseased and continuous carriers of rabies. It is important to ensure news about bats is effectively communicated to prevent human exposure to rabies, promote public appreciation of bats and the ecosystem services they provide, and promote bat conservation efforts (Klug et al. 2011, Lu et al. 2017). Based on their results, Lu et al. (2017) recommend crafting messages that include the benefits of bats and avoid blaming bats for the spread of disease.

2.5.2. Histoplasmosis

Also known as Darling's disease, cave disease, or spelunker's disease (Tankeshwar 2016), histoplasmosis is a fungal infection that can be indirectly passed to humans through bat and bird droppings. The fungus that causes histoplasmosis, *Histoplasma capsulatum*, occurs naturally in soil. In the U.S. it mainly occurs in the central and eastern states around the Ohio and Mississippi River valleys but is occasionally reported in the western U.S. (CDC 2021).

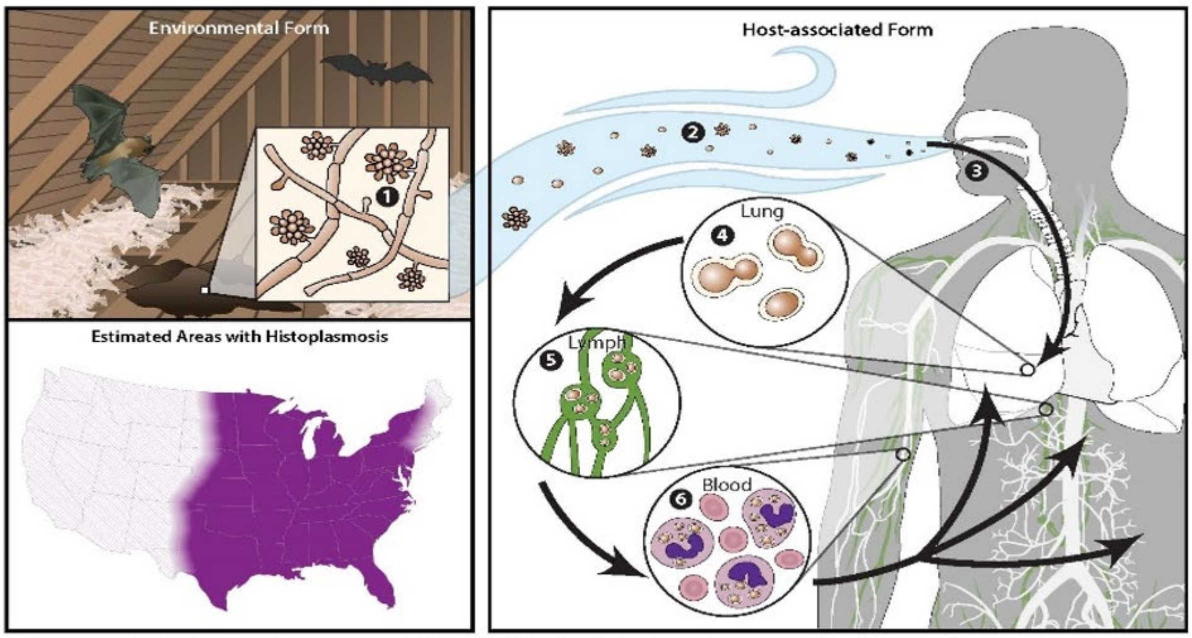
Bat and bird droppings provide nutrients to *H. capsulatum* in the soil and facilitate its growth. Bats infected with *H. capsulatum* help spread the fungus in the environment; however, not all bat species are susceptible to infection (Hoff and Bigler 1981). Gonzalez-Gonzalez et al. (2012) note that colonial bat species with long migratory routes (e.g., Mexican free-tailed bat) are more likely to spread *H. capsulatum* over a wider geographic area. Birds do not become infected by the fungus but can spread it by carrying it on their feet, beaks, and wings (Encyclopedia Britannica 2019).

H. capsulatum is transmitted by inhaling spores released from accumulations of bat guano or bird droppings, often after soil disturbance. Breathing in the spores may cause flu-like symptoms such as fever, cough, fatigue, chills, headache, chest pain, and body aches; however, many people that are exposed do not get sick. Those that do get sick tend to get better on their own without medication. People with depressed immune systems may suffer more severe infections if it spreads from the lungs to other organs. According to the CDC, 60-90% of people living in proximity to *H. capsulatum* have been exposed. Histoplasmosis incidence rates have been recorded as high as 6.1 cases per 100,000 people depending on age and location (CDC 2021).

Histoplasmosis symptoms typically appear 3-17 days after inhalation of the fungal spores and typical cases last three weeks to one month. Histoplasmosis does not spread from human to human or from animal to human. Animals, particularly cats, can also get histoplasmosis. Infection can be prevented by avoiding disturbance of areas with accumulations of bird or bat droppings such as in caves and old buildings (CDC 2021), or areas around roost trees, houses, bridges, or other structures (Hof and Bigler 1981).

H. capsulatum occurs in the environment as a mold and when transferred to a host, the increased temperature within the host signals it to transform into a yeast. The host's immune system reacts to the yeast and transports the yeast to the lymph nodes and potentially other parts of the body through the blood (CDC 2021). Histoplasmosis is diagnosed through a blood or urine test and if treatment is needed, is treated with antifungal prescription medication (CDC 2021).

Biology of Histoplasmosis



In the environment, *Histoplasm capsulatum* exists as a mold (1) with aerial hyphae. The hyphae produce macroconidia and microconidia (2) spores that are aerosolized and dispersed. Microconidia are inhaled into the lungs by a susceptible host (3). The warmer temperature inside the host signals a transformation to an oval, budding yeast (4). The yeast are phagocytized by immune cells and transported to regional lymph nodes (5). From there they travel in the blood to other parts of the body (6).

313841-A https://www.cdc.gov/fungal/diseases/histoplasmosis/causes.html

While the occurrence of *H. capsulatum* is possible around any concentration of bird and bat droppings, based on our current knowledge it is unlikely this fungal infection occurs in Nevada (N. LaHue, personal communication, May 2021). Precautions, such as wearing protective masks, to prevent inhalation of fungal spores should still be taken at high-risk sites such as caves containing large bat colonies.

2.5.3. Bat Coronaviruses

Since the beginning of the 20th century, bats have been known to be a natural host of several human diseases, but not until 2005, while researching the origins of severe acute respiratory syndrome (SARS), were coronaviruses detected in bats (Ge et al. 2015). Coronaviruses are so named because their appearance under the electron microscope is similar to the appearance of the solar corona. Coronaviruses are classified into four genera (*Alpha-*, *Beta-*, *Gamma-*, and *Delta-*). *Alphacoronaviruses* and *Betacoronaviruses* affect mammals, while *Gammacoronaviruses* and *Deltacoronaviruses* affect primarily birds (Ge et al. 2015, Banerjee et al. 2019).

Coronaviruses have been detected in more than 100 bat species worldwide (Ge et al. 2015). Six of these species occur in Nevada, although the actual coronavirus detections occurred in other parts of the U.S. and in Mexico. These six species are the big brown bat (*Eptesicus fuscus*), long-eared myotis (*Myotis evotis*), little brown myotis (*M. lucifugus*), cave myotis (*M. velifer*), long-legged myotis (*M. volans*), and Mexican free-tailed bat (*Tadarida brasiliensis*) (Dominguez et al. 2007, Donaldson et al. 2010, Osborne et al. 2011, Ge et al. 2015).

Heightened interest and awareness of bat coronaviruses developed in the U.S. in 2020 due to the SARS-CoV-2 (COVID-19) global pandemic; however, the first coronavirus to cause SARS (SARS-CoV) was detected in China in 2002. Although ultimately traced to bats, SARS-CoV required an intermediate host (farmed civets) before spreading to humans (Cui et al. 2019). Without proper controls, the virus underwent rapid mutations and eventually became the SARS outbreak of 2002-2003 (Cui et al. 2019). The instance of spillover of virus from natural hosts to humans is largely due to human activities (e.g., agricultural practices, urbanization) and will continue unless barriers are maintained to prevent spillover (Cui et al. 2019). The SARS-CoV-2 virus is similar to viruses found in bats and pangolins, but not similar enough to conclusively be the direct source, and research continues into the origin of SARS-CoV-2 (Weinberg and Yovel 2022, WHO 2021). In fact, the role of bats in the origin of human pathogens tends to be overly exaggerated and without appropriate scientific basis (Weinberg and Yovel 2022).

Bat Susceptibility to Illness from Coronaviruses

There is very little information on the mechanisms by which bats limit disease after viral infection. This type of research is a relatively new field and setting up experiments "can be difficult due to lack of reagents and the need to develop appropriate in vitro and in vivo systems." (Banerjee et al. 2019). Most experiments focus on other types of viruses (e.g., henipaviruses and filoviruses), and there is a need for future studies about bats and coronaviruses (Banerjee et al. 2019).

Hall et al. (2020) tested the susceptibility of big brown bats (*Eptesicus fuscus*) to the SARS-CoV-2 virus. Big brown bats inoculated with SARS-CoV-2 did not show any evidence of clinical disease during the experiment and the authors concluded that big brown bats are resistant to the SARS-CoV-2 infection. Similarly, Bosco-Lauth et al. (2022) concluded that Mexican free-tailed bats are minimally susceptible to two SARS-CoV-2 variants and spillover of the virus from humans to Mexican free-tailed bats is unlikely.

Other research has shown that stressors can increase the levels of virus (viral load) in certain bat species. For example, little brown myotis infected with both the fungus that causes WNS (*Pseudogymnoascus destructans*) and coronavirus had increased coronavirus replication. The consequence of increased viral replication is increased viral shedding, which can lead to subsequent infection of susceptible animals. Additionally, higher viral loads may affect survival rates for hibernating bats also infected with WNS (Davy et al. 2018).

Best Practices for Scientists and Researchers

In this new age of SARS-CoV-2 in the U.S. and the ever-changing knowledge about the virus, the International Union for Conservation of Nature (IUCN), Species Survival Commission (SSC), and the Bat Special Group (BSG), developed a strategy for bat researchers to reduce the risk of transmission of SARS-CoV-2 from humans to bats (Kingston et al. 2021). The "AMP" strategy, Assess-Modify-Protect, recommends first assessing the level of risk a project poses to bats in an epidemiological context and based on team status; secondly, modifying research activities based on the assessment; and lastly, protecting bats during research activities by practicing good field hygiene (e.g., masks, gloves, disinfecting equipment, minimizing contact). The IUCN-SSC-BSG guidelines can be found at their website, https://www.iucnbsg.org/bsg-publications.html.

To reduce the risk of transmission of SARS-CoV-2 from field researchers to bats during winter surveys, the U.S. Geological Survey (USGS) and U.S. Fish and Wildlife Service (USFWS) recommend the following options, which closely resemble the AMP strategy above: suspension of field work (case-by-case basis), testing and vaccination of field personnel, and use of Personal Protective Equipment (PPE) during field work (Cook et al. 2021). For more information see the USGS website: Decision Science Support for SARS-CoV-2 Risk to North American Bats.

As discussed in Rabies (Section 2.5.1), when communicating with the public about bats and their potential to carry and transmit disease to humans, the NBWG recommends promoting messaging that includes the benefits of bats and how to prevent human exposure, while refraining from generalizations that lead people to believe bats are the cause of disease (Weinberg and Yovel 2022).

3. NEVADA BAT FAMILIES

There are 18 bat families worldwide. Four are represented in North America, and three of those four are found in Nevada; Vespertilionidae (vesper bats), Molossidae (free-tailed bats), and Phyllostomidae (leaf-nosed bats).

Table 2: Nevada Bat Families

Common Name(s)	Scientific Name	Family
Allen's big-eared bat	*Idionycteris phyllotis*	Vespertilionidae
Big brown bat	*Eptuscus fuscus*	Vespertilionidae
Big free-tailed bat	*Nyctinomops macrotis*	Molossidae
California leaf-nosed bat	*Macrotus californicus*	Phyllostomidae
California myotis	*Myotis californicus*	Vespertilionidae
Canyon bat, western pipistrelle	*Parastrellus hesperus*	Vespertilionidae
Cave myotis	*Myotis velifer*	Vespertilionidae
Fringed myotis	*Myotis thysanodes*	Vespertilionidae
Hoary bat	*Lasiurus cinereus*	Vespertilionidae
Little brown myotis	*Myotis lucifugus*	Vespertilionidae

Common Name(s)	Scientific Name	Family
Long-eared myotis	*Myotis evotis*	Vespertilionidae
Long-legged myotis	*Myotis volans*	Vespertilionidae
Mexican free-tailed bat, Brazilian free-tailed bat	*Tadarida brasiliensis*	Molossidae
Pallid bat	*Antrozous pallidus*	Vespertilionidae
Pocket free-tailed bat	*Nyctinomops femorosaccus*	Molossidae
Silver-haired bat	*Lasionycteris noctivagans*	Vespertilionidae
Spotted bat	*Euderma maculatum*	Vespertilionidae
Western big-eared bat, Townsend's big-eared bat	*Corynorhinus townsendii*	Vespertilionidae
Western mastiff bat, greater bonneted bat	*Eumops perotis*	Molossidae
Western red bat	*Lasiurus frantzii*	Vespertilionidae
Western small-footed myotis	*Myotis ciliolabrum*	Vespertilionidae
Western yellow bat	*Lasiurus xanthinus*	Vespertilionidae
Yuma myotis	*Yuma myotis*	Vespertilionidae

3.1. Vespertilionidae (vesper bats)


Pallid bat - Joseph Danielson

Vespertilionidae is the most biodiverse bat family globally, with representative species occurring on all continents except Antarctica. In Nevada, 18 of the 23 bat species are members of this family, which includes the largest bat genus, *Myotis*, or "mouse-eared bats." In general, vesper bats have small eyes, long wings, and well-developed tails. The tip of the tail ends at or near the rear edge of the uropatagium (the membrane connecting the hind legs and the tail), which is often used during flight to scoop prey from the air. Vesper bat fur color is typically brown, black, or gray, but can be marked with white as seen in the spotted bat. Ear size is variable, ranging from the large ears of the pallid bat used to detect their prey on the ground to the smaller ear size of myotis species. Vesper bats in Nevada have short, simple muzzles and are insectivorous. Nearly all are non-migratory and use trees, caves, or mines and other man-made structures for roosting and hibernating. Known migratory representatives of this family in Nevada include the silver-haired bat and hoary bat. Five species in this family in Nevada belong to monotypic genera, meaning they are the only species in their genus.

3.2. Molossidae (free-tailed bats, mastiff bats)

Four of Nevada's bat species (17%) are in the Molossidae family. The tail of Molossid bats extends far beyond the uropatagium, lending to the common name 'free-tailed bats.' This family may also be referred to as mastiff bats due to their broad muzzle and wrinkled upper lips. Molossid bats typically have long, slender wings, medium-sized eyes, large ears (sometimes pushed forward or joined across the forehead), and dark fur. Their broad muzzle and wrinkled upper lip enable the mouth to expand to take large insect prey. Although fast flyers, free-tailed bats are not agile and cannot achieve flight from the ground. Molossid bats typically form colonies and roost in caves, cliffs, buildings, and trees high enough to allow them to exit the roost and fall through the air fast enough to generate lift for powered flight. They do not hibernate, and some species migrate (Section 2.4, Table 1).

Mexican free-tailed bat near Ely, Nevada - Almeta Helmig

3.3. Phyllostomidae (leaf-nosed bats)

Phyllostomid bats are referred to as leaf-nosed bats or New World leaf-nosed bats, named for the fleshy, upright projection on their muzzles. Globally, this family of bats is very large, but only one of Nevada's species belong to Phyllostomidae; The California leaf-nosed bat of the genus *Macrotus*.

4. SPECIES ACCOUNTS

This section includes all bat species found in Nevada. Species accounts are listed alphabetically by the primary common name used throughout this document, with additional common names listed after. Each species account serves as an introduction to the species with a focus on Nevada specific information. Photos, morphological descriptions, and acoustic examples are not intended to be used as a primary resource for species identification. Additional resources for morphological and acoustic species identification can be found on the NBWG website (https://www.pacwestbats.org/nbwg-resources). Distribution maps for each species can be found in Appendix 7.1.

4.1. Allen's Big-eared Bat (*Idionycteris phyllotis*)

4.1.1. Conservation Status*

Federal	
BLM	S
USFS	None
State	
NDNH	G4 S1
NDOW	SGCN

*Conservation status definitions can be found in Appendix 7.2

Allen's big-eared bat - Joseph Danielson

4.1.2. Description and Morphology

Allen's big-eared bat is a medium sized vesper bat (8-16 g) with a forearm length of 42-49 mm. This species may appear larger due to its 'big' ears (34-43 mm; tragus 16 mm). Well-developed 'lappets' (flaps of skin) at the base of the ear project forward over the forehead, a characteristic that helps differentiate this species from other large-eared bats that occur in Nevada (spotted bat, western big-eared bat, California leaf-nosed bat, and pallid bat). Fur is long and tawny to blackish-brown in color. The calcar is keeled.

4.1.3. Taxonomy

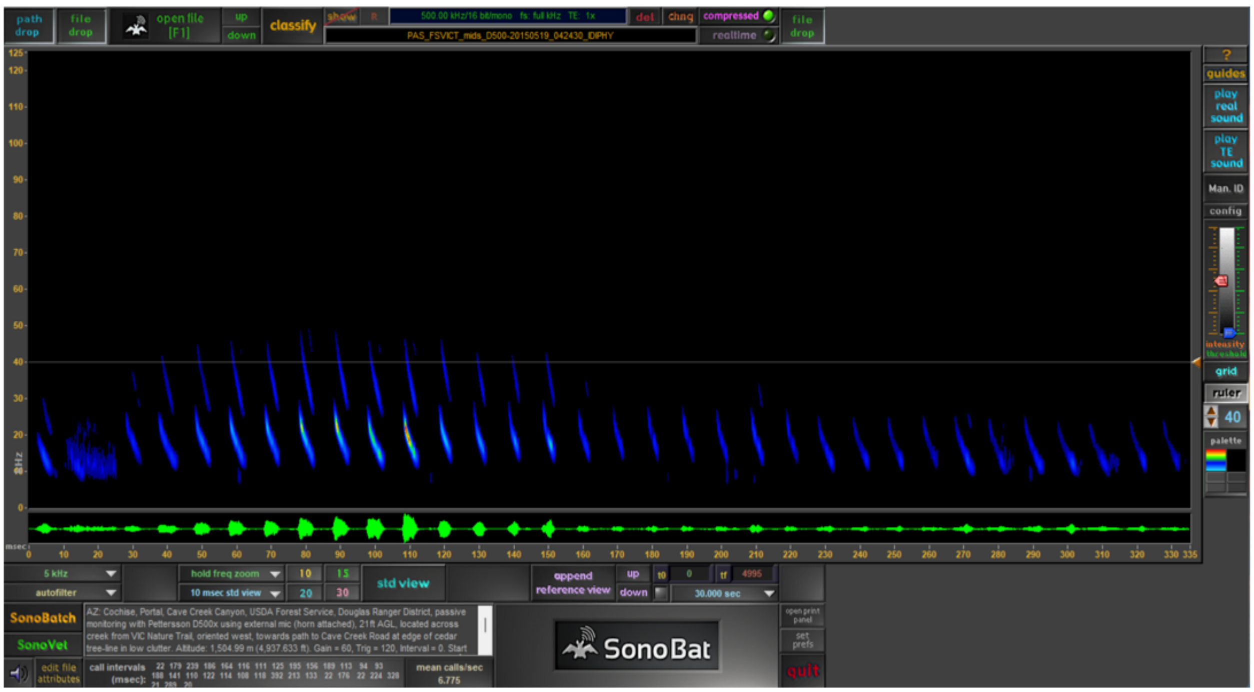
This species was initially named *Corynorhinus phyllotis* by Allen (1916), then reclassified to the *Plecotus* genus by Handley (1959). Subsequent evidence and reliable taxonomic research eventually placed Allen's big-eared bat in the genus *Idionycteris* (Tumlinson and Douglas 1992, Bogdanowicz et al. 1998). Two subspecies, differentiated by distribution and morphology, have been suggested. *Idionycteris phyllotis hualapaiensis* is found in the northern part of the range including Nevada, Utah, and northern Arizona and is smaller in size compared to *Idionycteris phyllotis phyllotis,* which occurs in the remaining southern portion of the species range.

4.1.4. Population Status

Population status and trends for Allen's big-eared bat are poorly understood, but this species is considered one of the rarest bats in North America. The dearth of records prior to the 1950's may suggest that Allen's big-eared bats have only relatively recently expanded their range north into the U.S. (Barbour and Davis 1969, Hoffmeister 1986). In the U.S., the first specimen was collected in the Chiricahua Mountains of southeastern Arizona in 1955; prior to the Arizona record the species was only known from two individuals in Mexico in 1878 and 1922 (Cockrum 1956). In Nevada, only a few records exist from Clark County. Range-wide this species appears to be quite localized in distribution. This species is not skilled at avoiding mist nets like some other big-eared bat species and is easily captured. Based on review of capture data, they are very uncommon, patchy in distribution, and low in abundance (O'Shea et al. 2018).

4.1.5. Flight Characteristics and Acoustic Niche

Though often described as a slow, direct flier, able to hover in confined and cluttered spaces (Jones 1961, Commissaris 1961). Allen's big-eared bats produce loud human-audible calls and communication signals (similar to those of the spotted bat but lower in pitch) in flight and near roosts (Jones 1961, Simmons and O'Farrell 1977). Their use of lower frequency echolocation calls, with a characteristic frequency between 10-15 kHz, may be related to a specific foraging strategy (see 4.1.10 below).



© Joe Szewczak

The acoustic call sequence and examples above provide a limited sample for the species listed and should be considered insufficient for manual vetting purposes. It is important to understand that bats vary their acoustic calls to suit different areas and activities. Manual vetting entails understanding the full repertoire of call types presented by each species, and which of those overlap with other species and which types provide species-discriminating characteristics. Acoustic file provided by Janet Tyburec.

4.1.6. Habitat

Allen's big-eared bats are most often found in mid-elevation scrub woodland and forest from 1,100 - 2,500 m (3,600 - 8,200 ft). Throughout their range they have been captured in Mojave Desert scrub, pinyon-juniper, ponderosa and pine-oak communities, and riparian hardwood habitats across a wide elevational gradient between 510 - 3,225 m (1,673 - 10,580 ft). Most captures of this species have been associated with or in proximity to rocky slopes and cliffs (Siders and Jolley 2009, Solvesky and Chambers 2009).

4.1.7. Roosts and Roosting Behavior

Seasonal roost sites have been documented in boulder piles, abandoned mines, sandstone crevices, under exfoliating bark of pine tree snags, and rarely on buildings (O'Shea et al. 2018). There is little information on hibernacula roosts or winter colony sizes. Maternity colonies have been found in abandoned mines (Cockrum and Musgrove 1964), sandstone cliffs (Siders and Jolley 2009), and under exfoliating bark of pine trees. Radio telemetry research associated with snags (Solvesky and Chambers 2009) documented maternity colony sizes based on emergence counts averaged 11 bats (range 2-21) and showed that pregnant and lactating females used 1-3 different roosts during a 10-day tracking period. Roosting behavior of males is poorly understood, although two radio-tagged males in northern Arizona were tracked to two different roosts in sandstone cracks, and it was unknown if they were roosting singly or with others.

4.1.8. Reproduction

There is little information available regarding the reproductive biology of Allen's big-eared bats, and population dynamics are poorly understood. They typically have one young per year with birth occurring in June to July.

4.1.9. Food Habitats and Foraging

Primary food items are small moths (6-12 mm) which are gleaned from surfaces or pursued and taken in flight. At a capture site in Clark County, Nevada, this species was seen among pinyon pine trees where they were observed to forage slowly, hover near vegetation, and occasionally attack small insects in or on the vegetation (Simmons and O'Farrell 1977). Allen's big-eared bats have been described as small moth strategists and between-, within-, and below-canopy foragers (Black 1974). Other prey species include beetles and flying ants, which may be taken opportunistically when the bats encounter swarms. Simmons and O'Farrell (1977) have suggested that Allen's big-eared bats specialize in small moths with simple "ears" tuned to specific ultrasonic frequencies, which may explain the bats use of low echolocation calls that are below the range of the moths hearing. A telemetry study in northwestern Arizona documented this species traveling relatively long distances (70-100 km, 43-62 mi) round-trip to forage nightly in an adjacent mountain range (Brown and Berry 2004).

4.1.10. Seasonal Movements

Information regarding seasonal movements and especially winter status is largely lacking, although it has been suggested that individuals may move from higher elevation summer ranges and roosts to lower elevation winter habitats (O'Farrell, unpublished data).

4.1.11. Threats

Threats to Allen's big-eared bats include loss of roosting sites such as snags and abandoned mines. Due to the size and slow maneuverability of this species, wildlife friendly gate closures on abandoned mines may not be accepted by this species and use may be discontinued after gates are installed. Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.1.12. Research Needs

There is so little capture and roost data associated with Allen's big-eared bat resulting in many research needs for this species. Focused surveys are needed to determine roost locations and seasonal use. Research on use of abandoned mines before and after wildlife friendly gates are installed would also be essential to understanding this species. Within cave and abandoned mine roosts, Allen's big-eared bat may be difficult to identify visually, as they may roost in clusters with western big-eared bats. There are many general research needs attributed to several or all bat species, including distribution, population status, habitat use, seasonal movements, etc. Please see the Section 6 (Conservation Strategies) for more information.

4.2. Big Brown Bat (*Eptesicus fuscus*)

4.2.1. Conservation Status*

Federal	
BLM	None
USFS	None
State	
NDNH	G5 S3S4
NDOW	PM

*Conservation status definitions can be found in Appendix 7.2

Big brown bat - Joseph Danielson

4.2.2. Description and Morphology

The big brown bat is widely distributed and includes 11 subspecies with varied morphologies across North and South America. It is a large vespertilionid bat (11-23 g) with a forearm length of 39-54 mm, and a total body length of 10-13 cm. Females are slightly larger than males (Burnett 1983). The ears are thick, rounded, and short and barely reach the nostrils when laid forward (Kurta and Baker 1990). The tragus is blunt and round. This species has a wingspan of 32-35 cm and a keeled calcar. Pelage is soft and somewhat oily. Pelage varies across its range and depends on the subspecies, but ranges from tan to dark brown. Subspecies found in the eastern portion of North America are darker than their western counterparts. The face, ears, and wings are mostly hairless and are blackish in color. The tip of the tail extends 3 mm beyond the uropatagium (Miller 1907).

4.2.3. Taxonomy

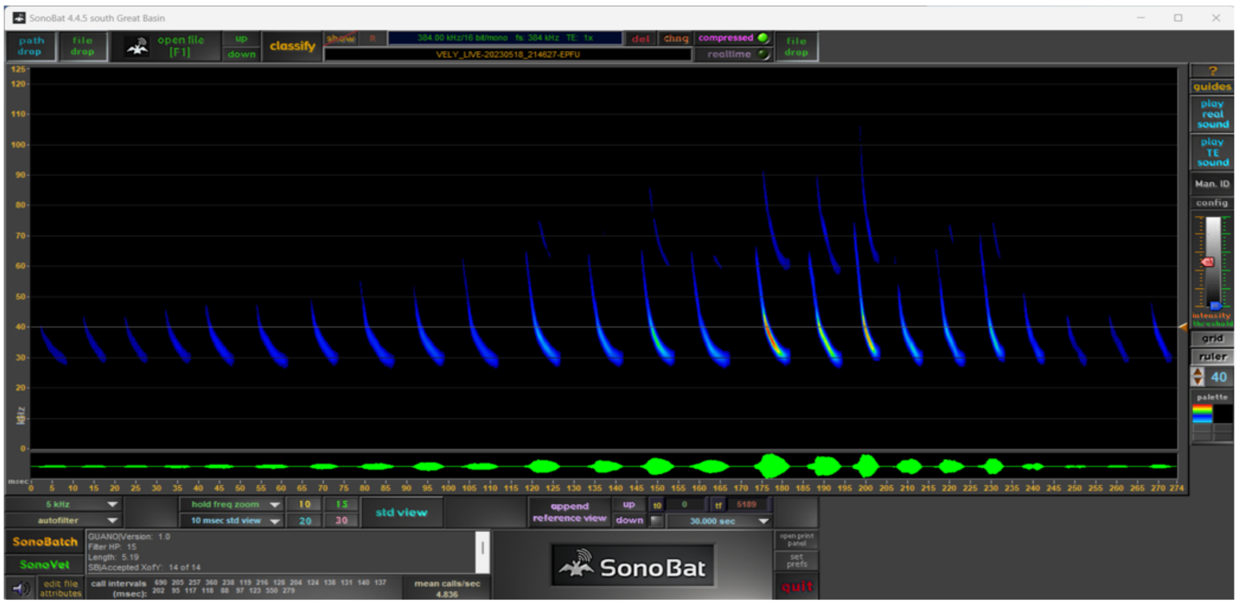
The big brown bat is widespread across North and South America; two subspecies are found in Nevada. Of these, *E. fuscus pallidus* occurs throughout Nevada, and *E. fuscus bernardius* can occur in the northwestern corner of the state. Overlap between these two subspecies can occur along the western edge of the state and in the northwestern corner of the state (Lawlor 1982).

4.2.4. Population Status

The big brown bat is listed as S3S4 by the Nevada Division of Natural Heritage, indicating populations are stable but are vulnerable to known stressors. Neighboring states rank the little brown bat similarly, suggesting populations appear mostly stable in the western United States.

4.2.5. Flight Characteristics and Acoustic Niche

The big brown bat is capable of maintaining moderate speeds with good maneuverability. This species has an echolocation call with a characteristic frequency of 29 kHz, with a range of 23-84 kHz (Szewczak 2018) and pulses have little inflection.



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The acoustic call sequence and examples above provide a limited sample for the species listed and should be considered insufficient for manual vetting purposes. It is important to understand that bats vary their acoustic calls to suit different areas and activities. Manual vetting entails understanding the full repertoire of call types presented by each species, and which of those overlap with other species and which types provide species-discriminating characteristics.

4.2.6. Habitat

This species is known to occur in a wide range of habitats and elevation gradients in Nevada, from low desert habitats of creosote bush scrub to high elevation pine and aspen forests. The big brown bat is also commonly found in urban environments and will roost in buildings and under bridges (Agosta 2002). Activity is higher around riparian areas in the southwest, where insect populations are more plentiful (Bell 1980).

4.2.7. Roosts and Roosting Behavior

The big brown bat uses a variety of day roosts including caves, abandoned mines, bat boxes, rock crevices, tree cavities, and buildings (Kunz 1982b). Day roosts are often located near foraging areas. Big brown bats show site fidelity to areas with a high concentration of roosts and return to the same area year after year

(Willis and Brigham 2004). Some fidelity to roost-mates has also been exhibited, with pairs often switching roosts together (Willis and Brigham 2004).

Maternity roosts used by the big brown bat can occur in tree cavities, caves, mines, rock crevices, buildings, which are often favored (Davis et al. 1968). Pregnant females separate into maternity colonies around April (Schwartz and Schwartz 2001). Maternity colonies can range in size from 5-700 individuals; however, colonies of less than 75 individuals are more common (Kurta 1990). One study in Kentucky suggested this species is intolerant of heat and will move their young if roost temperatures exceed 32° C (90° F) (Davis et al. 1968).

4.2.8. Reproduction

Female big brown bats ovulate in the fall when mating takes place. Gravid females form maternal colonies following the emergence from hibernation in early spring (Schwartz and Schwartz 2001). In western populations, big brown bats commonly give birth to one pup each year and less commonly have twins (Kurta 1990). Mother bats will leave pups in the roost while they forage. Pups nurse for approximately one month and begin flying at three to five weeks old (Davis et al. 1968). Maternity colonies begin to disperse in late summer, and the bats move closer to hibernacula in the fall to mate before entering hibernation (Davis et al. 1968).

4.2.9. Food Habitats and Foraging

Big brown bats begin foraging 30 minutes after sunset under normal conditions (Brigham 1991). They consume a wide variety of both hard and soft-bodied insects, but, beetles are highly represented in their diets (Agosta 2002). Individual bats do not forage a great distance from their roosts, usually travelling less than 2 km (1 mi) to foraging sites that can vary nightly (Brigham 1991). Lactating females and juveniles forage almost twice as long and complete more foraging bouts compared to pregnant and non-pregnant females (Brigham 1991). Big brown bats will forage over water or wherever insects are present. The flexibility in where foraging takes place is somewhat dependent on the distribution of prey (Brigham 1991).

4.2.10. Seasonal Movements

Big brown bats do not undertake long distance migrations, instead moving short distances to winter roosts favorable for hibernation in the fall (Neubaum 2006). During the winter months, hibernating big brown bats periodically wake to drink and will forage if conditions are opportune (O'Farrell and Bradley 1970).

4.2.11. Threats

There are no species-specific threats in Nevada for the big brown bat, however all bat populations are threatened by multiple factors including climate change, habitat loss, roost disturbance, environmental contaminants, energy development, abandoned mine closures, mining and mineral exploration, and WNS. Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

Recent research suggests the big brown bat possesses some resistance to the recently emerged novel coronavirus SARS-CoV-2. Big brown bats inoculated with the virus showed no clinical signs of the disease, nor infection, excretion, or any detectable virus in tissues (Hall et al. 2021).

The big brown bat also appears to be resistant to WNS, as bats lack wing and skin lesions associated with infection, and demonstrate no noticeable decrease in torpor duration during winter. Populations of big brown bat using hibernacula known to be infected with the fungal agent causing WNS, have not exhibited population declines seen in other bats (Frank et al. 2014).

4.2.12. Research Needs

There are no species-specific research needs for the big brown bat in Nevada, but research into distribution, population status, habitat use, and seasonal movements is needed for all Nevada bat species. Please see Section 6 (Conservation Strategies) for more detailed information.

4.3. Big Free-tailed Bat (*Nyctinomops macrotis*)

4.3.1. Conservation Status*

Federal	
BLM	S
USFS	None
State	
NDNH	G5 S1
NDOW	SGCN

*Conservation status definitions can be found in Appendix 7.2

Big free-tailed bat - Scott Altenbach © Nevada Department of Wildlife. Used with permission.

4.3.2. Description and Morphology

The big free-tailed bat is a large molossid bat (22-30 g) with a wingspan of 417-436 mm, a forearm length of 58-62 mm, and a tail (40-57 mm) that can extend 20 mm beyond the edge of the uropatagium. It is a bonneted bat, with round ears that reach the tip of the thin and wrinkled muzzle when laid forward. Dorsal pelage is reddish brown to nearly black with a glossy or greasy appearance. Hairs are nearly white at their base and the ventral pelage is comparatively lighter in color than the dorsal pelage. The wings are long and narrow. The big free-tailed bat can be distinguished from the Mexican free-tailed bat by its larger size and larger ears. Sexual dimorphism has been observed in this species, with males larger than females.

4.3.3. Taxonomy

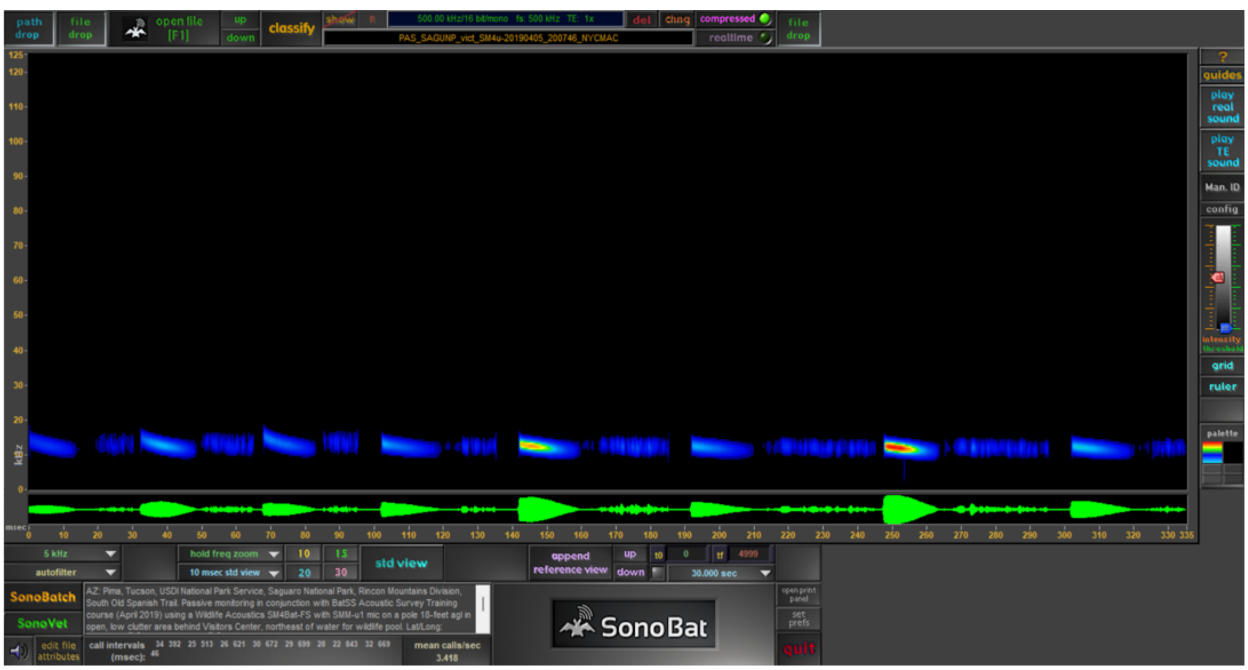
There are no recognized subspecies of big free-tailed bat. This species was previously placed in the genus *Tadarida*.

4.3.4. Population Status

The big free-tailed bat is an uncommon but regular seasonal visitor to Nevada, with only a handful of acoustic and physical records to verify their presence in the state. Site records of the big free-tailed bat in Nevada include detections from July through October in southern Nevada at locations including the Muddy and Virgin River drainages, Eagle Valley, Clover Creek, Upper Moapa Valley, Kyle and Lee canyons, Las Vegas Wash, White River Valley, Dry Lake Valley, southern Spring Valley, and Meadow Valley Wash (Bradley et al. 1965; Williams et al. 2006; O'Farrell 2002a, 2002b, 2006a, 2006b, 2006c, 2006d; Kenney and Tomlinson 2005). More information is needed to determine the population status and trend of this species in Nevada. The big free-tailed bat is currently listed as critically imperiled within the state (NDNH S1).

4.3.5. Flight Characteristics and Acoustic Niche

The big free-tailed bat is a fast, high-flying open-air specialist with high wing aspect and loading ratios (Milner et al. 1990). Long, tapered wings allow for high flight speeds but limit the maneuverability of this genus in cluttered habitat (Voigt and Holderied 2011). Long, narrow band acoustic pulses have a characteristic frequency between 18-25 kHz and are long duration with long interpulse intervals (Mora and Torres 2008) and is audible to the human ear when echolocating.



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The acoustic call sequence and examples above provide a limited sample for the species listed and should be considered insufficient for manual vetting purposes. It is important to understand that bats vary their acoustic calls to suit different areas and activities. Manual vetting entails understanding the full repertoire of call types presented by each species, and which of those overlap with other species and which types provide species-discriminating characteristics. Acoustic file provided by Janet Tyburec.

4.3.6. Habitat

The big free-tailed bat can be found in a wide variety of habitats including desert riparian, pinyon juniper and ponderosa pine woodlands (Corbett et al. 2008), sub-alpine meadows, and sagebrush steppe. In Nevada this bat has been documented along lowland riparian systems in the Mojave Desert, cliff, and canyon ecotypes. These bats are found from 0 to 2,600 m (0 to 8,530 ft) throughout their range, but observations are more typical below 1,800 (5,905 ft) m in the southwestern U.S. (Jones 1965, Milner et al. 1990).

4.3.7. Roosts and Roosting Behavior

Big free-tailed bats typically roosts singly or in small groups within rocky or cliff habitats, utilizing vertical or horizontal crevices. Individuals have also been found roosting in mines, buildings, and trees (Milner et al. 1990, Huey 1932 and 1954). This species segregates to form maternity roosts of female bats during the summer (Barbour and Davis 1969). Corbett et al. (2008) found maternity colonies of more than four individuals in cracks or crevices of upper portions of vertical cliffs.

4.3.8. Reproduction

It is unknown if big free-tailed bats breed in Nevada. Female bats give birth to a single pup in late spring or early summer, nursing the pup as late as September (Barbour and Davis 1969, Constantine 1961). Juveniles may fledge by early August. Juvenile bats grow quickly and can be difficult to discern from adults by October (Milner et al. 1990).

4.3.9. Food Habitats and Foraging

The big free-tailed bat typically emerges from the roost an hour after dark. This species is not a specialist feeder and will eat many insect species, but it does show some preference for Lepidoptera (large moths) (Milner et al. 1990, Easterla and Whitaker 1972, Debelica 2006). Bats may forage more than 40 km (25 mi) from day roosts and upwards of 300 m (984 ft) in altitude over meadows and grasslands, washes, riparian, and forested habitats. This species may require larger bodies of water to drink (Corbett et al. 2008).

4.3.10. Seasonal Movements

Little is known about migration routes and wintering distribution of big free-tailed bats, though they are known to enter Nevada between late summer and fall. It is not known if the big free-tailed bat breeds or winters in Nevada.

4.3.11. Threats

There are no species-specific threats in Nevada for the big free-tailed bat, however all bat populations are threatened by multiple factors including climate change, habitat loss, roost disturbance, environmental contaminants, energy development, abandoned mine closures, mining and mineral exploration, and WNS. Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.3.12. Research Needs

There are no species-specific research needs for the big free-tailed bat in Nevada, but research into distribution, population status, habitat use, and seasonal movements is needed for all Nevada bat species. Please see Section 6 (Conservation Strategies) for more detailed information.

4.4. California Leaf-nosed Bat (*Macrotus californicus*)

4.4.1. Conservation Status*

Federal	
BLM	S
USFS	None
State	
NDNH	G3 S2
NDOW	SGCN

*Conservation status definitions can be found in Appendix 7.2

California leaf-nosed bat - Scott Altenbach © Nevada Department of Wildlife. Used with permission.

4.4.2. Description and Morphology

The California leaf-nosed bat is medium-sized (9-17 g) phyllostomid with large ears (29-38 mm), relatively large eyes, and forearm length of 45-51 mm. Pelage appears gray, but the basal two-thirds of the hairs are white. Wings are short and broad. The tail extends 5-10 mm beyond the edge of the uropatagium. The snout is short and has a distinct erect leaf-like outgrowth of skin from the tip of the nose, making it easily distinguishable from all other species found in Nevada.

4.4.3. Taxonomy

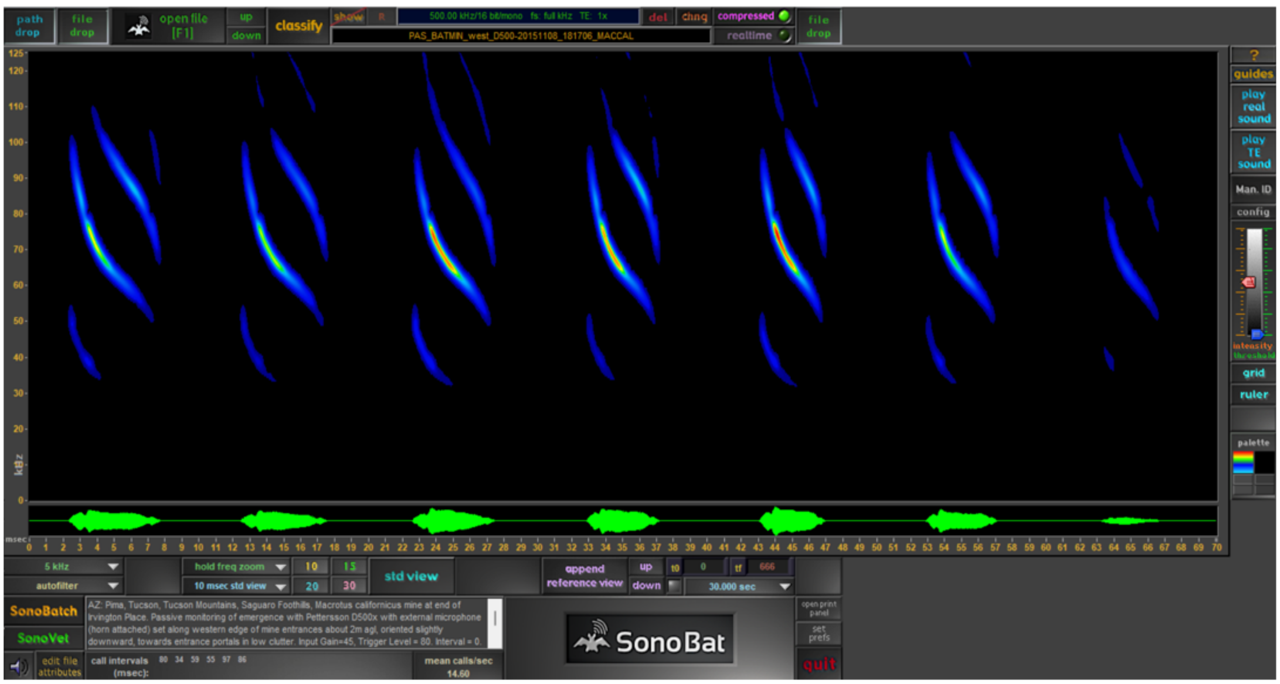
There are two species in the genus *Macrotus, M. californicus* and *M. waterhousii*, but only the former occurs in Nevada. At one time both were considered a single species, resulting in confusing references to *M. waterhousii californicus* in some early literature. Prior to the mid-1960's there was speculation of three possible species of *Macrotus* (Anderson and Nelson 1965), but careful genetic and morphological analysis have shown two distinct species (Davis and Baker 1974, and Greenbaum and Baker 1976). Currently there are no recognized *Macrotus* subspecies. "*Macrotus"* is derived from Greek words referring to "long" and "ear", and the specific epithet is based on geography. Another common name is California big-eared bat.

4.4.4. Population Status

Little information is available concerning the population status of the California leaf-nosed bat in Nevada and throughout its entire range. As a mostly Sonoran-associated species, populations in Nevada may be relatively limited based on geography, climate and available habitat or nearby roosts. Where this species does occur, individuals are not known to range widely, and recaptures of banded individuals often occurred near the original banding site (Cockrum et al. 1996). Regional survey efforts using mist nets set over water have seldom reported capture of this species. This may be due to the bats restricted roosting and foraging habits, low propensity to disperse far from roosts, and maneuverable flying abilities allowing them to readily avoid capture (O'Shea et al. 2018). This species is known to frequently switch roost sites making it difficult to determine trends using count data (O'Shea and Bogan et al. 2003). Monitoring at known roosts in Nevada have resulted in observations ranging from zero to over 100 individuals, suggesting temporal variation in occupancy at these sites and that other nearby roosts must exist.

4.4.5. Flight Characteristics and Acoustic Niche

California leaf-nosed bats are rapid fliers and extremely maneuverable, but their flight while foraging can also be slow, buoyant, nearly silent, and include hovering (Vaughan 1959). The echolocation characteristics of this species are suited to foraging in cluttered environments, especially when gleaning prey from vegetation or ground surfaces. This results in low intensity, high frequency, short duration call pulses.



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4.4.6. Habitat

California leaf-nosed bats are usually found in low elevation desert scrub habitats, often below 1,100 m (3,600 ft) (Bradshaw 1961). The most common habitat association in Nevada is Mojave creosote bush-white bursage scrub, but the species has also been acoustically detected in riparian areas in the upper Moapa Valley (Williams et al. 2006) and the Las Vegas Wash (Hammond 2020). Outside of Nevada, this bat is strongly associated with lower Sonoran Desert scrub vegetative communities. In Nevada, the northern most documented latitude for this species is in Meadow Valley Wash at the border of Clark and Lincoln counties, from one visual and multiple acoustic records.

4.4.7. Roosts and Roosting Behavior

Preferred roost sites are caves and abandoned mines, but California leaf-nosed bats have also been found in buildings, bridges and rock shelters. Day roosts are often simple mines or caves where individuals may be within 25 m (82 ft) of the entrance and do not always seek out complete darkness. Three previously unknown roost sites have been discovered in southern Nevada since 2015, two natural caves and one abandoned mine. Known roosts in Nevada are distributed between 480-900 m (1,575-2,950 ft).

They day roost singly or in groups up to several hundred, but do not form tight clusters; instead, small groups of individuals are often observed with each bat slightly separated from nearby individuals (Vaughan 1959, Cockrum et al. 1996). These bats are often seen hanging from one foot and using the other to groom themselves, causing them to swing back and forth like a pendulum. Night roosts may be the same as day roosts, but also include a wider variety of sheltered sites. Roost sites appear to be selected near preferred foraging areas. Some caves and mines used as roosts may be shared with other species (Bradshaw 1961).

Maternity sites include caves and mines with relatively warm temperatures. Some roost sites may be occupied year-round, whereas others are principally used during the summer or winter, depending on average temperatures (Schmidt 1999). Studies have shown this species exhibits life-long fidelity to roost sites but may also switch roosts if disturbed (Brown et al. 1993). A few males may be found in maternity roosts, but generally sexes segregate during summer months and mix again during fall and winter.

California leaf-nosed bats do not hibernate or enter daily torpor on a regular basis. They are capable of slightly lowering their body temperature for short periods and may appear lethargic in roosts, but their thermoneutral zone is limited to body temperatures of 33° C (91.5° F) and above (Bell et al. 1986). Since they lack specialized physiological adaptations to protect against cold, their temperate desert existence is possible due to behavioral adaptations. Adaptations include foraging style and selecting warm roost sites with temperatures of about 23-28° C (73-82° F) and higher (Bradshaw 1961), which are often geothermally heated caves or mines. The three recently discovered roosts sites in southern Nevada all appear to be in natural geothermally heated rock formations. Winter colony size can range from a few individuals to several thousand, and they are not known to form dense clusters (Brown 2013). The appearance of abandoned mines on the landscape in the past two centuries may have allowed this species to increase and expand their distribution (Bradshaw 1961, Altenbach and Sherwin 2002).

4.4.8. Reproduction

Mating and fertilization occur in the fall; however, a long period of embryonic diapause occurs during the winter, followed by accelerated development in the spring when temperature and insect availability increase (Bradshaw 1962, Bleier 1975). One young per year is born between mid-May and early-July after a nine-month gestation and twins occur very infrequently. Females may mate in their first autumn, and males the following year (Bradshaw 1961). Natural history observations indicate this species has a lek-based mating system. Several males may hang from the ceilings of a mine or cave and attempt to attract females with vocalizations and wing-flapping courtship displays. Aggression between males has been observed at lek sites which are often in or near features that are used during the maternity season.

4.4.9. Food Habitats and Foraging

Desert washes and river flood plains are favored foraging habitats by this species, and they rarely travel more than 10 km (6 mi) from roost sites to foraging grounds (Brown et al. 1993). The California leaf-nosed bat feeds primarily on moths and large diurnal insects including grasshoppers, butterflies, crickets, cicadas, beetles, and caterpillars. Flight is low and extremely maneuverable as this species gleans stationary prey items from the ground or vegetation (Bradshaw 1961, Bell 1985), a strategy that reduces total time and energy necessary for hunting. They are well adapted to foraging in cluttered environments and will also cue on audible sounds of some prey (Bell 1985). California leaf-nosed bats are adept at hunting in total darkness, but they also have excellent vision and may interrupt echolocation and switch to visually locating insects, especially on moonlit nights (Bell and Fenton 1986). As a species acclimatized to arid habitats, they are able to concentrate their urine, reducing the need to regularly drink water, and obtain moisture from prey items. Taylor (2007) noted the propensity of this bat to fly low to the ground and their maneuverability allows them to drink from small areas of surface water when available. These factors may contribute to the low incidence of captures in mist nets at artificial water sources.

4.4.10. Seasonal Movements

California leaf-nosed bats do not migrate or make extensive seasonal movements to other habitats (Hoffmeister 1986). One study documented maximum movement distance of 93 km (58 mi) between a California leaf-nosed bat winter roost and maternity site, and the longest known movement of any kind is 137 km (85 mi) (Cockrum et al. 1996). Without use of daily torpor, hibernation, or migration the seasonal movement of this species is limited by warm roosting locations and year-round availability of forage.

4.4.11. Threats

Like many other bat species, California leaf-nosed bats have benefitted from the creation and then abandonment of thousands of mines during the past two centuries, which resulted in new roosting habitat including in regions of Nevada generally devoid of natural caves. However, relatively speaking, only a small fraction of mines (or natural caves) have geothermal properties, thus any subsequent loss of a geothermal feature due to natural caving, closure for safety, energy development, or renewed mining is exacerbated and may be especially detrimental to this species. Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.4.12. Research Needs

California leaf-nosed bats have been generally described as an abandoned mine obligate user in much of their range; thus, the appearance of abandoned mines on the landscape in the past two centuries may have allowed for distribution expansion (Bradshaw 1961, Altenbach and Sherwin 2002). Research into roost site locations and conditions within Nevada are needed to help determine the overall range and accepted roost conditions for this species within the state. With increased interest in geothermal energy production in Nevada, research is also needed to determine potential impacts to roost sites for this species. There are many general research needs attributed to several or all bat species, including distribution, population status, habitat use, seasonal movements, etc. Please see Section 6 (Conservation Strategies) for more information.

4.5. California Myotis (*Myotis californicus*)

4.5.1. Conservation Status

Federal	
BLM	S
USFS	None
State	
NDNH	G5 S3S4
NDOW	PM

*Conservation status definitions can be found in Appendix 7.2

California myotis - Scott Altenbach © Nevada Department of Wildlife. Used with permission.

4.5.2. Description and Morphology

The California myotis is a small vesper bat (3.3-5.4 g), with a forearm length of 30-35 mm, a wingspan of 70-94 mm, and an ear length of 12-15 m. The ears extend beyond the nose when pushed forward, and the tragus is narrow and pointed. This species, one of the smallest Myotis species in North America, possesses a prominently keeled calcar. The pelage is long and dull, showing geographic variation in color ranging from rusty reddish-brown to dark chestnut-brown. In arid areas the fur is a lighter pale yellowish-orange, but may be darker in color in forested or high elevation areas. No distinct sexual dimorphism exists within this species; however, females are on average larger than males. The ears, wings, and tail membranes are black. The hind foot is small (5-7 mm), less than half the length of the tibia. The skull is characterized by a steeply sloping forehead.

4.5.3. Taxonomy

The California myotis is closely related to the western small-footed myotis *(M. ciliolabrum).* A phylogenetic study using mitochondrial DNA sequence divergence data did not distinguish lineages of California myotis and western small-footed myotis recognized as distinct morphologically (Rodriguez and Ammerman 2004), suggesting these two species are sympatric and have only recently diverged (Ammerman et al. 2016).

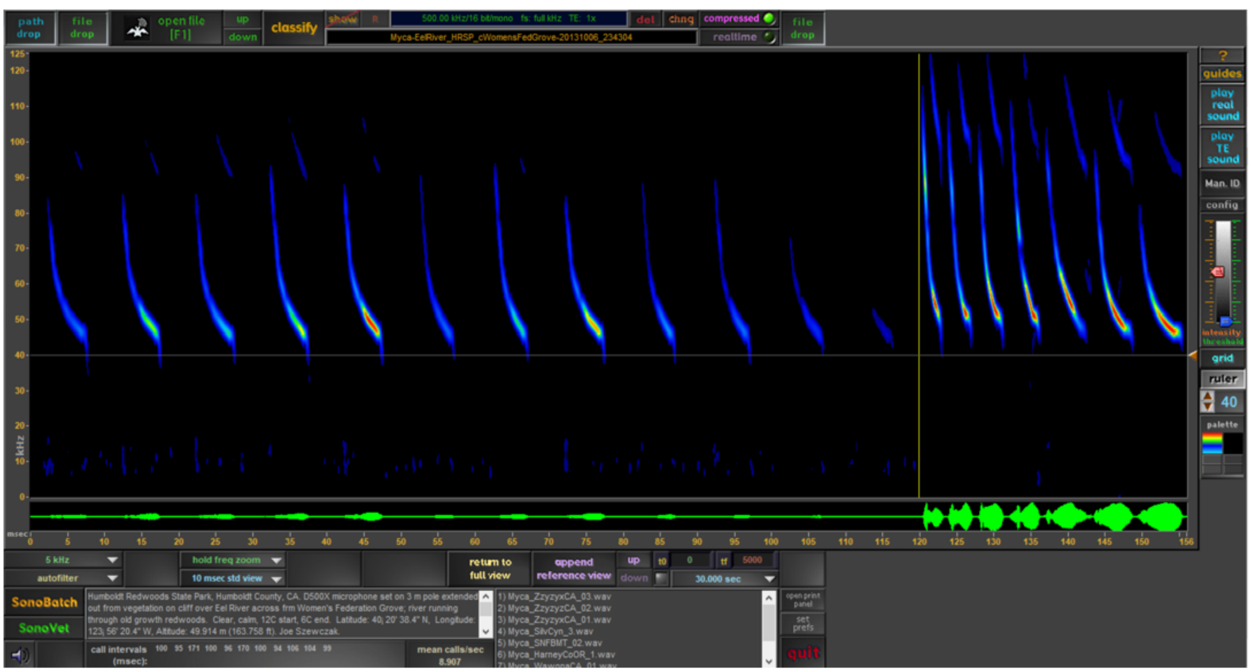
Four subspecies of *M. californicus* are recognized: *M. californicus californicus, M. californicus caurinus, M. californicus mexicanus, and M. californicus stephensi* (Simmons 2005). Subspecies are poorly delimited, and all four can occur within Nevada (Simmons 2005).

4.5.4. Population Status

The California myotis is listed as S3S4 by the Nevada Division of Natural Heritage indicating populations are stable but vulnerable to known stressors. It is listed as either an S3 or an S4 in neighboring states, and not below an S3 anywhere across its range, indicating this species may face threats across its range but it is not experiencing population declines across its range.

4.5.5. Flight Characteristics and Acoustic Niche

The California myotis is a slow, low-flying bat with a large wing load ratio that allows for highly maneuverable flight (Vaughan 1966). California myotis have an echolocation call with a characteristic frequency of 50 kHz or above, with a range of 45.3 kHz to 111 kHz, often exceeding 100 kHz. California myotis and Yuma myotis may have overlapping call features as the two 50 kHz myotis species found in Nevada.



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4.5.6. Habitat

The California myotis is a habitat generalist, capable of inhabiting both warm and cold deserts within Nevada. Abundant in desert scrub, this species is also found in forested and montane areas as well as urban locations. Nevada records indicate this species is distributed between 210-2,730 m (689-8,956 ft) throughout the state. Williams et al. 2006 found California myotis was well represented in riparian woodlands, with high preference for mesquite bosques adjacent to open water sources in southern portions of the state. Other studies in this region found California myotis to be abundant at a variety of natural and man-made water sources (Hall 2000, Hansen et al. 2008, O'Farrell and Bradley 1970).

4.5.7. Roosts and Roosting Behavior

California myotis favor small crevices beneath tree bark or in rocks as day roosts, though they will also use tree cavities, caves, abandoned mines, and man-made structures such as buildings and bridges. These bats have been observed roosting on shrubs and on the ground (Brigham et al. 1997).

Maternity colonies occur in many of the same roost sites. In tree dwelling populations, females prefer relatively open canopy areas with a high density of conifer snags in intermediate stages of decay (Vonhof and Gwilliam 2007). When habitat containing trees is limited, bats may utilize rock crevices, abandoned mines, or caves. Males and possibly non-reproductive females roost singularly or in small groups separate from reproductive females during the summer and change roosts frequently (Barclay et al. 2001).

4.5.8. Reproduction

California myotis males become scrotal in mid-July. Breeding occurs in late fall or early spring. Females in southern California give birth to one pup per season in late May to mid-June (Barbour and Davis 1969). This seasonality is believed to be similar in populations inhabiting southern Nevada. In the northern portion of its range parturition is slightly later, occurring in late June to early July. Young become volant at one month of age (Wilson and Ruff 1999).

4.5.9. Food Habitats and Foraging

The California myotis is a generalist, utilizing strategies of both hawking over open water and gleaning insects off vegetation (Gordon 2019, Wilson and Ruff 1999). This species has rounded wingtips and low wing loading, which facilitate slow but maneuverable flight and allow it to forage over very small water sources. Flight behavior may appear erratic when pursuing prey, and high frequency echolocation suggests prey is taken at close range (Ober and Hayes 2008b). Foraging occurs over water where insect numbers are concentrated, but can also occur along riparian corridors and habitat edges. Foraging usually commences at sunset and ends within a few hours of darkness. Additional peaks in activity are sometimes noted throughout the night (Verts and Carraway 1998).

4.5.10. Seasonal Movements

The California myotis hibernates alone or in small groups in caves, abandon mines, and buildings with both sexes roosting together (Perkins et al. 1990). This species may emerge from hibernation on evenings that are still below freezing. This species is often active during the winter and has been observed both drinking and foraging at springs in Nevada during the winter months (O'Farrell et al. 1967).

Little information exists on the seasonal movements of California myotis. Their presence at water sources during the winter (O'Farrell et al. 1967, Perkins et al. 1990) indicates seasonal movements are possibly limited or do not exist in some regions.

4.5.11. Threats

There are no species-specific threats in Nevada for the California myotis, however all bat populations are threatened by multiple factors including climate change, habitat loss, roost disturbance, environmental contaminants, energy development, abandoned mine closures, mining and mineral exploration, and WNS. Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.5.12. Research Needs

Morphological similarities between the California myotis and western small-footed myotis make these two species difficult to distinguish. Developing molecular markers that can distinguish between the two species will be an important tool for conservation and management. Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

4.6. Canyon Bat, Western Pipistrelle (*Parastrellus hesperus*)

4.6.1. Conservation Status

Federal	
BLM	S
USFS	None
State	
NDNH	G5 S3S4
NDOW	SGCN

*Conservation status definitions can be found in Appendix 7.2

Canyon bat - Scott Altenbach © Nevada Department of Wildlife. Used with permission.

4.6.2. Description and Morphology

The canyon bat is a member of the vesper bat family and is the smallest bat in North America (3-6 g) with a total body length of 62-88 mm (Grinnell 1918), a forearm length of about 28 mm, and a wingspan of 190-215 mm (Barbour and Davis 1969). This species is sexually dimorphic as females are slightly larger than males. It has a distinctive hairless black facial mask and black ears. The uropatagium is almost entirely hairless except for the lower third of the uropatagium. The body has long, soft, brown-grey fur. This species has a slightly curved, club-shaped tragus (Davis and Schmidly 1994) and a keeled calcar. The club-shaped tragus distinguishes it from small myotis species.

Where their ranges overlap, the morphologically similar eastern pipistrelle (*Perimyotis subflavus)* can be distinguished from the canyon bat by its larger size and unkeeled calcar.

4.6.3. Taxonomy

Canyon bats (*Parastrellus hesperus*) were formerly classified as *Pipistrellus Hesperus* before being reclassified to the monotypic genus *Parastrellus* following genetic research. Canyon bats the sole member of the genus *Parastrellus* with no known relatives (Hoofer et al. 2006).

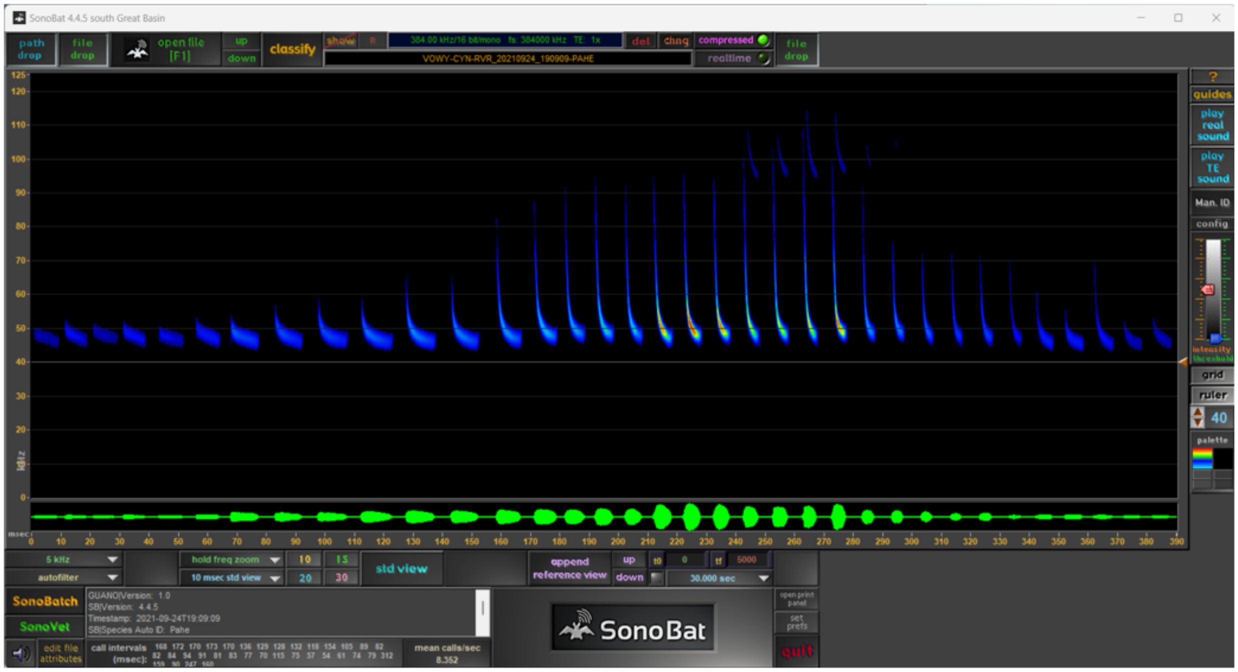
Two subspecies of *P. hesperus* exist: *P. hesperus hesperus* and *P. hesperus maximus. P. hesperus maximus* is found along the coast and central valley of California, whereas *P. hesperus hesperus* is found in the deserts inland east of the Coast and Sierra Nevada ranges. *P. hesperus hesperus* is the only subspecies known to occur in Nevada.

4.6.4. Population Status

Populations of canyon bats are presumed to be relatively stable across most of their range, never ranking below an S3 ranking of “vulnerable” in states where they are observed. There is little known about the population status of this species within Nevada, but it is frequently captured in the Mojave Desert.

4.6.5. Flight Characteristics and Acoustic Niche

Canyon bats have short broad wings with a low aspect ratio, allowing it to fly at speeds as low as 2.2 mps (5 mph), exhibiting a slow, fluttery flight pattern (Hayward and Davis 1964). The canyon bat has a characteristic frequency of 46 kHz, with a range of 41-70 kHz (Szewczak 2018) and calls are generally consistent across the sequence.



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4.6.6. Habitat

Canyon bats use a variety of habitats ranging from rocky canyons, cliff outcroppings, sagebrush scrub and creosote scrub, but they are more common in lower-elevation, less mountainous areas across their range. They can be found in forested areas, though less frequently. As their common name suggests, canyon bats are generally associated with rocky outcrops and cliffs, which they use for roosting. Canyon bats are among the most common bats found below 1,524 m (5,000 ft) across much of their range (Barbour and Davis 1969).

4.6.7. Roosts and Roosting Behavior

Canyon bats primarily roost in cracks and crevices of rocks. They exhibit little fidelity to a particular crevice but will remain in the general roost area (Cross 1965). Abandoned mines and caves are often used as winter roosts, and occasionally buildings (Barclay 2014). Maternal roosting generally takes place in rock crevices but has also been observed in buildings (Cox 1965, Koford and Koford 1948). Females can form small maternity colonies of up to 12 individuals but may also roost singly. Some evidence of increased female captures while foraging and drinking compared to males suggests females may utilize roosts closer to water to bare and nurse young (Cox 1965).

4.6.8. Reproduction

One, or more commonly two, young are born between June and July following an approximately 40-day gestation. Pups mature quickly and can fly within a month of being born (Cox 1965). Volant young of the year are difficult to distinguish from adults. Lactating females may require more water as they comprise a large proportion of individuals captured over water sources (Cox 1965).

4.6.9. Food Habitats and Foraging

Canyon bats are insectivorous and consume variety of prey including; caddisflies, stoneflies, moths, small beetles, leaf and stilt bugs, leafhoppers, flies, mosquitos, ants, and wasps. Stomach contents of individual bats often contain only a single species of insect, or, if more than one kind of insect is present, the remains are clumped together within the stomach, suggesting this species takes advantage of swarming insects and feeds intensively (Demere 2016). This small bat is easily affected by wind speeds and strong wind will cause individuals to seek shelter. Canyon bats are most active immediately following sunset and immediately preceding sunrise and are usually not active in the overnight hours (Grinnell 1918). They are commonly observed flying before sunset and occasionally observed in flight in the late morning. Foraging usually occurs between 4-15 m (13-49 ft) above the ground and can occur over water or wherever large numbers of insects are present in open areas. Nocturnal activity is lower during the winter; however, foraging can also occur during this time as bats may emerge to forage on warm winter nights (O'Farrell et al. 1967). Canyon bats are adapted to dry conditions and can concentrate their urine allowing them to maintain a positive water balance for over a week without water (Geluso 1978). Despite this adaptation, their small size and diet require this bat to visit perennial drinking water sources year-round.

4.6.10. Seasonal Movements

Canyon bats are not known to make any long-distance migrations, instead using torpor to conserve energy through periods of cold temperatures (Cockrum and Cross 1965). This species remains active during the winter, arousing to drink at water sources (O'Farrell 1967 et al., Hansen et al. 2008). This species may undertake minor seasonal movements to adapt to changing conditions.

4.6.11. Threats

Due to reliance on perennial water sources the canyon bat is especially susceptible to natural or artificial water sources drying out or shrinking in size. Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.6.12. Research Needs

Despite the canyon bat being among the most common in Nevada, there is a dearth of knowledge on its seasonal movements and roosting preferences. This is due in part to the bat being too small to attach GPS transmitters, which have yielded this information for other bat species. Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

4.7. Cave Myotis (*Myotis velifer*)

4.7.1. Conservation Status

Federal	
BLM	S
USFS	None
State	
NDNH	G4 S1
NDOW	SGCN

*Conservation status definitions can be found in Appendix 7.2


Cave myotis - Scott Altenbach © Nevada Department of Wildlife. Used with permission.

4.7.2. Description and Morphology

The cave myotis is a large vesper bat (12-15 g), with a forearm length of 37-47 mm, a wingspan of 28-33 cm, an ear length of 12-15 mm, and a large hind foot (9-12 mm). The dorsal fur is black to brownish-gray, while ventral fur is a lighter yellow to cream. The hairs are bicolored or tricolored. This species can sometimes be distinguished from other myotis by a bare patch of skin between the scapulae. Ears are short and gray to brown. The tragus is short and triangular within relatively short ears. The calcar is not keeled.

4.7.3. Taxonomy

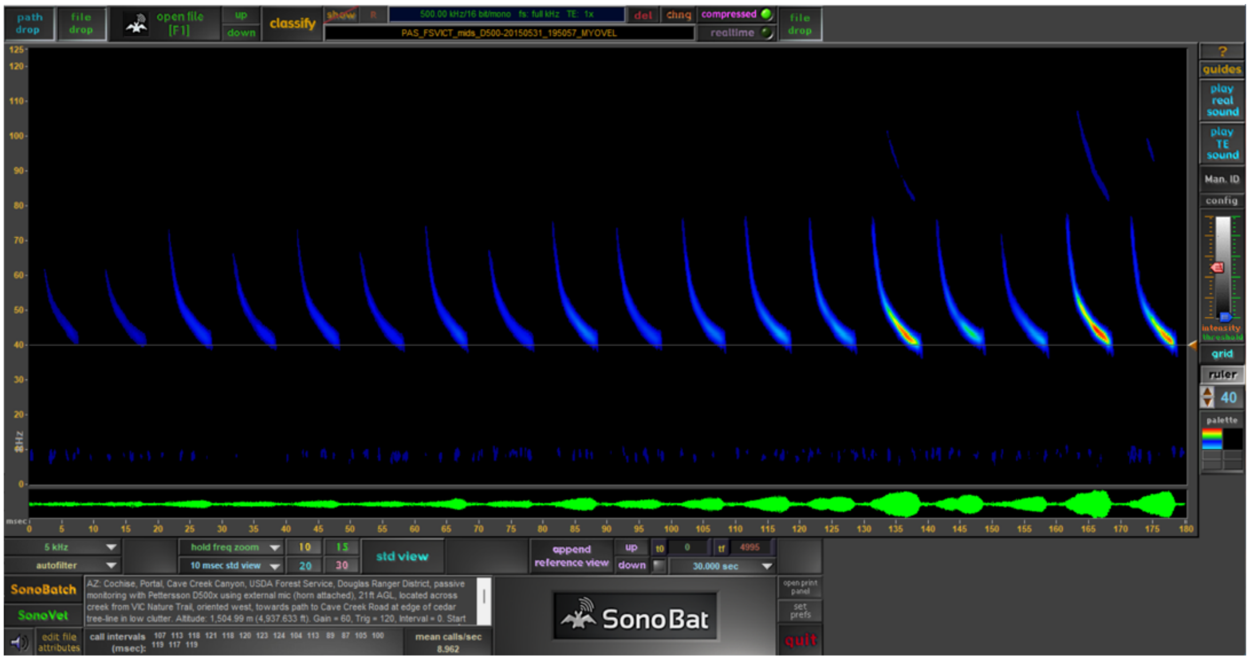
Five subspecies of *M. velifer* are recognized. *Myotis velifer velifer* is the subspecies found in Nevada (Fitch et al. 1981).

4.7.4. Population Status

Only one roosting population of cave myotis has been documented in Nevada, located inside a historical mine complex at Lake Mead National Recreation Area in 1961 (Cockrum and Musgrove 1965). This location was historically a maternity roost. California biologist Pat Brown indicated only males were observed in 2000, which is the last known capture event at the Lake Mead roost, but that cave myotis were detected acoustically and seen flying during exit count surveys in 2010 (Pat Brown, unpublished data).

4.7.5. Flight Characteristics and Acoustic Niche

The cave myotis is a fast, open-air specialist with low wing loading and high wing aspect ratios (Fitch et al. 1981). Cave myotis call pulses are vertical with defined toes and a characteristic frequency around 40 kHz. Though loud and easy to detect acoustically, this species is acoustically ambiguous with other 40 kHz myotis due to overlapping pulse characteristics and a diverse acoustic repertoire.



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4.7.6. Habitat

The cave myotis occurs in low elevation areas in the southeastern tip of Nevada dominated primarily by desert scrub including creosote bush, palo verde, brittlebush and various cacti species (BLM 2017). They have also been documented in mid-high elevation forest habitats.

4.7.7. Roosts and Roosting Behavior

This species roosts in caves, mines, buildings, culverts, and bridges, generally close to the entrance or near open areas, and has been repeatedly found in swallow nests, particularly in the non-reproductive season. Cave myotis are most often found in sheltered cracks and crevices where there is little air movement (Barbour and Davis 1969) and roost colonially. Maternity colonies can be very large (greater than ten thousand individuals), while males generally roost in groups of less than 100. The cave myotis periodically wakes to forage or drink during hibernation and demonstrates high roost fidelity between years. Ambient humidity and proximity to water are thought to be important factors of roost selection for cave myotis (Tinkle and Patterson 1985, Dunnigan and Fitch 1967).

4.7.8. Reproduction

Females and males become reproductively active after their first year. Mating occurs throughout August-September. In Arizona, females ovulate in April and give birth to a single young annually between May and June after a gestation period of 60-70 days (Hayward 1970). Young become volant after four to eight weeks and are weaned after approximately 43 days (Kunz et al. 1995a).

4.7.9. Food Habitats and Foraging

Cave myotis leave their roosts approximately 30 minutes after sunset and usually fly directly to water to drink before foraging (Barbour and Davis 1969, Hayward 1970). They forage for short periods over the top of riparian and dry desert wash vegetation before returning to night roosts. This species is an aerial hawker with a diet including butterflies, moths and beetles, but prey is probably opportunistic based on local insect abundance (Kunz 1974).

4.7.10. Seasonal Movements

This species is a summer resident in Nevada. Winter ecology of the cave myotis in Nevada is poorly understood. The cave myotis is a permanent resident in Kansas and Texas (Barbour and Davis 1969), but in California and Arizona this species most often migrates south for the winter, though in Arizona some resident populations enter local hibernacula between late September and early October (Hayward 1970, Fitch et al. 1981).

4.7.11. Threats

Primary threats to cave myotis include recreational caving (Mann et al. 2002) and mine closures which disturb roosts, especially maternity roosts where female bats congregate in large numbers. Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.7.12. Research Needs

The single documented roost in Nevada (near Lake Mead) should be monitored for evidence of renewed use. Additional surveys for extant populations of cave myotis, especially in abandoned mines in southern Nevada slated for closure, should be conducted. With some evidence of documented species decline, immediate research needs include determining the population status within Nevada. However, research into distribution, population status, habitat use, and seasonal movements is needed for all Nevada bat species. Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

4.8. Fringed Myotis (*Myotis thysanodes*)

4.8.1. Conservation Status

Federal	
BLM	S
USFS	R5S
State	
NDNH	G4 S2
NDOW	SGCN

*Conservation status definitions can be found in Appendix 7.2

Fringed myotis - Scott Altenbach © Nevada Department of Wildlife. Used with permission.

4.8.2. Description and Morphology

The fringed myotis is a medium to large myotis (6-9 g) in the vesper bat family but has been recorded up to 11.7 g during autumn fat deposition (Armstrong et al. 2010, Ammerman et al. 2012, Ewing et al. 1970). It has a forearm length of 39-47 mm, wingspan of 27-30 cm, and ear length of 12-22 mm (Barbour and Davis 1969, O'Farrell and Studier 1980, Hoffmeister 1986). The ears extend 3-5 mm beyond the snout when laid forward (Miller 1897). Its most distinctive feature and namesake is a conspicuous fringe of hair along the posterior border of the uropatagium that extends 1 to 1.5 mm beyond the uropatagium (Keinath 2004). A less pronounced fringe can sometimes be discerned on the trailing edge of the tail membrane of the long-eared myotis but the long-eared myotis is smaller and has longer and darker ears (O'Shea et al. 2018). The fringed myotis is sexually dimorphic, and females typically have larger heads and bodies, as well as forearm lengths (Williams and Findley 1979). Fur color ranges from yellowish brown to darker olive tones, with little difference between dorsal and ventral surfaces (O'Farrell and Studier 1980). Color varies geographically, with a tendency towards darker coloration in northern populations (Miller and Allen 1928). The wing membranes are moderately thick, possess moderate elasticity, and have a high puncture strength, presumably to mitigate injury while gleaning insects on the ground or in thorny vegetation (O'Farrell and Studier 1980). The robust calcar is not distinctly keeled (O'Farrell and Studier 1980).

Fringe of hairs on uropatagium of fringed myotis - Johnathan Palmer

4.8.3. Taxonomy

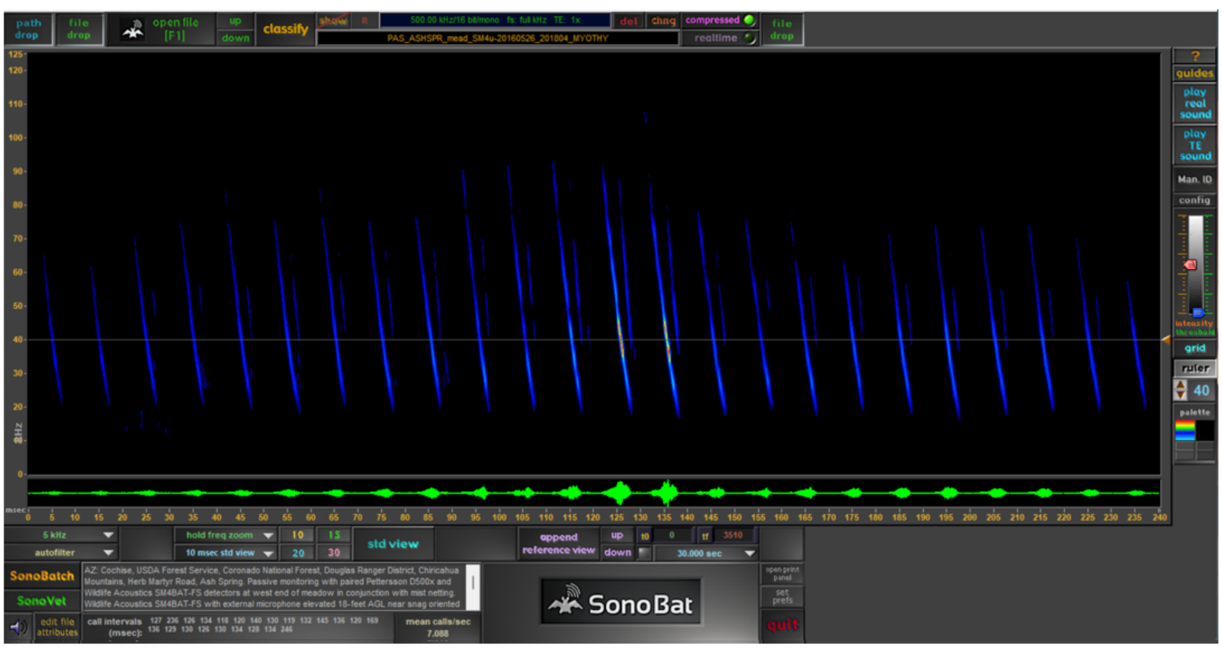
There are three recognized subspecies of fringed myotis (Keinath 2004). *Myotis thysanodes thysanodes* is the subspecies found in Nevada. There have been no major changes to the nomenclature of this species since the original description by Miller (1897). Studies have suggested close evolutionary relationships of fringed myotis with the long-eared myotis, Keen's myotis, and one subspecies of the little brown myotis (Dewey 2006, Stadelmann et al. 2007, Carstens and Dewey 2010, Vonhof et al. 2015). Relationships among some of these species based on morphology, allozyme variation, and other traits have also been hypothesized (Reduker et al. 1983).

4.8.4. Population Status

The status of the fringed myotis in Nevada is unknown with limited information available on its status in other parts of its range. Analysis of counts at two summer colonies in Arizona found no evidence of trends, whereas counts at one hibernaculum used by small numbers of fringed myotis decreased from 1969 to 1992 (O'Shea and Bogan 2003). Rodhouse et al. (2015) detected a decline in occurrence probabilities with time for fringed myotis using eight years of mist net and acoustic monitoring data in Washington and Oregon.

4.8.5. Flight Characteristics and Acoustic Niche

The fringed myotis is a slow, highly-maneuverable bat with a low wing aspect ratio. Mean flight speed in an artificial mine tunnel was estimated at 3.8 mps (8.6 mph) (Hayward and Davis 1964). The characteristic frequency for this species is around 25 kHz, and the call shape is similar to long-eared myotis, which can produce pulses as low as 28 kHz. These two species may be acoustically ambiguous in some parts of the state. Pulses have high bandwidth and are nearly vertical, with converging harmonics. Because this species is a quiet echolocator, the full frequency range of individual pulses may not be rendered.



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The acoustic call sequence and examples above provide a limited sample for the species listed and should be considered insufficient for manual vetting purposes. It is important to understand that bats vary their acoustic calls to suit different areas and activities. Manual vetting entails understanding the full repertoire of call types presented by each species, and which of those overlap with other species and which types provide species-discriminating characteristics. Acoustic file provided by Janet Tyburec.

4.8.6. Habitat

The fringed myotis is found in a wide range of habitats in Nevada from low desert scrub to high elevation coniferous forests. Current Nevada records indicate this species is distributed between 420-2,250 m (1,378-7,382 ft). This species has been found in upper elevation creosote bush desert to pinyon-juniper and white fir up to 2,150 m (7,054 ft) in the White Pine Range (White Pine County). In south-central Nevada the fringed myotis has been documented in the Mojave Desert, Great Basin Desert, and transition ecoregions between 994-2,250 m (3,261-7,382 ft) (Hall 2000, Bechtel Nevada 2006). Collections in the fall have been made at water troughs in the creosote bush-burro bush vegetation association in southern Nevada (O'Farrell unpublished data). One study found fringed myotis in desert and steppe areas were within an hour flight from forested or riparian habitat (O'Farrell and Studier 1980) and ideal habitat includes roost sites with nearby water sources (Keinath 2004).

4.8.7. Roosts and Roosting Behavior

The fringed myotis has been found day and night roosting in mines, caves, trees, buildings, bridges, rock crevices, rock outcrops, and cliff faces during the warm season (O'Shea et al. 2018). Snags used as roosts are generally larger and taller than surrounding trees and are typically in open microsites surrounded by contiguous forest cover (Keinath 2004). Groups of roosting bats often switch locations within roost sites, possibly to find appropriate microclimates for thermoregulatory purposes which suggests ideal day roosts have a variety of microclimates within them (Keinath 2004). Behavioral thermoregulatory features such as microhabitat selection and movement within roost may be of greater survival value than physiological thermoregulation (O'Farrell and Studier 1980).

Maternity colonies range from 1-118 individuals in tree roosts (Chung-MacCoubrey 1996, Pierson et al. 2006, Lacki and Baker 2007), 4-162 individuals in rock features (Bogan et al. 1998, Hayes and Adams 2015), 50-2,000 individuals in caves and abandoned mines (Cockrum and Ordway 1959, von Bloecker 1967, Easterla 1973, Altenbach et al. 2000), and 50-1,200 individuals in buildings (Dalquest 1947, O'Farrell and Studier 1975). Maternity colonies are generally warm to minimize thermoregulatory expenditures of pregnant and lactating females and developing young. Three maternity colonies of fringed myotis have been documented in abandoned mine adits in south-central Nevada (Bechtel Nevada 2005, Hansen et al. 2010). All three are in the transition ecoregion between Mojave Desert and Great Basin Desert in the blackbrush vegetation association at elevations ranging from 1,293-1,665 m (4,242-5,463 ft). Two of these are known to concurrently house maternity colonies of western big-eared bats.

Few winter roosts have been documented, but they are generally cool and found in caves or mines with little temperature fluctuation throughout the winter, facilitating hibernation at a uniformly low metabolic rate (Keinath 2004). Fringed myotis were documented hibernating in mines in Arizona with damp conditions and cool temperatures of 16.7° C (62° F) to 21.7° C (71° F) (Cockrum et al. 1996). They have also been discovered hibernating in buildings and mines along the coast range north of San Francisco Bay (Pierson 1998). Based on limited data, they typically hibernate in small numbers of 2-10 bats (Ellinwood 1978, Perkins et al. 1990, Cockrum et al. 1996, Choate and Anderson 1997).

Roost site fidelity appears to vary across its range and is likely related to the roosting structures in a given geographic area (Keinath 2004). Roosts in relatively permanent structures, such as caves, buildings, and rock crevices, appear to have high fidelity, while roosts in trees do not (Lewis 1995, Weller and Zabel 2001). Nursery colonies likely remain more stable, because lactating females with pups are less likely to shift day roosts (Chung-MacCoubrey 1996, Keinath 2004). Maintaining viable maternity colonies and hibernacula is essential to the survival of breeding females (Keinath 2004).

4.8.8. Reproduction

Most of what is known about reproduction of the fringed myotis, comes from a study in New Mexico by O'Farrell and Studier (1973). In this study, timing of copulation was unknown but occurred between leaving the summer roost and returning in the spring. Ovulation, fertilization, and implantation occurred during the first two weeks of May, and gestation was 50-60 days. Parturition was synchronous with nearly all births occurring within a two-week period at the end of June and beginning of July. Young were capable of limited flight by 16.5 days and adultlike flight by 20.5 days. At 21 days of age, they attained adult size.

Female fringed myotis have one young per year (Cockrum 1955, Barbour and Davis 1969). Some level of communal care is evident with several females remaining in roost to suckle pups and retrieve young that fall from the roost (O'Farrell and Studier 1980). During the weeks prior to parturition, this species is very sensitive to disturbance (O'Farrell and Studier 1973).

During the summer adult males are segregated from the maternity colony (O'Farrell and Studier 1975, Easterla 1973) and are found singly or in small groups. Males and non-reproductive females inhabit higher elevations than reproductive females (Cryan et al. 2000, Cockrum et al. 1996, Chung-MacCoubrey 2005, Geluso and Geluso 2012, Hayes and Adams 2014). Warmer temperatures at lower elevations are more favorable for rapid growth and development of young, whereas cooler temperatures at higher elevations can allow deeper daily torpor for males and non-reproductive females (Cryan et al. 2000, Bogan and Mollhagen 2016, Weller et al. 2009).

4.8.9. Food Habitats and Foraging

Fringed myotis are opportunistic when foraging, feeding on a variety of insects when abundant, but beetles always comprise a large portion of their diet (Black 1974, Rainey and Pierson 1996, Warner 1985). Of 68 diet samples collected over two summers 90% contained remains of beetles; followed by butterflies and moths (62%); flies (53%); net-winged insects (24%); sawflies, wasps, bees, and ants (9%); true bugs (9%); and 9% other insects (Warner 1985). Whitaker et al. (1977; western Oregon) found a variety of insect classes in stomachs of fringed myotis with nearly 50% of total volume accounted for by potentially flightless taxa including harvestmen, spiders, and true crickets. Whitaker et al. (1981) reported butterflies and moths were the primary prey eaten and to a lesser extent other insects in northeastern Oregon. In northwestern Colorado, Armstrong et al. (1994) indicated that butterflies and moths were the major dietary component followed by caddisflies and beetles in descending order of proportional frequency.

Ober and Hayes (2008b) sampled in riparian areas in the Oregon Coast Range and documented a diet of primarily spiders, butterflies, and moths.

Black (1974) and Banfield (1975) speculated that fringed myotis hunt insects in flight, usually over vegetative canopy from sunset until around midnight. However, their wing morphology is indicative of dexterous, low-speed flight suitable for foraging in areas with a lot of vegetative clutter, suggesting these bats may glean insects from vegetation (O'Farrell and Studier 1980). Glass and Gannon (1994) found that the fringe of uropatagial hairs is connected to a muscle in the tail membrane that is unique to fringed myotis that may allow the hairs to flare perpendicular to the uropatagium, thus preventing escape of insects that have been ensnared in the tail membrane. They suggested it is also possible that such hairs may help to glean insects by adding tactile sensitivity to the tail. Fringed myotis also forage over bodies of water (Keinath 2004) as insect abundance is often much greater in these areas (Grindal et al. 1999). Fringed myotis appear to be most active for the first 1-2 hours after sunset, up to about 4.5 hours after sunset (O'Farrell and Studier 1980). One radio-tagged female travelled from a rock crevice day roost in chaparral to a Jeffrey pine forest 305 m (1,000 ft) higher in elevation and 12.8 km (8.0 mi) distant while foraging, returning at dawn (Miner et al. 1996, Simons et al. 2000).

4.8.10. Seasonal Movements

The fringed myotis appears to be a year-round resident in Nevada but presumably makes seasonal movements like their counterparts in other parts of their range. Studier and O'Farrell (1972) speculated, based on physiological performance of their bats in New Mexico, that fall migrations were of short distances to lower elevations or more southern areas where the bats could be periodically active in winter. Spring migration to a maternity roost was rapid, occurring from mid- to late April. Within the maternity roost, the population remained stable until September, and then declined rapidly during fall migration (O'Farrell and Studier 1975). O'Farrell and Studier (1980) determined the known activity period to extend from April through September and suggested that hibernation may be periodically interrupted throughout the winter. Year-round acoustic monitoring at a pond in pinyon-juniper habitat in south-central Nevada documented 19 minutes of winter (December-February) bat activity for fringed myotis over three winters (2004-2006) (Hansen et al. 2008).

4.8.11. Threats

The fringed myotis is especially sensitive to human presence. It is threatened by recreational caving, mine closures, renewed mining, timber harvest, indiscriminate pest control, and bridge replacements and building demolitions that do not consider presence and use patterns. Climate change is another potential threat to fringed myotis. A recent simulation study shows fringed myotis populations could decrease in size by more than 90% by 2086 (Hayes and Adams 2017) and Capelli et al. (2021) predict fringed myotis is likely to lose up to 44% of its range. This species uses a wide range of roost structures but is also associated with late seral stage forest attributes in north-western montane regions (Weller 2008), a limited and declining resource, and lactating females are highly dependent on water sources (Adams and Hayes 2008). These factors combined indicate elevated conservation concern for fringed myotis from changing climates. Population declines may have already begun, as modelled occurrence probabilities for this species in the Pacific Northwest declined from 2003 to 2010 (Rodhouse et al. 2015). Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.8.12. Research Needs

There are no species-specific research needs for the fringed myotis in Nevada, but research into distribution, population status, habitat use, and seasonal movements is needed for all Nevada bat species. Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

4.9. Hoary Bat (*Lasiurus cinereus*)

4.9.1. Conservation Status

Federal	
BLM	S
USFS	None
State	
NDNH	G3 S2S3
NDOW	SGCN

*Conservation status definitions can be found in Appendix 7.2


Hoary bat - Scott Altenbach © Nevada Department of Wildlife. Used with permission.

4.9.2. Description and Morphology

The hoary bat is a large vesper bat (20-38 g) with a forearm length of 50-57 mm and a wingspan of 40-43 cm. The fur is long and soft, and each hair transitions in color from dark brown or black at the base to cream to mahogany brown to white at the tip. The upper three layers of color are visible, giving the hoary bat a distinctive frosted (or hoary) appearance. This species is uniformly colored except for a yellow-brown collar circling under the chin and behind the ears. Dense fur extends to the tip of its tail and just beyond the wrists along the undersides of its wings, with white patches on the shoulders and wrists. Wings are long and narrow with black membranes. Ears are large, rounded, and primarily yellow but bordered with black skin. The tragus is short and blunt.

4.9.3. Taxonomy

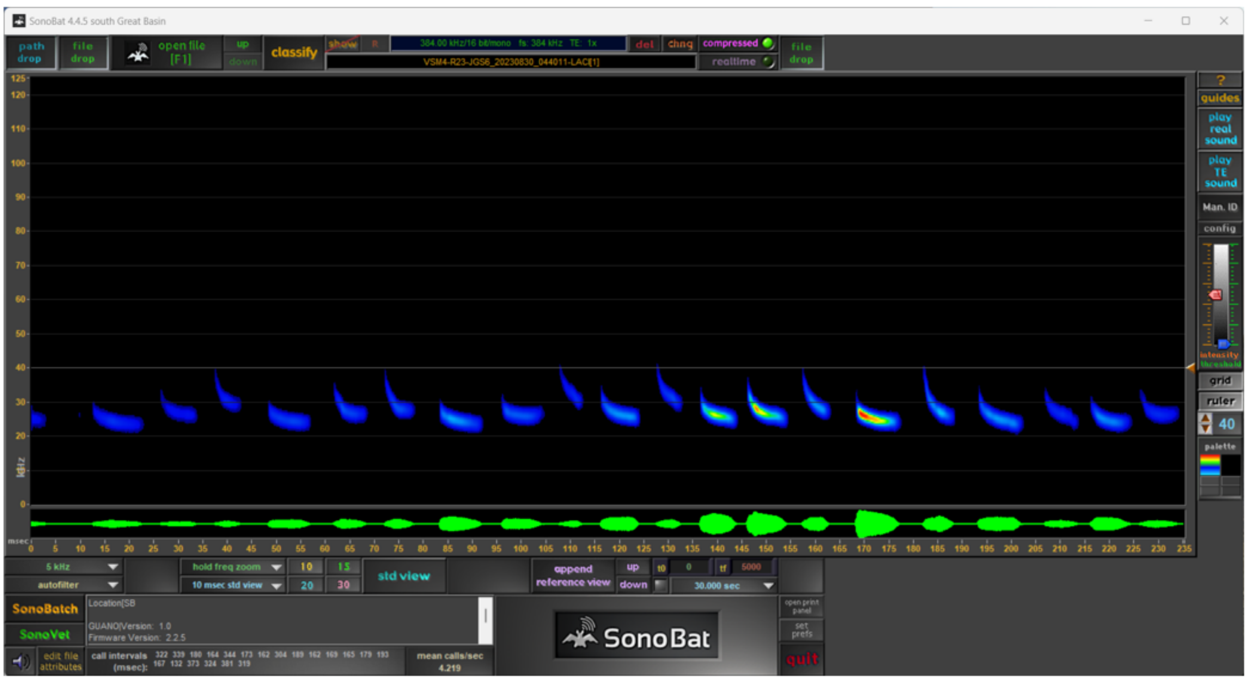
There are three recognized subspecies of *Lasiurus cinereus*, with *Lasiurus cinereus cinereus* present in North America, including Nevada.

4.9.4. Population Status

The population status of hoary bats in Nevada is currently unknown. The species is currently ranked as imperiled or vulnerable (S2S3) in the state of Nevada. Rodhouse et al. (2019) has documented declines in hoary bat populations in Oregon.

4.9.5. Flight Characteristics and Acoustic Niche

The hoary bat is a fast, high-flying, open-air specialist and has one of the highest wing aspect and wing loading ratios of any north American bat species (Barclay 1985). Typical characteristic frequencies of hoary bat calls 'bounce' between 20-25 kHz, and power is often centered within a given pulse. Hoary bats may fly without the use of echolocation, or while producing quieter 'microcalls,' potentially complicating acoustic monitoring efforts (Corcoran and Weller 2018).



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The acoustic call sequence and examples above provide a limited sample for the species listed and should be considered insufficient for manual vetting purposes. It is important to understand that bats vary their acoustic calls to suit different areas and activities. Manual vetting entails understanding the full repertoire of call types presented by each species, and which of those overlap with other species and which types provide species-discriminating characteristics.

4.9.6. Habitat

The hoary bat occurs throughout Nevada, typically in forested riparian habitat, including stream and river corridors, washes, and lake shores (O'Farrell and Shanahan 2006, Szewczak et al. 1998). Ports and Bradley (1996) additionally reported the use of perennial springs, mid-to high elevation coniferous forests, and mid-to high elevation deciduous forest. It has also been found in low desert scrub and pinyon-juniper (Hansen et al. 2008).

4.9.7. Roosts and Roosting Behavior

Hoary bats have been found roosting in tree cavities, caves, buildings, squirrel nests, beneath rock ledges, and on bridges (Nagorsen and Brigham 1993, Hendricks et al. 2005), but most often root within foliage 3-12 m (10-39 ft) above the ground in both coniferous and deciduous trees, relying on fur coloration to provide nearly perfect camouflage. During summer, they prefer tree roosts in edge habitats close to foraging grounds. Most females have been found rearing young in deciduous trees, while males seem more likely to roost in conifers. Both tend to prefer older trees and demonstrate high roost fidelity, revisiting a given site for up to five weeks.

Mothers and young usually roost higher than solitary adults. Hoary bat maternity roost preferences include dense vegetation above and unobstructed space below. They also select for areas with dark-colored ground cover to minimize reflected sunlight, and sufficient surrounding vegetation to protect from wind and enhance heat and humidity retention. Southern exposure is ideal, where vegetation is dense, and heat gain greatest.

Little is known about the night, migratory, or winter roosts of this species. The species is rarely seen during winter hibernation, and they are the only bats known to hibernate out in the open (Tuttle 1995).

4.9.8. Reproduction

The hoary bat is solitary, usually living alone or in family groups consisting of a mother and her young, except during migration. Males and females come together to mate in the fall (Shump and Shump 1982b, Cryan 2003). Females typically give birth between mid-May and late June and most have twins, but litters of one to four pups are possible. At birth, young are covered with fine, silvery-gray fur on the head, shoulders, tail membrane, and feet. Their eyes and ears open in three days, and by the seventh day they begin to hang alone away from their mother for short periods of time. They learn to fly in approximately 33 days. Based on litter size, these bats are assumed to be relatively short-lived, most probably living no more than 6 or 7 years.

4.9.9. Food Habitats and Foraging

The hoary bat is an aerial-hawking species that feeds in the open airspace above the forest canopy or over water sources and has also been recorded feeding around wind turbines (Foo et. al 2017). Its diet consists primarily of butterflies and moths, especially moths, but also includes grasshoppers, locusts, crickets, and beetles (Foo et al. 2017, Valdez and Cryan 2013). Long-range echolocation is used to detect prey at a distance before initiating pursuit.

4.9.10. Seasonal Movements

Hoary bats are believed to be migratory bats and are only summer residents in Nevada. In California, summer residents are primarily males. Non-lactating females and reproductively active males have been caught in Nevada in August (Bradley and Baldino 1997, Jeffress 2013). Fall migration is believed to occur between early August and October (Cryan 2003) and hundreds of hoary bats may travel together at this time. Specific migratory patterns in Nevada are not known. In Nevada, most female captures have been during spring (April and May) and fall (August through October) migration, and most male captures have been May through August. This is consistent with other findings indicating males tend to occur in the mountainous regions of western North America in the summer, and females may migrate farther distances and are more numerous in the eastern regions (Cryan 2003). An increase in detections during migration periods is also reflected in acoustic monitoring efforts (O'Farrell and Shanahan 2006). Most hoary bats are believed to overwinter in coastal areas, including parts of California and Mexico, but some overwinter in the eastern U.S. (Cryan 2003). A year-round acoustic study in south-central Nevada showed activity from April through November with peaks in April and May with no winter activity detected from 2004-2006 (Hansen et al. 2008). One acoustic record was detected in January 2019 in Moapa, NV indicating some winter use (Hammond et al. 2020).

4.9.11. Threats

In areas being developed for wind energy, wind turbines are a major source of mortality, especially during migration. Hoary bats, like other tree bats, are particularly vulnerable to mortality at wind energy facilities (Green et al. 2021). Annual total bat mortality from wind energy facilities in the U.S. likely exceeds 400,000 bats and may threaten some species with extinction (Green et al. 2021, Rodhouse et al. 2019, Frick et al. 2017). Recent studies outside of Nevada have found that hoary bats comprise a substantial proportion of the tens to hundreds of thousands of bat fatalities estimated to occur each year at wind energy facilities in North America (Ellison 2012). This has also been true for the Spring Valley Wind Farm near Ely, where several hoary bat mortalities have been documented (Western EcoSystems Technology 2013).

The hoary bat may be especially at risk from loss of roosting habitat due to timber harvest and loss of riparian habitats. The application of pesticides near riparian areas may also pose a threat to this species. Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.9.12. Research Needs

Population impacts from mortality at wind farms require further study. Focused surveys and monitoring should be conducted to determine the impact of alternative energy development on this species, due to known vulnerabilities. Research into distribution, population status, habitat use, and seasonal movements is needed for all Nevada bat species. Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

4.10. Little Brown Myotis, Little Brown Bat (*Myotis lucifugus*)

4.10.1. Conservation Status

Federal	
BLM	S
USFS	Under Review
State	
NDNH	G3 S2S3
NDOW	SGCN

*Conservation status definitions can be found in Appendix 7.2

Little brown myotis - Scott Altenbach © Nevada Department of Wildlife. Used with permission.

4.10.2. Description and Morphology

The little brown myotis is a small vesper bat weighing approximately 4-9 g. They have an average forearm length of 34-41 mm, ear length of 11-16 mm, unkeeled calcars, gradually sloping foreheads, and narrow, blunt tragus (Barclay and Fenton 1980, Morgan et al. 2019). Their long, glossy dorsal pelage ranges widely among shades of brown, yellowish-brown, and olive-brown, while ventral fur varies among shades of buff, yellow, and gray-white (Barclay and Fenton 1980, Morgan et al. 2019). Little brown myotis face and wing membranes are typically dark brown to black (Harris 1974, Barclay and Fenton 1980). Females tend to be slightly larger than males (Fenton 1970).

Where their ranges overlap, it is not possible to reliably distinguish between little brown myotis and Yuma myotis without genetic samples or voucher calls. In these areas, little brown myotis is more likely to be misidentified as Yuma myotis than the reverse (Rodhouse et al. 2008, Luszcz et al. 2016). Researchers in northern Washoe county reported the species are distinct enough, at least in that part of the state, to be distinguished in-hand (Van Gunst et al. 2020). Pelage shine has been found to be the most reliable trait for distinguishing between these two species, followed by ear color and forehead slope, but no method has been found to be completely reliable (Rodhouse et al. 2008, Luszcz et al. 2016).

4.10.3. Taxonomy

The five currently recognized subspecies of *Myotis lucifugus* are *M. l. alascensis*, *M. l. carissima*, *M. l. lucifugus*, *M. l. pernox*, and *M. l. relictus*. The subspecies most likely found throughout its range in Nevada is *M. l carissima*, though the range of *M. l. relictus* may extend into the Sierran portion of the state (Morales and Carstens 2018, Barclay and Fenton 1980). There is evidence of gene flow between several of these subspecies (Lausen et al. 2008), but some researchers still argue that they may constitute five separate species (Morales and Carstens 2018). There is also some evidence that the Arizona myotis (*M. occultus*) may be conspecific with *M. lucifugus* (Valdez et al. 1999).

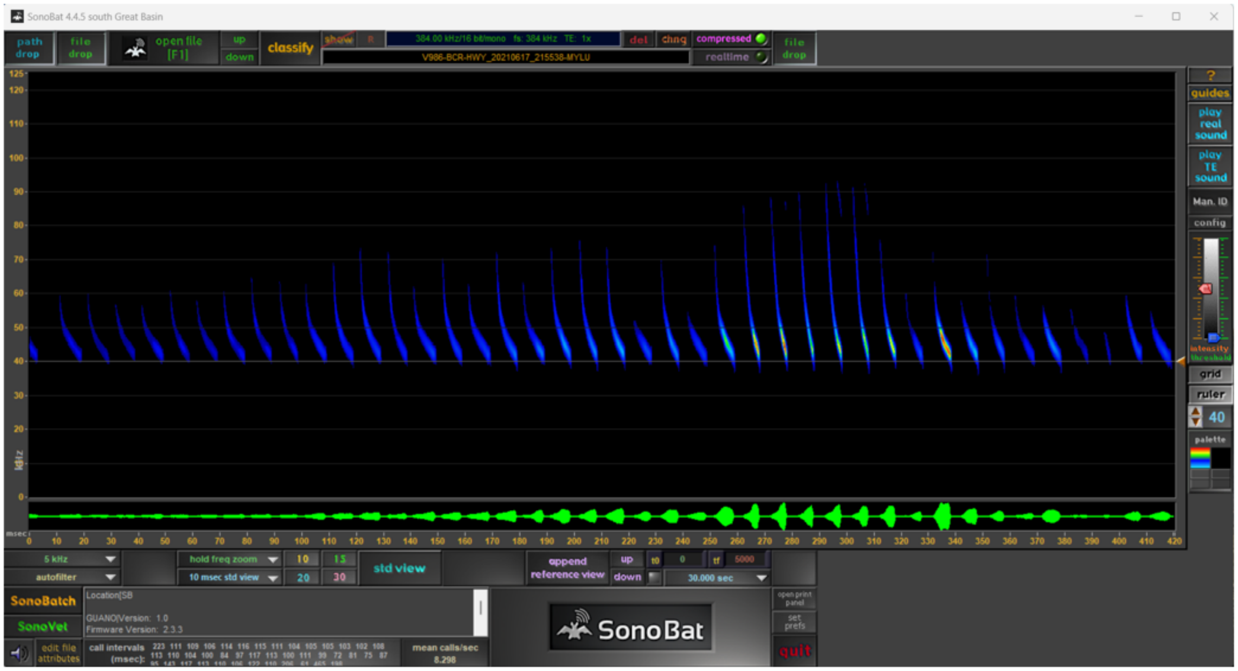
4.10.4. Population Status

Prior to the introduction of WNS, there were likely over six million little brown myotis in the northeastern core of its population, making the species possibly the most common bat in the U.S. and Canada (Miller-Butterworth et al. 2014, Frick et al. 2010). Historically, it has been particularly common in the northern parts of its range, and it apparently remains among the most common bats in northern areas currently unaffected by WNS. However, populations have declined precipitously in the northeast and in any areas where WNS has spread (Frick et al. 2010), with infected hibernacula often experiencing a 70-90% reduction in population within a few years of the disease's arrival (Frick et al. 2010, Turner et al. 2011). Conservative estimates in 2010 placed the likelihood of extinction in the northeastern U.S. at 99% by 2026 (Frick et al. 2010), but some areas appear to be stabilizing or even recovering slightly (Ineson et al. 2020).

This species does not appear to be particularly common in Nevada. It represented less than 1% of 1,120 bat captures between two studies conducted in northern Nevada (Van Gunst et al. 2020, Ports and Bradley 1996) and is only rarely detected acoustically in most parts of the state (Van Gunst et al. 2020). Overall population trends in the state are unknown.

4.10.5. Flight Characteristics and Acoustic Niche

The little brown myotis is a highly maneuverable bat with low wing loading and wing aspect ratios. The characteristic frequency for this species is around 40 kHz. In Nevada there is considerable overlap in acoustic niche of little brown myotis, long-legged myotis, and western small-footed myotis as the 40 kHz myotis guild and shorter duration little brown myotis clutter calls are indistinguishable from long-legged myotis search-phase call pulses.



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4.10.6. Habitat

The little brown myotis has the largest range of any North American bat species and is adapted to a broad variety of habitats. It is generally associated with forest and wetland habitats and is also one of the species most likely to be found in or near human habitation (Nelson and Gillam 2017). The little brown myotis prefers foraging in edge habitats and near water sources (Nelson and Gillam 2017). In Nevada, it might show similar preference for mesic habitats and habitats with higher tree cover. Eight of eleven individuals mist-netted between two studies in northern Nevada (Van Gunst et al. 2020, Ports and Bradley 1996) were captured in riparian or upland conifer habitat while three were in sagebrush or salt desert. It was also the species most commonly detected during acoustic surveys in the western and southern portions of the Lake Tahoe basin (Morrison et al. 2010), so it may also be common on the Nevada side of the border in similar habitat (alpine meadows and coniferous forest in the Sierra region). It has not been detected in the southwestern Great Basin in the vicinity of the White Mountains (Szewczak et al. 1998, Kuenzi et al. 1999). It has been detected in low numbers in the transition zone between the Mojave Desert and Great Basin Desert and is nearly absent in the Mojave Desert and most of southern Nevada. There are recorded occurrences of little brown myotis at high elevations throughout Nevada.

4.10.7. Roosts and Roosting Behavior

This species has typically been observed to hibernate in locations with relatively stable temperatures between 2-12°C (36.5-53.6°F) (Fenton 1970) and humidity between 85% and 100% (Barbour and Davis 1969, Fenton 1970). Southern populations typically enter hibernation in November and emerge in mid-March. In the eastern U.S., little brown myotis have been known to hibernate in caves in groups numbering hundreds of thousands (Davis and Hitchcock 1965). In the western U.S., however, these bats have not been observed to roost in such numbers, and generally appear more likely to roost singly or in smaller groups (Vonhof et al. 2015), though 300 little brown myotis have been found roosting in a bridge in Idaho (Keeley and Tuttle 1999). No myotis species in Nevada has been observed hibernating in groups greater than four (Weller et al. 2018). One study reported acoustic detections of little brown myotis at 14 mines in Nevada between May and September (Morrison and Fox 2009).

During the summer, pregnant and lactating females show a strong preference toward forming maternity colonies in buildings even when other suitable habitat is available (Johnson et al. 2019, Davis and Hitchcock 1965). Maternity colonies are generally 5-10°C (41-50°F) warmer than the ambient temperature and are usually closer to water and foraging grounds than are typical day roosts (Barclay and Fenton 1980). Males and non-breeding females typically roost singly or in small groups under tree bark or in rock crevices, often with southwestern exposure (Johnson et al. 2019, Fenton 1970). These sites are typically much cooler than maternity roosts and the bats are often torpid while roosting (Fenton 1970). After the initial feeding, all except lactating females generally retire to night roosts. These roosts are usually communal and tend to be highly enclosed. They are often near day roosts or even in the same structure, but they are very rarely the same as the day roost (Barclay and Fenton 1980).

4.10.8. Reproduction

Little brown myotis breed during the swarming periods in late summer and early fall, and males also mate with torpid females throughout the winter (Davis and Hitchcock 1965). Fertilization is delayed until females emerge from hibernation in the spring and begin ovulating (Barclay and Fenton 1980). After this point, gestation typically lasts 50-60 days (Wimsatt 1945), but this can be prolonged by sustained bouts of torpor, which little brown myotis have been found to use during pregnancy and lactation (Besler and Broders 2019). Each female in a maternity colony generally gives birth to a single pup, and the births within a colony are typically staggered over a three-week period (Barclay and Fenton 1980). Pups are able to thermoregulate within 9.5 days on average and are typically volant within 18-21 days (Kunz and Anthony 1996).

4.10.9. Food Habitats and Foraging

Little brown myotis have rounded wing tips which allow for maneuverable flight (Norberg and Rayner 1987), but they have generally been found to prefer foraging in uncluttered environments (Crampton and Barclay 1998). They specialize in capturing small emergent aquatic insects (3-10 mm) by flying through swarms over water and selecting individuals by species or size (Clare et al. 2011, Ober and Hayes 2008a). They typically use high frequency, close range calls suitable for selecting between prey items at short distances, with average distances of 2.3 m and maximum distances of 2.9 m (Grinnell and Griffin 1958, Fenton and Bell 1981). Little brown myotis show great flexibility in their diets across their range and by age and have been observed gleaning spiders as well as hawking small insects (Ober and Hayes 2008b, Maucieri and Barclay 2021). Juveniles and individuals at the northern extent of the range tend to show more variability, likely due to inexperience and shortened foraging periods respectively.

4.10.10. Seasonal Movements

Little brown myotis make late-summer migrations averaging 100 km (62 mi), but up to 500 km (310 mi) from their summer grounds to their hibernacula (Fenton 1969, Davis and Hitchcock 1965, Norquay et al. 2013). They swarm in great numbers around roost entrances, generally spending only a day or so each at the location before dispersing again (Davis and Hitchcock 1965). Mating may occur at this time. It has also been hypothesized swarming could be a method of determining suitability of hibernation locations and an opportunity for juveniles to familiarize themselves with potential hibernacula (Fenton 1969). In late fall (typically around November in southern portions of their range), these bats return to the hibernacula again for hibernation (Barclay and Fenton 1980). They do not always swarm and hibernate in the same locations (Fenton 1969). Seasonal movement patterns in Nevada are unknown.

4.10.11. Threats

The little brown myotis has experienced possibly the greatest population decline of any species following the introduction of WNS. It is unclear how survival in western populations will be affected by differences in roosting behavior from eastern populations. Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.10.12. Research Needs

Thanks to its wide range, previous abundance, and habit of roosting in or near urban areas, the little brown myotis is probably the best researched of all North American bat species. Much of what is known about the biology of bats in general is derived from studies conducted on little brown myotis (Barclay and Fenton 1980). This species has not, however, been particularly well studied in the western U.S., and better knowledge of its winter roosting habitat is urgently needed in order to assess the impacts of WNS. Further research is also needed to resolve current taxonomic confusion, as the taxonomic status of these populations may affect policy decisions. Additionally, there do not appear to have been concentrated survey efforts for bats in the Carson Range or Tahoe Basin, where previous studies have indicated it may be more common than in other areas of the state (Morrison et al. 2010). Surveying these areas could provide a better picture of this bat's status in Nevada. Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

4.11. Long-eared Myotis (*Myotis evotis*)

4.11.1. Conservation Status

Federal	
BLM	S
USFS	None
State	
NDNH	G5 S3
NDOW	SGCN

*Conservation status definitions can be found in Appendix 7.2

Long-eared myotis - Joseph Danielson

4.11.2. Description and Morphology

The long-eared myotis weighs 5-9 g with a forearm length of 37-40 mm, a wingspan of 23-30 cm, a slender and pointed tragus, and the longest ears of any North American myotis (19-22 mm) which extend approximately 5 mm beyond the nose when laid forward. Its body is covered in short, dull to pale yellow or brown fur which is often lighter on the ventral side. The muzzle and wings are darkly colored. The calcar is not keeled or if so, only slightly. Some individuals have an inconspicuous fringe of hairs along the uropatagium, which may be morphologically ambiguous with fringed myotis. Long-eared myotis have larger molars than other myotis species allowing it to crack thicker carapaces of beetles and other larger insects (Manning and Jones 1989). Long-eared myotis overlaps morphologically with Keen's myotis, which does not occur in Nevada.

4.11.3. Taxonomy

There are six recognized subspecies of *Myotis evotis* (Simmons 2005); only one, *M. evotis chrysonotus*, is known to occur in Nevada. However, specimens and occurrence records are limited for other subspecies (such as *M. e. jonesorum* known from northwestern Arizona, and *M. e. pacificus* known from southeastern Oregon) which could potentially occur within Nevada (Manning 1993).

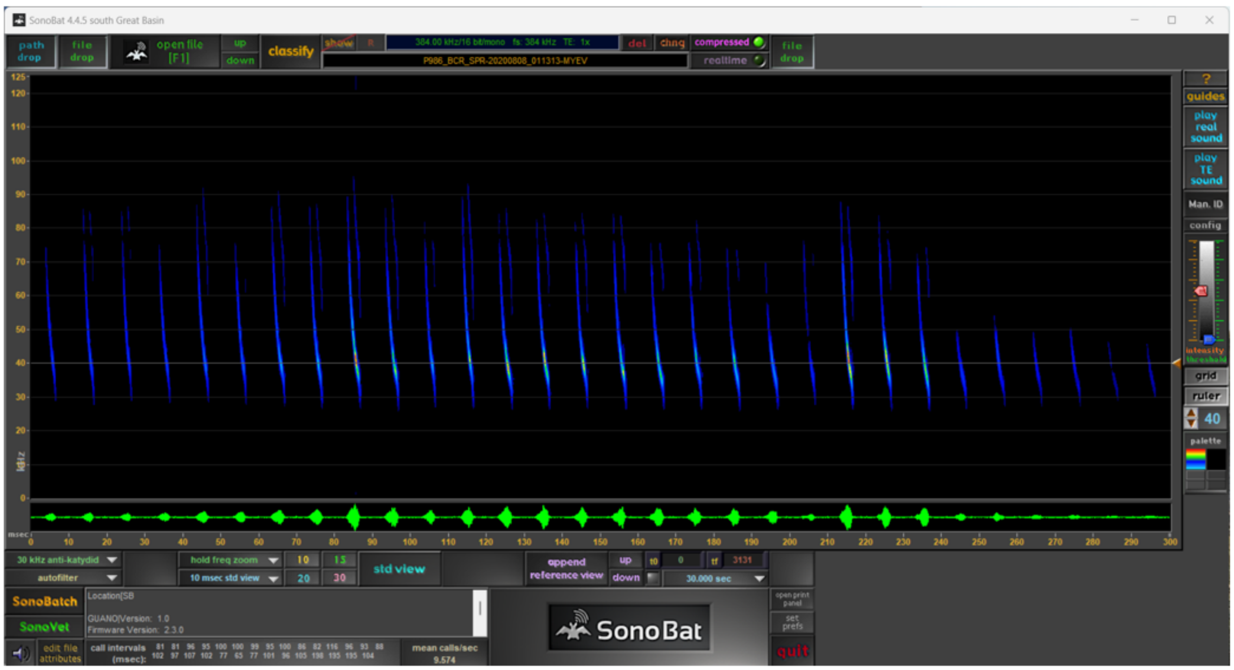
There is recent evidence that *M. keenii,* believed to occur in coastal forests between Alaska and Washington, is genetically indistinct from *M. evotis* and therefore misrepresented as a unique species (Lausen et al. 2019) despite morphological differences highlighted by Manning (1993).

4.11.4. Population Status

Little information is available concerning the population status of long-eared myotis in Nevada, but the species is currently ranked as vulnerable within the state (S3). This species has been recorded in most of the western U.S. and southwestern Canada but is not known to exist in significant numbers in any region. The solitary nature of the long-eared myotis contributes to the lack of available information.

4.11.5. Flight Characteristics and Acoustic Niche

Long-eared myotis is a maneuverable but slow, low-flying bat that transitions readily between clutter and open-air navigation. The wings are short and wide, with low aspect and wing loading ratios, allowing for highly maneuverable flight through thick vegetation (Vaughan 1966). This species has a characteristic frequency at 34 kHz, which distinguishes it from myotis in the 40 kHz guild. Echolocation calls during aerial hawking are short in duration and tend to be higher frequency. Gleaning calls tend to be shorter and at a lower amplitude (Faure and Barclay 1994). Frequency modulation may be nearly linear making the characteristic frequency difficult to recognize (Szewczak 2018).



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4.11.6. Habitat

In southern Nevada, the long-eared myotis occurs in high elevation ponderosa pine forests and pinyon-juniper-sagebrush vegetation and tends to avoid lower elevation desert scrub. In central and northern Nevada, the long-eared myotis can be found in higher-elevation pinyon-juniper and aspen habitats as well as lower-elevation sagebrush and desert scrub (Manning and Jones 1989, Rancourt et al. 2005, Anthony and Sanchez 2018). Current Nevada records indicate this species is distributed in elevations between 690 m and 3,090 m (2,263-10,137 ft). This species is closely associated with forests, but recent research suggests this association is related to foraging habits rather than roosting sites (Chruszcz and Barclay 2002, Rancourt et al. 2005). Habitat use may be positively associated with proximity to water, especially in reproductive females (Snider et al. 2013, Waldien and Hayes 2001, Anthony and Sanchez 2019). The long-eared myotis operates in both low and high clutter environments. A study by Snider et al. (2013) found that habitat use by long-eared myotis was negatively associated with proximity to recent wildfire events.

4.11.7. Roosts and Roosting Behavior

Summer day roosts include stumps, dead trees, exfoliating bark, and human-made structures, but recent research suggests rock crevices may be the most used roost type, especially by reproductive females (Solick and Barclay 2007, Anthony and Sanchez 2018 and 2019, Snider et al. 2013, Vonhof and Barclay 1997, Morrison and Fox 2009). The orientation, height, distance from water, and distance from burned habitat of a crevice may influence roost selection (Solick and Barclay 2007, Anthony and Sanchez 2018, Snider et al. 2013, Waldien and Hayes 2001). This species has low roost fidelity, with individuals switching locations every 1-4 days regardless of sex or reproductive status (Rancourt et al. 2005, Solick and Barclay 2007, Anthony and Sanchez 2018). Alternatively, the long-eared myotis has a high fidelity for roosting area. Nixon et al. (2009) estimated a roosting area of 2 ha (5 ac) despite Waldien and Hayes (2001) finding the nightly activity area of the long-eared myotis to be over 38 ha (94 ac). Home ranges for long-eared myotis are estimated to be the largest of any myotis species ranging up to 206 ha (509 ac) for lactating females and 434 ha (1,072 ac) for males. The mean maximum foraging distance for lactating females is up to 993 m (3,257 ft) and up to 1,522 m (4,993 ft) for males (Anthony 2016).

Roosts are often occupied by a single to few individuals, with the largest groups being observed in summer maternity colonies of up to 30 bats. Non-reproductive females and males may roost together or individually. Elevation has been noted to impact roost selection in reproductive female long-eared myotis in Canada (Solick and Barclay 2007). Individuals at higher-elevation sites prioritized thermal roosts to avoid torpor, while individuals at lower-elevation sites prioritized cooler roosts to facilitate torpor. This may be relevant to Nevada populations, which also exist at extreme elevational gradients, but this phenomenon has not been researched within the state.

Not much is known about the winter activity and movements of the long-eared myotis in Nevada. Winter hibernation is speculated to occur locally due to the enormous amount of energy that would be needed to migrate to areas with adequate food and based on the observations of the habits of other closely related myotis species. Year-round acoustic monitoring in south-central Nevada showed activity from April to October with no winter activity (Hansen et al. 2008). This suggests either a migration event or hibernation. Long-eared myotis have been observed periodically arousing from torpor during the winter, primarily due to dehydration experienced during winter torpor (Lausen and Barclay 2006). Hibernation is suspected to occur in caves, mines, and rock crevices.

4.11.8. Reproduction

Information on reproduction is limited for the long-eared myotis. After mating in the fall, males and females separate. Sperm is stored in the uterus until spring (Zahn and Dippel 1997) and reproductive females form small maternity colonies. In Alberta, Canada, reproductive females were pregnant from May-June and lactating from July-August (Chruszcz and Barclay 2002). Pregnant females were captured in

White Pine County, Nevada in June (Hall 1946). Females are assumed to give birth to a single young, and in South Dakota male young-of-the-year reached adult size by early August (Manning and Jones 1989).

4.11.9. Diet and Foraging

Foraging generally takes place near vegetation or close to the ground. The long-eared myotis has a flexible foraging strategy, gleaning insects from substrate and catching prey in aerial pursuit as it forages along rivers and streams, over ponds, and within cluttered forest environments. Forage targets include moths, small beetles, and flies. There may be intraspecific food resource partitioning, with females consuming more beetles and males consuming more moths (Husar 1976, Manning 1993).

Long-eared myotis can emerge as quickly as five minutes after sunset (Waldien and Hayes 2001) and feed all night long, spending less than 10% of the night roosting regardless of temperatures (Chruszcz and Barclay 2003). Some research suggests their varied foraging strategy may be more energy intensive, requiring long-eared myotis to forage for longer periods (Chruszcz and Barclay 2003) and explaining this early emergence.

4.11.10. Seasonal Movements

Due to the high caloric expenditure of migration, coupled with the lack of available prey during the winter months, it is speculated that long-eared myotis does not migrate but rather hibernates in small groups using available caves and mines (Manning and Jones 1989). Acoustic detections of long-eared myotis in Nevada during winter months support the idea that it is a year-round resident in Nevada.

4.11.11. Threats

There are no known species-specific threats in Nevada for the long-eared myotis, however all bat populations are threatened by multiple factors including climate change, habitat loss, roost disturbance, environmental contaminants, energy development, abandoned mine closures, mining and mineral exploration, and WNS. Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.11.12. Research Needs

Much of the life history information available for long-eared myotis is based on research conducted in the Pacific Northwest, where the bat is more common, rather than the southern portions of its range. Studying the behaviors of this species in areas that are warmer and more arid is critical to understanding long-eared myotis in Nevada and other southwestern states. Research into distribution, population status, habitat use, and seasonal movements is needed for all Nevada bat species. Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

4.12. Long-legged Myotis (*Myotis volans*)

4.12.1. Conservation Status

Federal	
BLM	S
USFS	None
State	
NDNH	G4 S3S4
NDOW	SGCN

*Conservation status definitions can be found in Appendix 7.2

Long-legged myotis - Joseph Danielson

4.12.2. Description and Morphology

The long-legged myotis is a relatively small vesper bat (6-9 g), but one of the larger *Myotis* species in Nevada, with a wingspan of 24-29 cm, forearm length of 37-41 mm, and ear length of 10-15 mm. Dorsal fur is reddish buff to yellowish brown and ventral color ranges from pale buffy to cinnamon brown to smoky brown. The ears, muzzle, and wing membranes are usually darker in color. Long-legged myotis are readily distinguished from other myotis species by the combination of their short, rounded ears that barely reach the nostril when laid forward, small hindfeet, distinctly keeled calcar, and fur on the underside of the wing membrane which extends from the body to a line joining the elbow and the knee (Warner and Czaplewski 1984).

4.12.3. Taxonomy

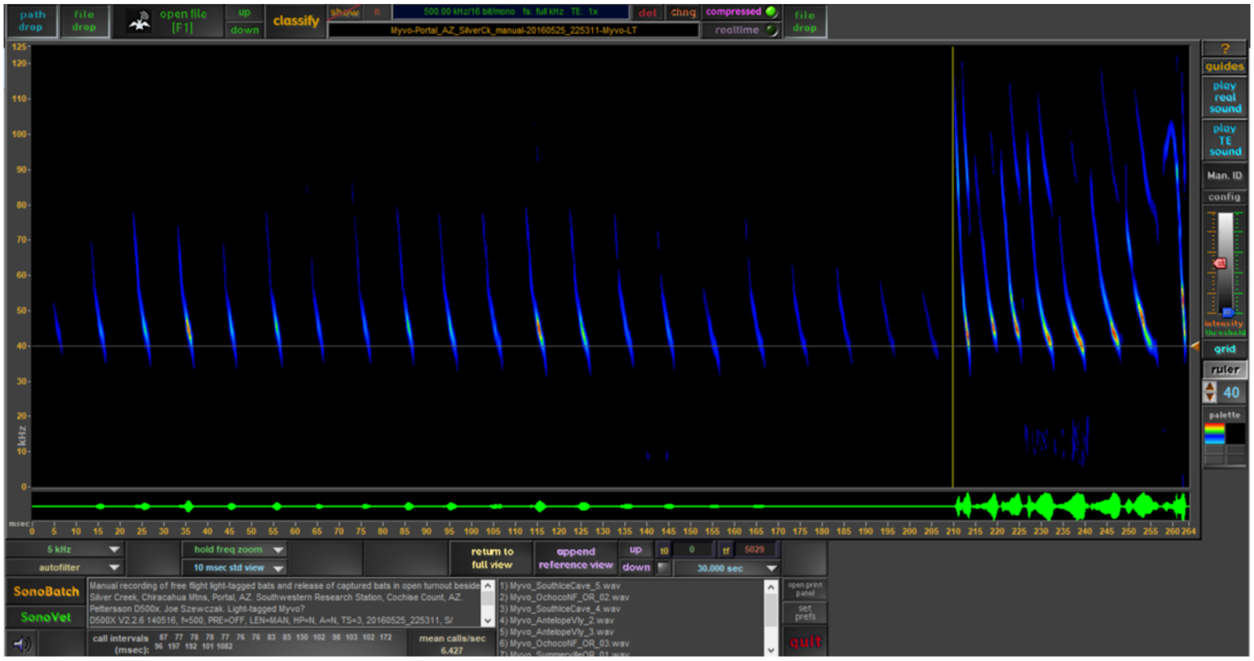
There are four recognized subspecies of *Myotis volans*, but only *M. v. interior* occurs within Nevada.

4.12.4. Population Status

Long-legged myotis are one of the most common bat species in woodland habitats at the Nevada National Security Site (NNSS) in south-central Nevada (Hansen et al. 2008). This species is ranked as vulnerable or apparently secure within the state (S3S4).

4.12.5. Flight Characteristics and Acoustic Niche

Long-legged myotis has a low wing aspect ratio and a high wing loading ratio. This species is a strong, direct flier capable of speeds of 15-17 kmh (9-10 mph) (Hayward and Davis 1964). In Nevada there is considerable overlap in acoustic niche between little brown myotis, long-legged myotis, and western small-footed myotis and shorter duration little brown myotis clutter calls are indistinguishable from long-legged myotis search-phase call pulses.



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4.12.6. Habitat

The long-legged myotis occurs primarily in mid to high elevations. Nevada records indicate this species is distributed between 930-3,420 m (3,051-11,220 ft) and is most common in woodland and forest habitats including pinyon-juniper, Joshua tree, and montane coniferous forest (Warner and Czaplewski 1984, O'Farrell 2002, Chung-MacCoubrey 2005). It is also found less frequently in riparian, Mojave Desert scrub, salt desert scrub, blackbrush, mountain shrub, and sagebrush habitats (Hall 2000, Warner and Czaplewski 1984).

4.12.7. Roosts and Roosting Behavior

Day roost sites include: snags and live trees with exfoliating bark; long vertical cracks or hollows, cracks and crevices in rocks, cliff faces, and in the ground; buildings; bridges; caves; and mines (Warner and Czaplewski 1984, Nagorsen and Brigham 1993, Chung-MacCoubrey 2005, Baker and Lacki 2010). Bridges, abandoned buildings, caves, mines, and trees in riparian habitats are used for night roosting (Barbour and Davis 1969, Ormsbee and McComb 1998, Adam and Hayes 2000). Ormsbee (1996) reported an average distance of 2.5 km (1.5 mi) with a range of 0.7-6.5 km (0.4-4 mi) between night roosts and day roosts. Home ranges of males averaged 647 ha (1,599 ac) and reproductive females 376 ha (929 ac) in Idaho (Johnson et al. 2007). Mines or caves are generally utilized as hibernacula (Schowalter 1980, Nagorsen and Brigham 1993).

Roost snags and trees used by reproductive females are typically taller and larger in diameter than those in the surrounding canopy, are farther from neighboring tall trees, occur in areas of lower canopy closure, and are in the early to intermediate stages of decay when more loose bark remains for roosting under (Ormsbee and McComb 1998, Johnson et al. 2007). In dry forests, ponderosa pine and firs are the primary trees used for roosting (Chung-MacCoubrey 2005, Rabe et al. 1998, Cryan et al. 2001, Baker and Lacki 2010). Lacki et al. (2010) found no evidence that proximity to water influenced choice of roosting sites by long-legged myotis. Reproductive females usually switch day roosts every 2 to 11 days (Ormsbee 1996, Baker and Lacki 2010, Arnett and Hayes 2009, Vonhof and Barclay 1996) with duration of roost use likely influenced by individual preference and reproductive stage, physical condition of the roost, and weather (Vonhof and Barclay 1996, Baker and Lacki 2010). Maternity colonies of up to 200-500 long-legged myotis have been documented but most contain fewer than 50 bats (Nagorsen and Brigham 1993, Baker and Lacki 2010).

4.12.8. Reproduction

Sperm production of male long-legged myotis occurs in July and August (Warner and Czaplewski 1984). Mating takes place in late August or September before hibernation (Nagorsen and Brigham 1993). Females store sperm over winter, with ovulation occurring from March through May and parturition from May through August (Druecker 1972). Timing of births is variable and probably influenced by elevation and latitude (Barbour and Davis 1969). Pregnant female long-legged myotis have been captured between June and July in Nevada (Hall 1946). Females produce one young per year. Some males, and possibly females, breed in their first autumn (Schowalter 1980, Warner and Czaplewski 1984).

4.12.9. Food Habitats and Foraging

Long-legged myotis feed on moths but also eat a variety of other, primarily soft-bodied, invertebrates including flies, true bugs, and small beetles (Warner and Czaplewski 1984). This bat is a rapid, direct flier and pursues prey over relatively long distances through, around, under, and over the forest canopy (Fenton and Bell 1979, Fenton et al. 1980, Grinnell 1918, Warner 1981). Prey are caught aerially (van Zyll de Jong 1985) along forest edges and cliff faces, inside forests, over the forest canopy, and over water (Whitaker et al. 1977, 1981; Warner and Czaplewski 1984; Thomas 1988, Nagorsen and Brigham 1993). It is suspected to be an opportunistic forager, taking prey in approximate proportion to their availability in the environment (Warner 1981). Long-legged myotis emerge from day roosts early in the evening (Whitaker et al. 1981) and are active throughout most of the night (Bell 1980, Warner 1981) with peak foraging activity in the first three or four hours after sunset (Cockrum and Cross 1964, Warner 1981, Adams 2003).

4.12.10. Seasonal Movements

Long-legged myotis are permanent residents in some parts of Nevada. They have been acoustically detected year-round in south-central Nevada (Hansen et al. 2008). It is suspected there are elevational and latitudinal movements between summer and winter roosts within the state, and transient colonies may occur in the spring on the eastern side of the Sierra Nevada.

4.12.11. Threats

Loss of juniper trees during pinyon-juniper removal projects may negatively affect this species by reducing suitable day roosts. Aerial pesticide spraying may impact long-legged myotis due to their non-selective feeding habits (Hinman and Snow 2003). Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.12.12. Research Needs

There are no species-specific research needs for the long-legged myotis in Nevada, but research into distribution, population status, habitat use, and seasonal movements is needed for all Nevada bat species. Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

4.13. Mexican Free-tailed Bat, Brazilian Free-tailed Bat (*Tadarida brasiliensis*)

4.13.1. Conservation Status

Federal	
BLM	S
USFS	None
State	
NDNH	G5 S4
NDOW	SGCN

*Conservation status definitions can be found in Appendix 7.2

Mexican free-tailed bat - Joseph Danielson

4.13.2. Description and Morphology

The Mexican free-tailed bat is a small to medium-sized mollosid (8-14 g), with a forearm length of 36-46 mm, and a wingspan of 29-33 cm. Its body is dark gray to smoky brown and covered in short, velvety fur of uniform color. The muzzle is nearly black and sparsely furred. Wings are long, slender, and pointed, with dark membranes. The "free" tail extends noticeably beyond the trailing edge of the uropatagium. Large, round ears bear a series of small papillae on the leading edge and lie forward along the head, above the eyes. Unlike other molossids in Nevada, the ears of the Mexican free-tailed bats do not connect above the nose. This bat is snub-nosed with a wrinkled upper lip. These wrinkles are used to focus and intensify echolocation calls. The calcar is not keeled. The foot is small (10 mm) and hairy.

4.13.3. Taxonomy

Although nine subspecies are recognized, these classifications are not supported by molecular or morphological data. The subspecies *mexicana* occurs in Nevada and is distinguished from the southeastern North American subspecies (*cynocephala)* ecologically and behaviorally. Within *T. b.*

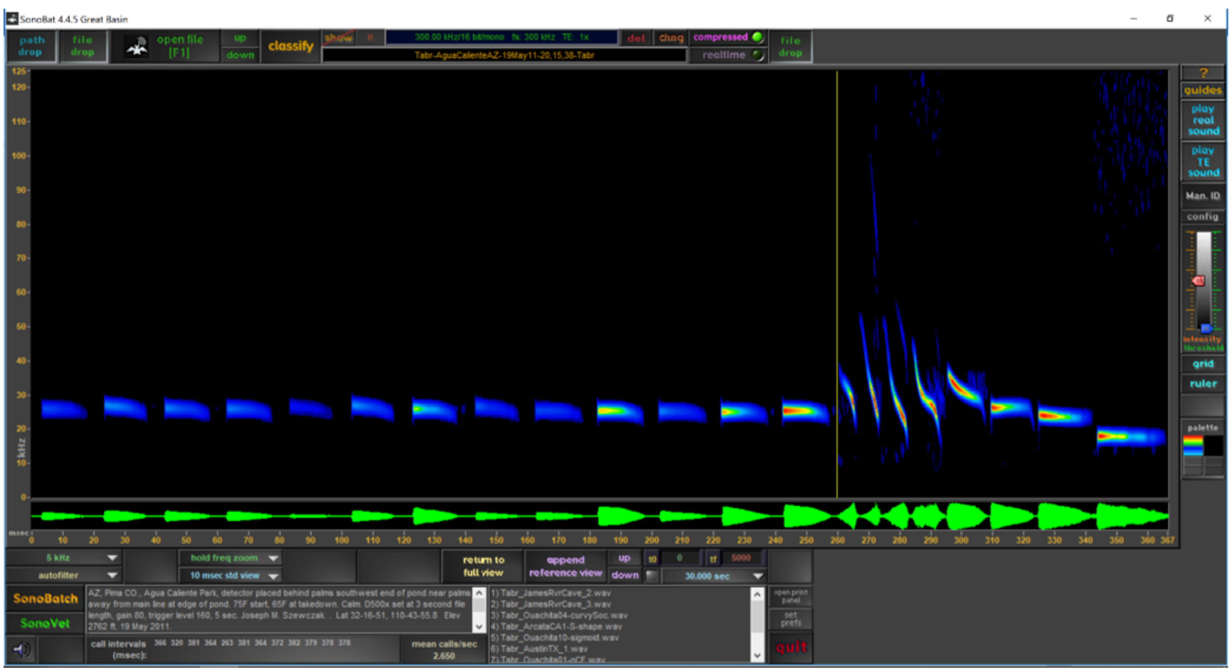
mexicana, populations are genetically similar indicating widespread gene flow throughout their distribution (Russell et al. 2005).

4.13.4. Population Status

Mexican free-tailed bats form some of the densest aggregations of mammals on earth, with some roosts hosting several million individual bats. Global populations are declining (Clark Jr. 2001, Medellin et al. 2017) but populations in the US are expanding north (McCracken et al 2018, Ommundsen et al. 2017).

4.13.5. Flight Characteristics and Acoustic Niche

Mexican free-tailed bats are a fast, high-flying species with long slender wings, high wing loading and high wing aspect ratios. They have a wide repertoire of echolocation calls, including social and breeding calls. Mexican free-tailed bats jam the echolocation apparatus of its conspecifics when competing for limited food resources (Corcoran and Conner 2014).



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4.13.6. Habitat

Mexican free-tailed bats occur in all habitats across Nevada. A high-flying species that forages in open airspace above vegetation, Mexican free-tailed bats have been recorded at altitudes of up to 10,000 ft above the ground (Gillam et al. 2009). In Nevada, they have been recorded on Wheeler Peak at 3,963 m (10,000 ft) and at least as low as 994 m (3,260 ft) in the southern part of the state. This species avoids clutter and requires relatively large areas of calm water for drinking.

4.13.7. Roosts and Roosting Behavior

Mexican free-tailed bats often center around large roosting sites such as bridges, buildings, and caves (Davis et al. 1962). This species does not hibernate and generally overwinters in the southern U.S. and Mexico (Krutzsch et al. 2002), migrating between winter and summer roosts to find adequate prey and suitable microclimates (Villa and Cockrum 1962, Gannon 2003). Smaller overwintering populations have been reported in northern California, Oregon and Salt Lake City, Utah. Summer roosts support critical life history functions such as mating and pup rearing (Villa and Cockrum 1962).

Mexican free-tailed bats use a variety of day roosts in Nevada including cliff faces, caves, buildings, bridges, rock talus, and hollow trees. Mine roosts are not documented in Nevada but are used in other states (Svoboda and Choate 1987).

Nevada's Largest Mexican Free-tailed Roost

Cave Information

A natural cave in eastern Nevada used by large groups of Mexican free-tailed bats, as well as bats of several other species.

Historical Use

In the 1920s guano mining began and later an adit was driven from the hillside to better facilitate removal of guano accumulations in the caves lower chamber. This second opening altered the caves internal climate and may have reduced the habitat quality for roosting bats. In 1996 the adit opening was sealed, which allowed historical internal climate conditions to return.

Recent Concerns

While irregular surveys had been conducted at the cave for decades, in response to a then proposed, now constructed wind farm in the valley 6 km (4 mi) from the cave, bat survey efforts increased beginning in 2010.

Harp trap at roost site – Kristin Szabo

Monitoring Strategies

Surveys include unassisted visual outflight counts, accurate outflight counts using IR cameras, telemetry and banding migration studies, the use of doppler radar, and assessment of colony composition through trapping. Bat assemblages are currently monitored daily with a beam break system to inform "smart curtailment" of the wind farm in order to reduce bat mortality.

Cave Status

The cave has been found to host up to 3 million bats on their migration through the area yearly, with the majority of bats staying at the cave for just 1-2 days. Tagged bats have been documented dispersing to most neighboring states, with one notable bat tagged in the 70's being documented in Kansas the following year. The cave has also been found to host maternity colonies in some years, although reasons for yearly variation in assemblage size and composition are still not understood.

Due to their high wing loading and low maneuverability in flight, Mexican free-tailed bats require spacious roosts with large entrance openings. An important roost in Nevada contains two chambers.

The deepest retains heat produced by roosting bats, buffering roosting bats from surface conditions, while the entrance chamber provides an area for bats to gain altitude before outflight by flying counterclockwise around the room (Danielson et al. 2022). Although some roosts support several million individuals, Nevada colonies generally number from several hundred to several thousand individuals. Larger colonies do exist in Nevada in limited locations at caves and bridges, associated with summer and fall use. A cave roost in eastern Nevada supports the largest known congregation of bats in the state. An estimated 1-3 million bats occupy the cave between mid-June and mid-October (Danielson et al 2022), with most individuals staying less than a week.

4.13.8. Reproduction

In North America, Mexican-free-tailed bats ovulate and mate in late February to early March (Sherman 1937, Jerrett 1979, Genoways et al. 2000, Keeley and Keeley 2004). Following breeding, females migrate north to summer roosts to give birth and rear their pups (Davis et al. 1962). Gestation ranges from 77-100 days and a single pup is born in late June to early July (Sherman 1937, Twente 1956). Pups are nursed on average for 42 days (Kunz et al. 1995b). Although some pups are capable of flight 35 days after birth (Short 1961, Wilkins 1989), most pups continue to nurse for an additional week or two post-volancy, with weaning complete by five to six weeks of age. Unlike most Nevada bat species, Mexican free-tailed bats do not store sperm. Instead, ovulation occurs immediately after spring mating.

4.13.9. Food Habitats and Foraging

Mexican free-tailed bats are the fastest free-fliers in the animal kingdom and can exceed 44 mps (99 mph) (McCracken et al. 2016). Food items include a variety of insects, but moths predominate. Foraging occurs in the open from valley bottoms to high altitudes. Some individuals are known to travel more than 40 km (25 mi) to reach feeding grounds, and this species has been documented feeding from at ground level to over 3,049 m (10,000 ft) when they follow spring moth migrations north from Mexico into the U.S. (Krauel et al. 2018).

4.13.10. Seasonal Movements

Mexican free-tailed bats are long distance migrants. Some individuals travel over 1,600 km (1,000 mi) between winter and summer ranges (Villa and Cockrum 1962, Gannon 2003). During the fall migration south, movements of up 160 km (99 mi) per night are documented in Nevada (Wilkins 1989). Mexican free-tailed bats overwinter in areas with above freezing temperatures, including northern California and southern Nevada. Limited winter activity occurs in south-central Nevada with calls recorded during all months except February at a site situated at 1,768 m (5,800 ft) elevation (Hansen et al. 2008).

4.13.11. Threats

Long distance migrations and the tendency to congregate in large numbers at roosts places entire populations at risk (Medellin et al. 2017). Mexican free-tailed bats are vulnerable to wind turbine strikes, with up to 85% of bat fatalities attributed to this species at some facilities (Arnett et al. 2008, Piorkowski and O'Connell 2010, Arnett et al. 2016). Historically, guano mining was a threat, including two roosts in White Pine County, Nevada. Mexican free-tailed bats are commonly found in cities roosting in buildings and bridges and are commonly encountered by pest control companies. Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.13.12. Research Needs

Mexican free-tailed bats are the most abundant bat in Nevada and the most economically valuable bat species in the U.S. However surprisingly little is known about their natural history, demographics, and conservation. Most research has been conducted at large roosts in Texas, with little work on populations in the western U.S. Considerable evidence suggests that Nevada and California populations differ from eastern populations in migration patterns, genetics, and breeding phenology. Given the distance of its migration, susceptibility to wind turbine strikes, and the increase in wind energy facilities, documenting migration corridors through the Motus network, stable isotopes, and GPS loggers are conservation priorities. Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

4.14. Pallid Bat (*Antrozous pallidus*)

4.14.1. Conservation Status

Federal	
BLM	S
USFS	R5S
State	
NDNH	G4 S3
NDOW	SGCN

*Conservation status definitions can be found in Appendix 7.2

Pallid bat - Delaney Martin

4.14.2. Description and Morphology

The pallid bat is a large vesper bat (20-35 g) with a forearm length of 48-60 mm and a wingspan of 37-41 cm. It has sizeable ears (31-36 mm) and a wavy-edged tragus with a rounded tip. Pelage is light yellow washed in brown or gray, with pale cream to almost white ventral fur. The muzzle is pale pinkish yellow, and the blunt nose is reminiscent of a pig snout. Membranes are dark brown to black. Female pallid bats are larger than males, and both sexes have scent glands on either side of the muzzle which can secrete a skunk-like odor.

4.14.3. Taxonomy

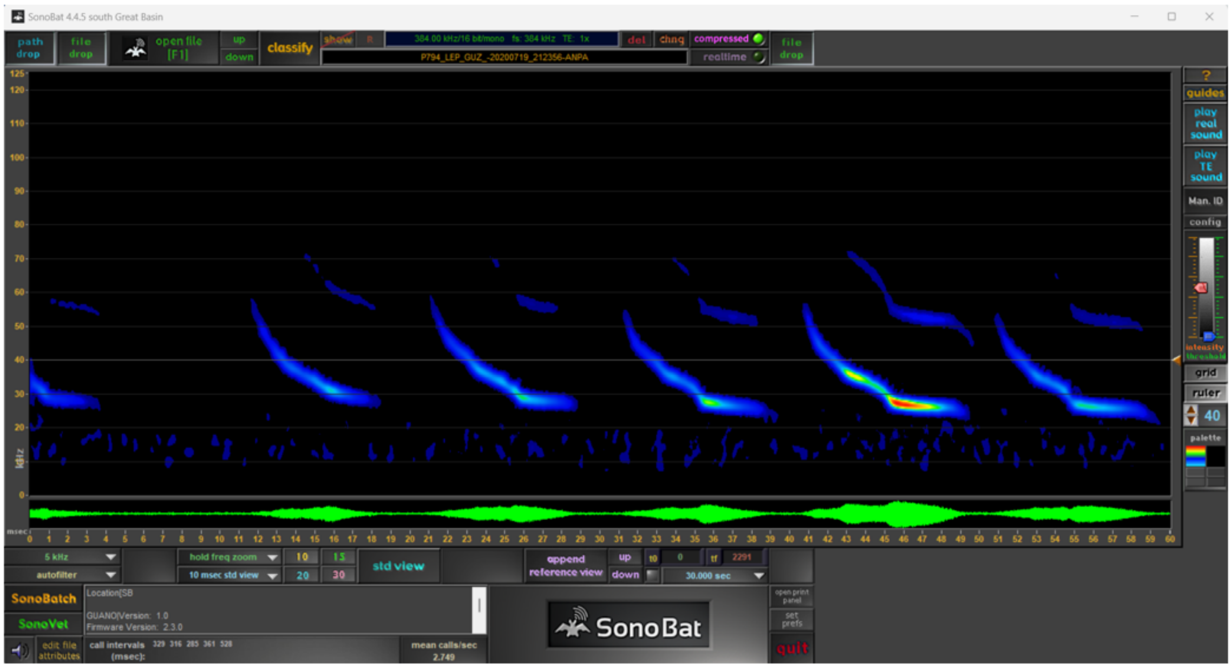
There are six recognized subspecies of pallid bat. Two are found in Nevada; *A. p. pallidus* and *A. p. minor* (Hermanson and O'Shea 1983). The pallid bat is the only species in its genus.

4.14.4. Population Status

The pallid bat is common throughout Nevada and populations are presumed stable. This species is ranked as vulnerable within the state (S3).

4.14.5. Flight Characteristics and Acoustic Niche

This slow, low flying, open-air specialist has a high wing loading and low wing aspect ratio (Davis 1969). Acoustically, this species can be difficult to distinguish from the big brown bat. Both species have a characteristic frequency around 30 kHz and considerable overlap in acoustic repertoire, but lower-frequency directive sequences and 'dog-paw' shaped pulses (directive calls) are unique to the pallid bat.



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The acoustic call sequence and examples above provide a limited sample for the species listed and should be considered insufficient for manual vetting purposes. It is important to understand that bats vary their acoustic calls to suit different areas and activities. Manual vetting entails understanding the full repertoire of call types presented by each species, and which of those overlap with other species and which types provide species-discriminating characteristics.

4.14.6. Habitat

The pallid bat is associated with arid regions of western North and South America (Hermanson and O'Shea 1983). It is found in a variety of habitat types from low Mojave Desert scrub, salt desert scrub, sagebrush steppe (Ammerman et al. 2012, Adams 2003), riparian areas, farmland (Rambaldini and Brigham 2008), and forests (Baker et al. 2008) between 420-2,580 m (1,377-8,464 ft). This species is found in Nevada year-round, primarily at low and middle elevations, although it has been observed at over 3,100 meters (10,170 ft).

4.14.7. Roosts and Roosting Behavior

The pallid bat uses a variety of day roosts including rock outcrops, boulders, mines, caves, trees, snags, and man-made structures (Trune and Slobodchikoff 1976, Brown and Grinnell 1980, Ball 1998, Schorr and Siemers 2013), but they are most often observed roosting in cliff-face crevices high above the ground to facilitate flight upon exit (Lewis 1994, Vaughan and O'Shea 1976). This species roosts solitarily or colonially, and day roosts are sometimes shared with other bat species, especially myotis species (Vaughan and O'Shea 1976, Pierson et al. 1996).

Night roosts include bridges, caves, mines, buildings, and trees (Hermanson and O'Shea 1983, Lewis 1994, Twente 1955, Pierson et al. 1996), and are typically warmer than the ambient temperature (O'Shea and Vaughan 1977). Roosts may be identified by guano piles with remnant parts of culled prey (Orr 1954). The pallid bat demonstrates a high roost fidelity within and between years (Lewis 1994, Rambaldini and Brigham 2008, Pierson et al. 1996), though O'Shea and Vaughan (1977) found individual roost selection to vary seasonally. When approaching and departing roosts, pallid bats produce loud contact calls to communicate with and locate roost mates (Vaughan and O'Shea 1976, Arnold and Wilkinson 2011).

Sexes roost separately during the summer months (Trune and Slobodchikoff 1976). Maternity colonies may contain up to several hundred individuals but generally less than fifty (Vaughan and O'Shea 1976, O'Shea and Vaughan 1977). Winter roosting habits are not well described in Nevada.

Pallid bats typically leave their roosts after sunset, though the time of emergence varies seasonally (Vaughan and O'Shea 1976, O'Shea and Vaughan 1977, Lewis 1994). Individuals may enter a night roost as soon as 10 minutes after exiting the day roost, though the reason for this behavior is not fully understood (Lewis 1994). Rambaldini and Brigham (2008) and O'Shea and Vaughan (1977) documented 1-2 foraging bouts nightly, and foraging distance has been recorded at 8.6 km (5.3 mi) (Ball 1998).

4.14.8. Reproduction

Mating occurs between October and February, with sperm stored until ovulation the following spring (Orr 1954, Barbour and Davis 1969). Embryonic development averages nine weeks (Orr 1954) before young are born over a two-week period beginning in late May or early June (Hermanson and O'Shea 1983), though parturition is dependent on local climate. Adult females usually give birth to two young while yearling females may give birth to only one pup (Twente 1955). Pallid bat pups are generally nursed for 6-8 weeks and volant by 33-36 days (Brown and Grinnell 1980, Trune and Slobodchikoff 1976).

4.14.9. Food Habitats and Foraging

The pallid bat is an aerial gleaner which typically flies 0-10 m (0-33 ft) above the ground while searching for prey (O'Shea and Vaughan 1977, Ball 1998). Prey is often captured on the ground and pallid bats have been observed forcing prey against surfaces before capture. There is evidence that pallid bats do not echolocate while foraging on the ground (Bell 1982), possibly because it interferes with audible prey cues such as rustling wings (Barber et al. 2003). Though maneuverable on the ground, pallid bats are especially vulnerable to predators including owls, hawks, and snakes while grounded (O'Shea and Vaughan 1977, Twente 1954, Orr 1954).

Pallid bats have a varied and opportunistic diet which can include moths, crickets and grasshoppers, beetles, flies, centipedes, scorpions, mice, and even lizards (Johnston and Fenton 2001, Lenhart et al. 2010, Ingram 2007, Bell 1982). Large prey is sometimes taken and consumed at a night roost where the bat removes undesirable parts (Orr 1954, Bell 1982). They are likely immune to the stings of many scorpions and centipedes.

4.14.10. Seasonal Movements

This species is presumed not to migrate and chooses winter roosts near summer roosts. O'Farrell and Bradley (1970) captured pallid bats over springs during all seasons in southern Nevada and observed hibernating bats in the Spring Mountains. Hansen et al. (2008) found pallid bats active during all months of the year on the Nevada National Security Site. Seasonal movements from summer maternity roost to winter roost were investigated by Nevada Department of Wildlife in 2003 for a small maternity roost (less than 50 bats) in north-central Nevada (NDOW JPR 2003). The winter roost for this maternity colony of pallid bats was only 10.8 km (6.7 mi) south of the summer roost in a vertical rock crevice at the top of a northeast facing slope. The last radio tagged bat departed from the summer roost for the winter roost on October 30th.

4.14.11. Threats

There are no species-specific threats in Nevada for the pallid bat, however all bat populations are threatened by multiple factors including climate change, habitat loss, roost disturbance, environmental contaminants, energy development, abandoned mine closures, mining and mineral exploration, and WNS. Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.14.12. Research Needs

There are no species-specific research needs for the pallid bat in Nevada, but research into distribution, population status, habitat use, and seasonal movements is needed for all Nevada bat species. Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

4.15. Pocketed Free-tailed Bat (*Nyctinomops femorosaccus*)

4.15.1. Conservation Status

Federal	
BLM	None
USFS	None
State	
NDNH	G5 S1
NDOW	PM

*Conservation status definitions can be found in Appendix 7.2

4.15.2. Description and Morphology

The pocketed free-tailed bat is the second smallest molossid bat in North America (11-18 g) with a forearm length of 45-49 mm, and a wingspan of 42-44 cm. This species can be differentiated from the Mexican free-tailed bat by its larger size and ears, which join anteriorly over the nose. Fur on the dorsum is brown to gray, while venter is slightly paler or sometimes buffy. The wings are long and narrow. A membranous sac located between the femur and tibia creates the 'pocket' that inspired this species' common name, though it exists to a lesser degree in other *Nyctinomops* species as well. The tail extends 40-52 mm beyond the end of the uropatagium.

4.15.3. Taxonomy

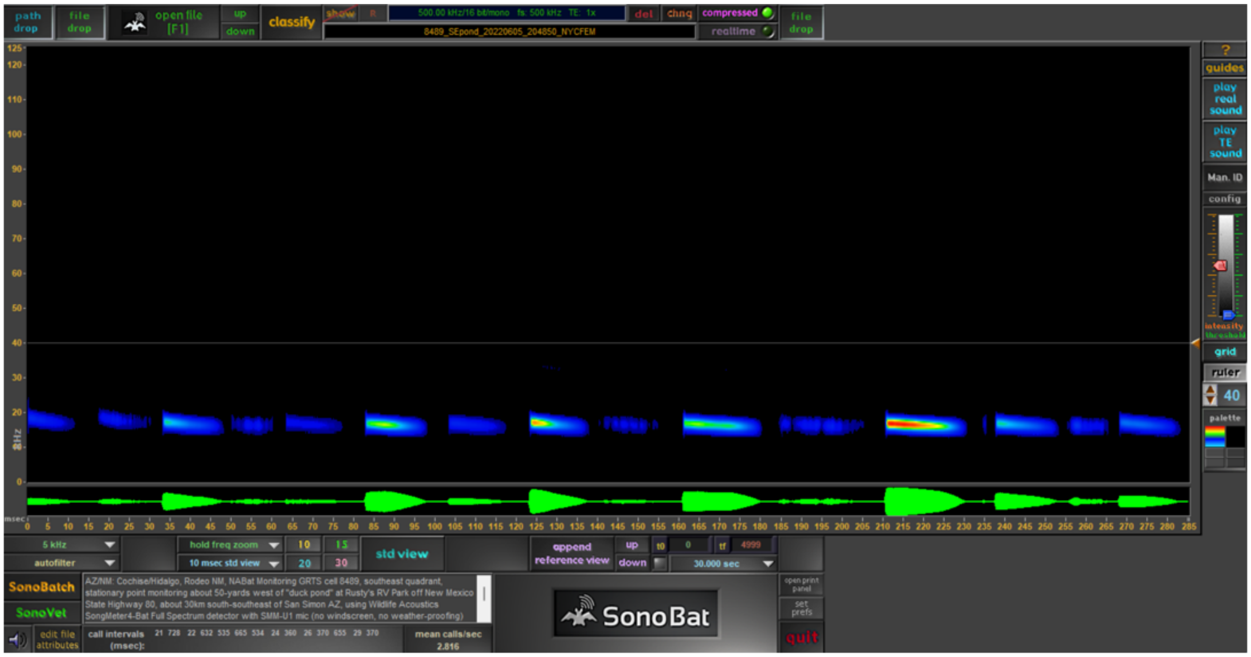
There are no recognized subspecies of *N. femorosaccus*.

4.15.4. Population Status

The population status of pocketed free-tailed bat in Nevada is not well understood. Pocketed free-tailed bats are ranked as critically imperiled within the state (S1). The only known observations of this species in Nevada are acoustic detections made in Clark County, Nevada in October 2009 (O'Farrell 2010). There is no distribution map for the pocketed free-tailed bat included in this plan.

4.15.5. Flight Characteristics and Acoustic Niche

Pocketed free-tailed bat is a strong, fast, high-flying species with high wing aspect and loading ratios. Distinguishing the pocketed free-tailed bat from big free-tailed bat and Mexican free-tailed bat can be challenging due to frequency modulation within species and similar call shapes (Pierson and Rainey 1998a).



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The acoustic call sequence and examples above provide a limited sample for the species listed and should be considered insufficient for manual vetting purposes. It is important to understand that bats vary their acoustic calls to suit different areas and activities. Manual vetting entails understanding the full repertoire of call types presented by each species, and which of those overlap with other species and which types provide species-discriminating characteristics. Acoustic file provided by Janet Tyburec.

4.15.6. Habitat

In California, habitat used by the pocketed free-tailed bat includes pinyon-juniper woodlands, desert scrub, desert succulent shrub, desert riparian, desert wash, alkali desert scrub, Joshua tree, and palm oasis (Harris 2000). Pocketed free-tailed bats have been observed from 0 m to 2,250 m (0-7382 ft) throughout their range, but the elevational range in Nevada is not known.

4.15.7. Roosts and Roosting Behavior

The pocketed free-tailed bat roosts colonially in cliff or rocky outcrop crevices, shallow caves, and buildings (Barbour and Davis 1969, Kumurai and Jones 1990) and has been observed sharing roosts with other bat species, though spatially partitioned. The height of the roost entrance is critical, as pocketed free-tailed bats require considerable assistance gaining initial altitude. Specific requirements for maternity or winter roosts are unknown.

4.15.8. Reproduction

Kumarai and Jones (1990) suggests insemination occurs just before ovulation in spring. A single offspring is born in late June or July.

4.15.9. Food Habitats and Foraging

This aerial-hawking species leaves roost sites to forage well after dark. While capable of fast flight between resource patches, their long and narrow wings limit maneuverability in confined spaces, making this species an open-air specialist (Voigt and Holderied 2011). Jaw morphology suggests primary prey are soft bodied (Kumurai and Jones 1990), and Lepidoptera (butterflies and moths), Coleoptera (beetles), Diptera (flies), Hemiptera (bugs), and Hymenoptera (bees and wasps) have all been found in sampled stomach contents (Matthew et al. 2010).

4.15.10. Seasonal Movements

The seasonal movements of the pocketed free-tailed bat in Nevada are unknown.

4.15.11. Threats

There are no species-specific threats in Nevada for the pocketed free-tailed bat, however all bat populations are threatened by multiple factors including climate change, habitat loss, roost disturbance, environmental contaminants, energy development, abandoned mine closures, mining and mineral exploration, and WNS. Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.15.12. Research Needs

There are no species-specific research needs for the pocketed free-tailed bat in Nevada, but research into distribution, population status, habitat use, and seasonal movements is needed for all Nevada bat species. Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

4.16. Silver-haired Bat (*Lasionycteris noctivagans*)

4.16.1. Conservation Status

Federal	
BLM	S
USFS	None
State	
NDNH	G3 S3
NDOW	SGCN

*Conservation status definitions can be found in Appendix 7.2

Silver-haired bat - Joseph Danielson

4.16.2. Description and Morphology

The silver-haired bat is a medium-sized vesper bat (8-12 g), with a forearm length of 37-44 mm, a wingspan of 27-31 cm, and overall body length ranging from 8-10 cm (Adams 2003). Predominately black in color with silver to white-tipped hairs on their back and tails, silver-haired bats are the only black bat in North America and are easily distinguishable from other Nevada bat species. Wings are short and broad with black membranes. The uropatagium is furred above only on the basal half. Ears are short, round, and naked with a broad blunt tragus (Kunz 1982a).

4.16.3. Taxonomy

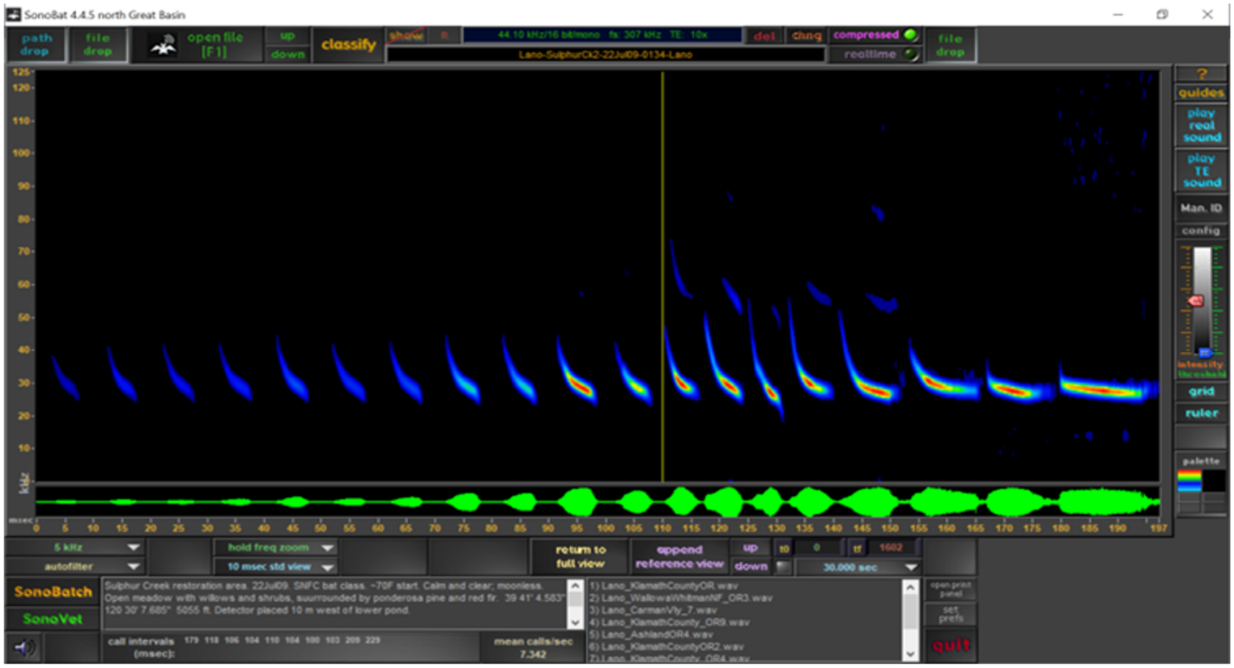
Although no subspecies are recognized, two distinct populations in eastern and western portions of their range have been suggested (Cryan 2003). Small but significant differences in mitochondrial DNA were found between eastern and western populations (Monopoli et al. 2020).

4.16.4. Population Status

The population status of silver-haired bats in Nevada is unknown. Silver-haired bats are expected to decline due to mortality from wind energy turbines (Green et al. 2021), but studies on site-specific trends are equivocal. Both declines and increases in abundance were observed in Canada and the northern U.S. (Green et al. 2021, Davy et al. 2021). In the montane west, populations may be male biased (Hayes and Wiles 2013) but reproductive females are regularly captured in Nevada. In some areas of Nevada, the species is locally common during the summer.

4.16.5. Flight Characteristics and Acoustic Niche

Silver-haired bats are slow, low-flying bats with intermediate aspect ratio wings and low wing-loading. These characteristics allow for deliberate, maneuverable flight, well suited to forested habitats (Kunz 1982a, Reimer et al. 2010). Characteristic call frequency is 27 kHz and some call variants can be confused with big brown or Mexican free-tailed bats. Short broad wings, low to mid-range echolocation frequency, and slow agile flight allow silver-haired bats to detect and capture insects at close range (Barclay 1986).



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4.16.6. Habitat

Silver-haired bats are a tree roosting bat associated with forests (Kunz 1982a). They are found primarily at higher latitudes and elevations in coniferous and mixed deciduous/coniferous forests of pinyon-juniper, subalpine fir, white fir, limber pine, aspen, cottonwood, and willow. Riparian habitat is critical to silver-haired bats in Nevada for foraging, roosting, and drinking. Older, structurally diverse forest may be preferred over more homogenous secondary growth. Woodlands of pinyon-juniper and mountain mahogany may not be used extensively for roosting. This species is likely absent from extensive shrublands and deserts far from water and trees but may move through these areas during spring and fall migration. Silver-haired bats occur at elevations from sea level to at least 1829 m (6,000 ft) (Nagorsen and Brigham 1993) and as high as 3048 m (10,000 ft) at Great Basin National Park in Nevada (Bryan Hamilton, unpublished data).

4.16.7. Roosts and Roosting Behavior

Silver-haired bats prefer to roost in trees but are also known to roost in caves and mines (Bonewell et al. 2017) and occasionally under bark (Kunz, 1982b). Roost trees include Ponderosa pine, aspen, Douglas fir, and cottonwood. Older trees and cavities may be preferred.

Silver-haired bats often segregate habitats by sex and reproductive condition. Males and non-reproductive females differ in roost preferences from reproductive females. Maternity roosts near Elko, Nevada, included dead, standing, broken-top, large-diameter, aspen trees riddled with woodpecker cavities. The largest of the six maternity colonies observed consisted of 26 individuals (Bradley 2011). In other western states, maternity colonies usually contain between 5-25 females with a maximum of 70. Taller isolated trees may be preferred as maternity roosts to optimize thermoregulation and energy expenditure in females and developing young. Reproductive females may switch roosts to optimize thermal conditions. Males and non-reproductive females typically roost individually rather than in groups (Mattson et al. 1996). Night roosts include bridges, trees, bat houses, wood piles and occasionally buildings.

4.16.8. Reproduction

Although presumed to mate in the autumn, with sperm stored over the winter and ovulation in the following spring, mating was observed in the spring in New Mexico (Clerc et al. 2022). Gestation is 50-60 days. Females give birth to one or two pups and twins are common. Young are born breech, hairless, and pink, with closed eyes and folded wings. Parturition occurs during late June to early July. Females nurse their pups for 36 days and young can fly by three weeks of age. Most young are sexually mature during their first summer (Adams 2003). Reproductive males are found from July-September.

4.16.9. Food Habitats and Foraging

Like most insectivorous bats, silver-haired bats are opportunistic feeders and take a variety of insect prey. This species has been documented feeding on 11 insect orders. Though most prey are moths, silver-haired bats also consume large numbers of flies and bugs (Reimer et al. 2010). Foraging is generally above the canopy layer in or near wooded areas and along edges of roads, streams, or water bodies. Silver-haired bats can travel considerable distances (up to 15 km) to preferred foraging areas. Foraging is often bimodal and interspersed with night roosting, occurring before midnight and at dawn (Adams 2003). Foraging may be reduced on cooler nights and evenings (Nagorsen and Brigham 1993). Silver-haired bats may accumulate fat and feed actively during migration. Nevada acoustic records and roost switching observations suggest winter foraging during warm spells.

4.16.10. Seasonal Movements

Although considered migratory, silver-haired bats are regularly documented overwintering in Nevada. Overwintering can occur in rock crevices at higher elevations and silver-haired bats will hibernate and/or use daily torpor depending on the severity of weather conditions (Hayes and Wiles 2013). Hibernation and torpor may be interrupted by foraging bouts (Johnson et al. 2017, Falxa 2007). Similar behavior of arousal from hibernation have been noted in Nevada, with acoustic calls recorded during warm, winter conditions. Silver-haired bats overwinter alone or in small groups (Humphrey 1975). During migration this species roosts individually or in small groups in trees. Migrating bats may remain torpid for several days during cold spells.

Most northern populations in the western U.S. migrate south to overwinter. In the eastern U.S., silver-haired bats may aggregate in flocks, sometimes flying with other bat species during migration. In the west, migrants move as individuals or small groups (Lacki et al. 2007). Silver-haired bats can travel 250-300 km (155-186 mi) per night during migration, and unlike other tree-roosting bats, may not be restricted to following linear features like riparian corridors (Wieringa et al. 2021). West of the Rocky Mountains, migration trends north to south, while eastern populations tend to follow an east to west pattern (Wieringa et al. 2021).

Summer segregation of the sexes occurs in some parts of their range, possibly because females migrate farther north than males (Cryan 2003). At Lake Tahoe, Nevada, in August 2014, the male/female ratio during one week of trapping was 13/1. In late August 2017, during one night of trapping at Stoneberger Basin in the Toquima Range, 59 males and no females were captured (Clinger and Slatauski 2018). Females begin to move south into areas occupied by males during late summer/early autumn, then as autumn progresses, both sexes shift south (Cryan 2003).

4.16.11. Threats

Silver-haired bats, like other tree bats, are particularly vulnerable to mortality at wind energy facilities (Green et al. 2021). Annual bat mortality in the U.S. likely exceeds 400,000 bats and may threaten some species with extinction (Green et al. 2021, Rodhouse et al. 2012, Frick et al. 2017). An estimated 149,000-308,000 silver-haired bats were killed at wind energy facilities in the U.S. and Canada between 2000-2011 (Arnett and Baerwald 2013). Forestry practices that reduce snags and forest heterogeneity may adversely affect local populations through roost loss. Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.16.12. Research Needs

Conservation strategies and research needs for migratory bats require broad scope and adequate scale to capture the full range and distribution. This requires cooperation across administrative, state, and international boundaries. Information on migration routes, fidelity to migratory routes, overwintering locations, and maternity roosts is needed to mitigate and plan the impacts of wind energy development.

In northern Nevada extensive conifer removal projects are often conducted without consideration for bat roosting and foraging habitat. Additionally, shifting fire severity and frequency threaten silver-haired bat habitat throughout their range. Tree roost selection and preferences of this species need to be understood to oppose these challenges. Pinyon, juniper, and mahogany trees may not be a significant roosting habitat for the species, but research is needed to confirm. Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

4.17. Spotted Bat (*Euderma maculatum*)

4.17.1. Conservation Status

Federal	
BLM	S
USFS	R4S
State	
NDNH	G4 S2
NDOW	SGCN

*Conservation status definitions can be found in Appendix 7.2

Spotted bat - Joseph Danielson

4.17.2. Description and Morphology

The spotted bat is a medium-sized vesper bat and one of the most striking bat species in North America (Snow 1974, Watkins 1977, O'Shea et al. 2018). Weight ranges from 9-18 g, forearm length 41-55 mm, ear length 32-50 mm, and wingspan 33-36 cm (Snow 1974, Watkins 1977, Poche 1981, Constantine 1987, Best 1988). Best (1988) reported forearms of females were significantly longer than males (52 mm and 50 mm, respectively). Spotted bats have pinkish-red ears, the largest of any North American bat species. Three large white spots on a blackish-colored dorsum inspired this species' common name with one spot over each shoulder and one over the rump. There is a circular, hairless patch about 10 mm in diameter in the throat area that is usually not visible until the head is moved upward and backward (Snow 1974, Watkins 1977).

4.17.3. Taxonomy

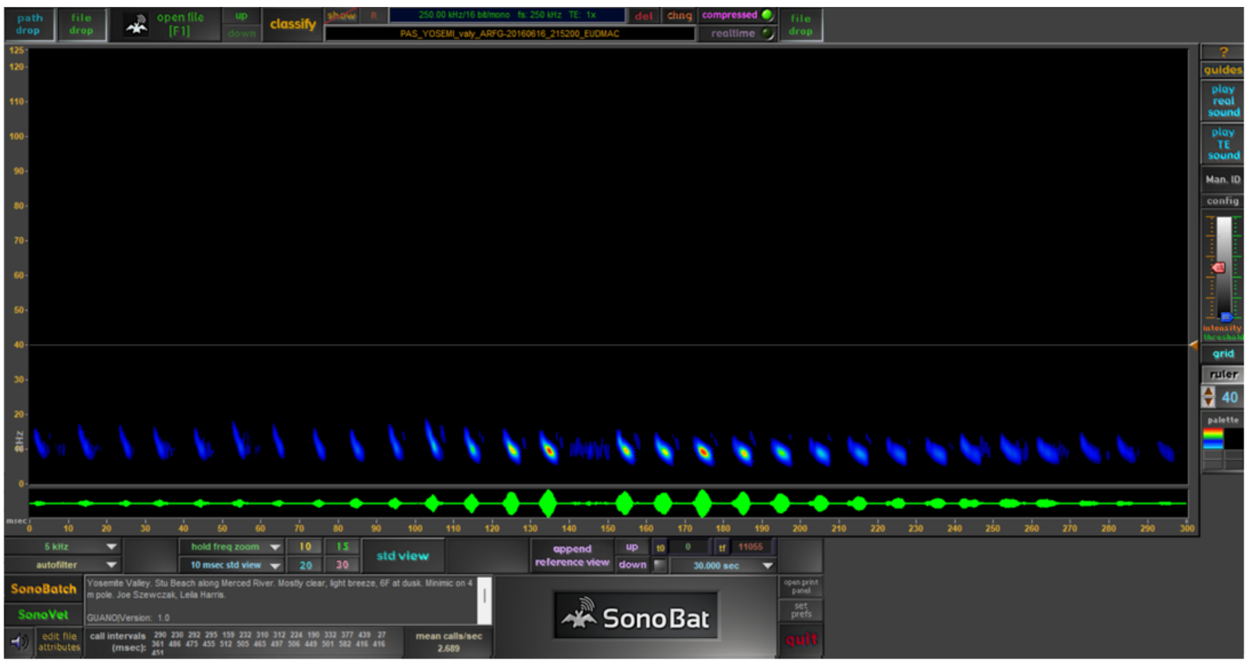
The scientific name of the spotted bat was first used in 1894 by Allen (1893). The generic name *Euderma* is a combination of two Latin words meaning "good" or "beautiful" and "skin", and the specific epithet stems from the Latin word meaning "spotted" (O'Shea et al. 2018). The spotted bat is the only species in the genus *Euderma*, and no subspecies are recognized (Watkins 1977).

4.17.4. Population Status

Little information is available on range-wide population status of the spotted bat, and no Nevada specific information is known. Presence-absence studies by Geluso (2006, 2017) in New Mexico found evidence of continued presence of spotted bats at 11 of 13 sites where they were historically known to occur. No population size estimates are available. Spotted bats are considered widely distributed but rare. Studies conducted in Nevada (Kuenzi et al. 1999, Hall 2000), California (Pierson et al. 1996, 2001; Duff and Morrell 2007), and Arizona (Cockrum et al. 1996, Herder 1998, Morrell et al. 1999, Chambers et al. 2011) resulted in a very small percentage (0-4%) of total captures. This indicates the spotted bat is either rare within its range or very difficult to capture, even when targeted for study.

4.17.5. Flight Characteristics and Acoustic Niche

Spotted bats fly at various speeds depending on their activity. Foraging spotted bats in Utah were described as slow and maneuverable in flight (Poche 1981), while Wai-Ping and Fenton (1989) measured foraging spotted bats moving at 19 kmh. Commuting speeds over long-distances have been measured at 30-53 kmh (Rabe et al. 1998, Chambers et al. 2011) indicating they are capable of rapid, long-distance flight when commuting. Spotted bats have a characteristic frequency near 7-10 kHz and is audible to the human ear when echolocating. Because they are low frequency, spotted bat calls can be missed by acoustic detectors if audio settings are not adjusted correctly or misidentified as non-bat noise during acoustic vetting. Consideration of this species' distribution range is required during acoustic monitoring efforts.



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4.17.6. Habitat

The spotted bat occurs in a wide variety of habitats throughout Nevada, from low desert scrub to high elevation coniferous forests from 540-2,130 m (1,771-6,986 ft). They appear to favor areas with both high cliffs for roosting and suitable habitats for foraging (Sherwin and Gannon 2005). Williams et al. (2006) reported spotted bat acoustic activity over open riparian marshes in southern Nevada (Mojave Desert) was greater than any other species measured, and spotted bats were active over mesquite bosque but not riparian woodland or riparian shrubland.

4.17.7. Roosts and Roosting Behavior

The spotted bat is primarily considered a cliff and crevice dwelling bat. Colony sizes have been recorded at 1-30 individuals (Bogan et al. 1998, Chambers et al. 2011, O'Shea et al. 2011). Spotted bats have also been found roosting in caves, mines, and buildings (Geluso 2000, Mead and Mikesic 2001, Sherwin and Gannon 2005, Chambers et al. 2011). Geluso (2000) suggested that buildings may exhibit a similarity to spotted bat natural roosting sites in cliffs or rocky areas. Rabe et al. (1998) in Arizona documented multiple spotted bats night roosting in trees.

No winter roosts are known in Nevada. In southeastern Utah, four individuals were observed hibernating in a cave (Hardy 1941). In New Mexico, a solitary spotted bat was observed roosting in a warehouse for portions of three winters (Sherwin and Gannon 2005).

4.17.8. Reproduction

Females give birth to one pup, usually in June (Easterla 1971, 1976; Poche 1981). Four lactating females were captured in July 1995 and 1996 at a spring in southwestern Nevada (Geluso 2000). There appears to be a high proportion (77%, 68 of 89 bats) of reproductive female spotted bats captured over water at all U.S. locations and years (O'Shea et al. 2018).

4.17.9. Food Habitats and Foraging

Spotted bats have been commonly observed foraging over meadows and or old fields, occasionally in close-proximity to trees but still above the canopy (Leonard and Fenton 1983, Wai-Ping and Fenton 1989, Storz 1995, Pierson and Rainey 1998a, Rabe et al. 1998). They have occasionally been observed chasing moths attracted by vehicle headlights near roadways in California (B. Rainey, personal communication, December 2021) or heard along road corridors lined with blooming rubber rabbitbrush that are swarming with moths during road surveys for other taxa (D. Hall, personal communication, December 2021). Spotted bats are aerial hawkers, with no evidence of gleaning prey from surfaces (Leonard and Fenton 1983, Wai-Ping and Fenton 1989, Storz 1995).

Spotted bats have been documented to travel up to 39-43 km (24-27 mi) one-way (Rabe et al. 1998) from their day roost locations to their foraging areas. Mean foraging home range sizes of four individuals in northern Arizona were large, estimated to be 297 ± 25 km^2 (115 ± 10 mi^2) (Chambers et al. 2011). Spotted bats are known to begin foraging shortly after dark with relatively constant activity throughout the night (Wai-Ping and Fenton 1989, Storz 1995), as well as foraging for part of the night and then night roosting for a few hours before returning to their day roost (Rabe et al. 1998, Chambers et al. 2011). In southern Nevada, spotted bats were observed at a riparian foraging area 2-3 hours after sunset, where they foraged well into the night. Distance from day roosts to foraging areas likely influence different strategies. Foraging activity is not strongly affected by moonlight (Leonard and Fenton 1983, Wai-Ping and Fenton 1989).

The dominant prey includes lepidopterans (butterflies and moths) ranging in size from 5-12 mm (O'Shea et al. 2018). Painter et al. (2009), in the most extensive dietary analysis to date, found lepidopterans composed over 99% of spotted bats diet by volume in two separate summers, and isotopic composition of feces indicated most of the moths eaten were owlet moths, lappet moths, and geometer moths. Other documented prey includes June beetles in 2 of 15 bats in Texas (Easterla and Whitaker 1972), one small beetle in British Columbia (Wai-Ping and Fenton 1989), and one grasshopper captured on the ground by a spotted bat released in daylight in Utah (Poche and Bailie 1974).

4.17.10. Seasonal Movements

No specific information is available on the migratory status of spotted bats in Nevada. They are likely to behave similarly to spotted bats in southwestern Utah that hibernate during the winter, but periodically arouse to forage and drink (Ruffner et al. 1979).

4.17.11. Threats

The main threats to spotted bats are habitat alteration, especially the loss or reduction of wet meadows and other foraging areas; roost loss or modification, especially in cliffs or rock features (Geluso 2000), due to recreational rock climbing, mining, and urban or energy development; and the use of pesticides that target lepidopterans (Luce and Keinath 2007). Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.17.12. Research Needs

More information is needed on both summer and winter roost locations, especially in cliff and rock features. This can be achieved by conducting radio-telemetry studies or possibly reaching out to the climbing community to help in documenting spotted bat roosts. Research into distribution, population status, habitat use, and seasonal movements is needed for all Nevada bat species. Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

4.18. Western Big-eared Bat, Townsend's Big-eared Bat *(Corynorhinus townsendii)*

4.18.1. Conservation Status

Federal	
BLM	S
USFS	R4S, R5S
State	
NDNH	G4 S2
NDOW	SGCN

*Conservation status definitions can be found in Appendix 7.2


Western big-eared bat - Bryan Hamilton

4.18.2. Description and Morphology

The western big-eared bat is a medium sized vesper bat (7-12 g) with a wingspan of 24-28 cm and an overall body length of 8-10 cm. This species has long (38 mm) and flexible ears which may curl around the head when roosting, lending the nickname of "rams eared bat" (Adams 2003). The tragus is long, pointed, and visibly exposed when the ears are curled behind the head. Fur color is light to dark brown with darker membranes and ears. The calcar is unkeeled (Hayes and Wiles 2013).

Small yet noticeable bilateral horseshoe-shaped lumps exist on either side of the snout, lending to the nickname "lump nosed bat" (Hayes and Wiles 2013). The lumps are enlarged sebaceous perirhinal glands that may be involved in mating (Pearson et al. 1952) and distinguish western big-eared bats from other big-eared bats such as Allen's big-eared bat, spotted bats, and California leaf-nosed bats. The lumps are visible but less pronounced in pallid bats.

4.18.3. Taxonomy

Five subspecies are recognized (Piaggio and Perkins 2005). Two (*C.t. ingens* and *C. t. virginianus*) are isolated to mountainous regions of the eastern U.S. and listed as Federally Endangered (Piaggio et al. 2009). The nominate subspecies (*C.t. townsendii*) is found in Nevada (Piaggio et al., 2009). Subspecies are well supported molecularly, with significant introgression at range boundaries (Piaggio and Perkins 2005).

4.18.4. Population Status

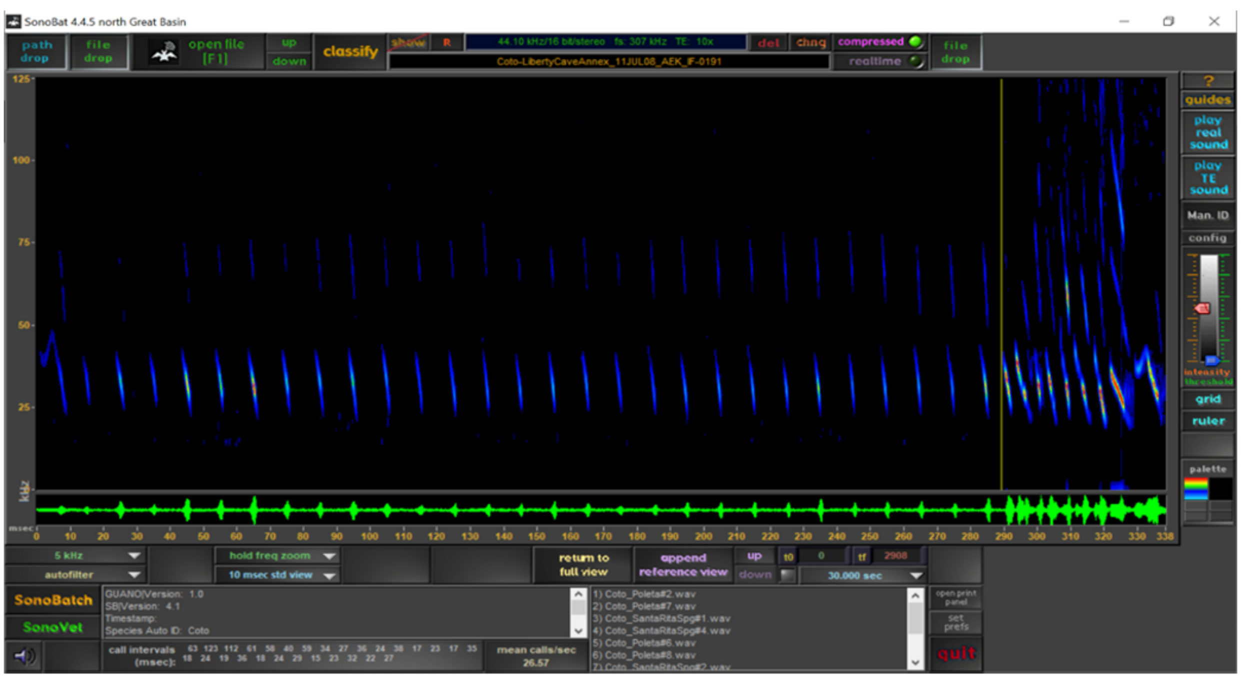
The western big-eared bat generally occurs at low densities across its western distribution (Hayes and Wiles 2013). Western big-eared bats have declined by up to 50% in California (Pierson and Rainey 1998b), Oregon (Perkins and Levesque 1987), Idaho (Adams 2003), and Colorado (Pierson et al. 1999). Declines are attributed to chronic roost disturbance, hard mine closures, and closures without bat compatible gates (Pierson et al. 1999). Protection of caves and mines through gating and seasonal cave closures have stabilized populations.

Populations at winter roosts are stable to increasing (Weller et al. 2018, Weller et al. 2014), suggesting that carefully implemented roost surveys may not be as disruptive as previously thought (Weller et al. 2014; Sherwin et al. 2003). Maternity colony sizes in Nevada range from a couple dozen females to over 2,500 and hibernacula counts range from a few individuals to over 500. Western big-eared bats can live up to 16 years (Harvey et al. 2011) and presumably have high survival rates.

The most common parasites found on western big-eared bats are parasitic flies from the family Streblidae. These flies are large, yellow, and extremely visible. They use the bats as hosts throughout the year. Another kind of wingless fly has been found on western populations, from the family Nycteribiidae.

4.18.5. Flight Characteristics and Acoustic Niche

Western big-eared bats are slow-flying clutter specialists capable of hovering in tight spaces (Lausen et al. 2022). Low wing-loading and aspect ratio imparts great lifting capacity and maneuverability. Short, broad wings facilitate pursuit of prey through vegetation. Their large ears are directed forward during flight. Although the ears generate lift (Johansson et al. 2016) and are used in thermoregulation (Betts 2010), their primary function is to improve hearing (Håkansson et al. 2017). Like other big-eared bats, echolocation calls are quiet and low intensity (Lausen et al. 2022), lending the nickname of "whispering bat". This species emits calls through the nose as effectively as the mouth (Kunz and Martin 1982).



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The acoustic call sequence and examples above provide a limited sample for the species listed and should be considered insufficient for manual vetting purposes. It is important to understand that bats vary their acoustic calls to suit different areas and activities. Manual vetting entails understanding the full repertoire of call types presented by each species, and which of those overlap with other species and which types provide species-discriminating characteristics.

Although quiet low intensity calls reduce detection probability with acoustic recording devices, detectors are still a viable survey method.

4.18.6. Habitat

Western big-eared bats are dependent on mines and caves to roost. Habitat preferences reflect roost availability (Gruver and Keinath 2006). When suitable roosts are present, a variety of habitats are occupied including deserts, mid to high-elevation mixed coniferous-deciduous forest, pinyon-juniper-mahogany, white fir, blackbrush, sagebrush, salt desert scrub, agricultural, and occasionally urban habitats. The species may occur at elevations above 3,048 m (10,000 ft) (Pierson et al. 1999) and has been observed in the high country caves of the Snake Range. Unlike other states where caves are prefered as roosts, mines are used more than caves in Nevada (Weller et al. 2018). This species has often been associated with ecotones between sagebrush and pinyon juniper woodlands (Sherwin et al. 2000).

4.18.7. Roosts and Roosting Behavior

The biology of western big-eared bats revolves around cave and mine roosts with roost selection driven by temperature and physiological needs (Gruver and Keinath 2006). Hibernation in Nevada occurs between November and March, with bouts of torpor flanking both sides of the hibernation season. Preferred hibernacula are cold (Humphrey and Kunz 1976) and individuals hibernating in caves are often found near entrances. Mines used as hibernacula generally have multiple openings (Hayes et al. 2011) that facilitate airflow (Sherwin et al. 2003). During hibernation, the species typically selects areas within a roost with the greatest amount of airflow to select for windchill. Western big-eared bats arouse and move regularly during hibernation (Kunz and Martin 1982), likely to select more favorable temperatures. Hibernating bats may be found individually, in small groups, or larger clusters hanging from roost ceilings and walls. Both males and females use the same hibernacula. While some hibernacula in Nevada support large numbers (up to 500), most consist of 20 or fewer individuals. Hibernacula in Nevada occur disproportionately in large, abandoned mine complexes, with caves providing a lesser number of sites and supporting fewer individuals (Weller et al. 2018). After spring emergence from hibernation, individuals segregate by sex (Pearson et al. 1952).

Female maternity roost selection is an exercise in thermoregulatory efficiency. Cooler roosts are preferred early in pregnancy to allow torpor use and save energy. Once young are born, warmer sites are preferred to facilitate efficient development of the pups (Hayes and Wiles 2013). When pups are volant after three weeks, the colony may move to still another, cooler roost to facilitate torpor. Larger colonies are more thermally efficient. Historical population declines may have caused a decrease in thermal efficiency of maternity colonies, causing clusters to move closer to cave and mine entrances, where temperatures are warmest. Clusters of females and pups are often found in domed ceilings, where the concave shape traps warmer temperatures. Nevada maternity colonies range from 80-2,500.

During the active season males use bachelor roosts, which are cooler than maternity roosts to allow daily torpor (Sherwin et al. 2009). Bachelor roosts typically consist of a few males. Night roosts are detectable through guano, moth wings, and other discarded insect parts (Sherwin et al. 2009). Trees, bridges, and bunkers are used as roost sites in other states, but this has not been documented in Nevada. In Nevada, in addition to primary roosting in mines and caves, this species has been documented by radio telemetry day roosting in trees, buildings, cliff faces, and talus.

4.18.8. Reproduction

Sperm production and mating peak in the late summer and early fall, with some copulations occurring during hibernation (Pearson et al. 1952). Mating may occur during fall swarming (Ingersoll et al. 2010). Females store sperm over the winter. Ovulation and fertilization occur in the spring after emergence from hibernation.

Males and females segregate during summer. Males are solitary or found in small bachelor groups, while females congregate at maternity colonies. The length of gestation varies with temperature between 56-100 days (Kunz and Martin 1982). Cooler temperatures and more frequent torpor lead to longer gestation. Parturition dates in Nevada are unknown but likely occur in June and July. Females reproduce annually, giving birth to a single pup, never twins. Pups are volant by 3 weeks of age and fully weaned by six weeks (Pearson et al. 1952). Females mate in their first autumn, but males do not breed until their second year (Hayes and Wiles 2013).

4.18.9. Food Habitats and Foraging

Ninety percent of the diet of western big-eared bats is small moths (6-12 mm) (Gruver and Keinath 2006). Although considered a moth specialist, like most insectivorous bats, this species feeds opportunistically on other flying insects such as beetles and flies. Western big-eared bats forage in and among foliage and gleaning of prey from plants (Pierson et al. 1999). In Nevada, this species had been documented foraging as much as 38 km (24 mi) away from its day roost (Ives et al. in press).

4.18.10. Seasonal Movements

Traditionally, western big-eared bats have been considered a dispersal limited species due to their short broad wings. However, the species migrates up to 64 km (40 mi) between roosts (Kunz and Martin 1982) and may cover 150 km (90 mi) during a night of foraging (R. Sherwin, personal communication, in Piaggio et al. 2009). Movements in Nevada of up 48 km (30 mi) between roosts have also been documented (B. T. Hamilton, unpublished data). This species may make seasonal elevational movements to find suitable temperatures for hibernation and pup rearing (Gruver and Keinath 2006, Cryan et al. 2000).

4.18.11. Threats

Roost destruction and disturbance are the primary threats to the western big-eared bat (Gruver and Keinath 2006). Hard closures of abandoned mines for reclamation and consumption of occupied roosts by renewed mining can lead to loss or entombment of entire populations (Pierson et al. 1999). Mine and cave gates are the primary conservation technique used to protect roosting populations. In fact, almost all bat compatible gates in Nevada were constructed for western big-eared bats. This species is highly tolerant of bat compatible gates, with a short term (less than 7 days) negative impact followed by full acceptance (Tobin and Chambers 2017, Tobin et al. 2018).

Although roosting on open surfaces in spacious mines and caves can make western big-eared bats highly susceptible to disturbance by researchers, recreational cavers, and mine explorers (Hayes and Wiles 2013), careful, well-planned roost surveys are compatible with conservation (Weller et al. 2018, Weller et al. 2014). Unregulated cave recreation and mine exploration can lead to direct mortality of adults and pups (Sherwin et al. 2000). This has been observed in Nevada at ungated caves. To avoid negative impacts, gates and seasonal closures should be implemented (Jason Williams, personal communication, no date) according to site specific periods of occupancy. Landscape scale surveys across seasons over multiple years are required to assess occupancy (Sherwin et al. 2000). For example, eliminating a site as a maternity roost or hibernacula, required four visits and eight visits, respectively (Sherwin et al. 2003). Maternity roosts should be closed to recreational caving from May 1 to October 1 and hibernacula between November 1 and April 1.

Overall fidelity to roosts is high at the landscape scale, with multiple generations of bats using the same roosts (Sherwin et al. 2003, Hayes and Wiles 2013, Fellers and Pierson 2002, Soulages 1966). Anderson et al. (2018) indicated limited dispersal with adequate gene flow at larger scales. Maintaining connections between roosts is critical to maintain population level demographic and genetic integrity (Anderson et al. 2018). Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.18.12. Research Needs

Low abundance, patchy distribution, use of multiple roost sites, quiet echolocation calls, and ability to avoid mist nets make documenting trends in population parameters difficult. Despite these challenges, the species is highly detectable when roosting, making long term counts during hibernation a viable survey method (Weller et al. 2018). Automatic Passive Integrated Transponder (PIT) tag readers at roosts can provide long term information on survival as well as patterns of roost occupancy and movement between roosts. These data are particularly useful to set closure periods for recreational caving and gating construction.

Many large hibernacula and maternity colonies remain undiscovered, especially considering the amount of abandoned mine land in Nevada. Roosts are regularly found during AML and radio telemetry surveys and many significant roosts could be discovered with future survey work. Finding and protecting these roosts is critical to conservation of western big-eared bats.

More information is needed about roost switching, gene flow, survival and recruitment. Research aimed at understanding how this species responds to culverts and bat compatible gates is also needed.
Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

4.19. Western Mastiff Bat, Greater Bonneted Bat (*Eumops perotis*)

4.19.1. Conservation Status

Federal	
BLM	S
USFS	None
State	
NDNH	G4 S1
NDOW	SGCN

*Conservation status definitions can be found in Appendix 7.2

Western mastiff bat - Joseph Danielson

4.19.2. Description and Morphology

The western mastiff bat is a molossid bat and the largest bat (51 g) in the continental U.S. It has an ear length of 36-47 mm, forearm length of 73-83 mm, and a wingspan of nearly two feet (530-570 mm). The dorsal pelage ranges from dark grey to dark brown or a mixture of both colors. Ventral pelage is ash brown, and hairs are white at the root (dorsal and ventral). Unlike other bonneted bats, the western mastiff bat lacks long hairs on the base of its rump. This species has long slender wings and large, rounded, non-erect ears that project forward. The distal half of the tail is free of the uropatagium. Male western mastiff bats are typically larger than females.

4.19.3. Taxonomy

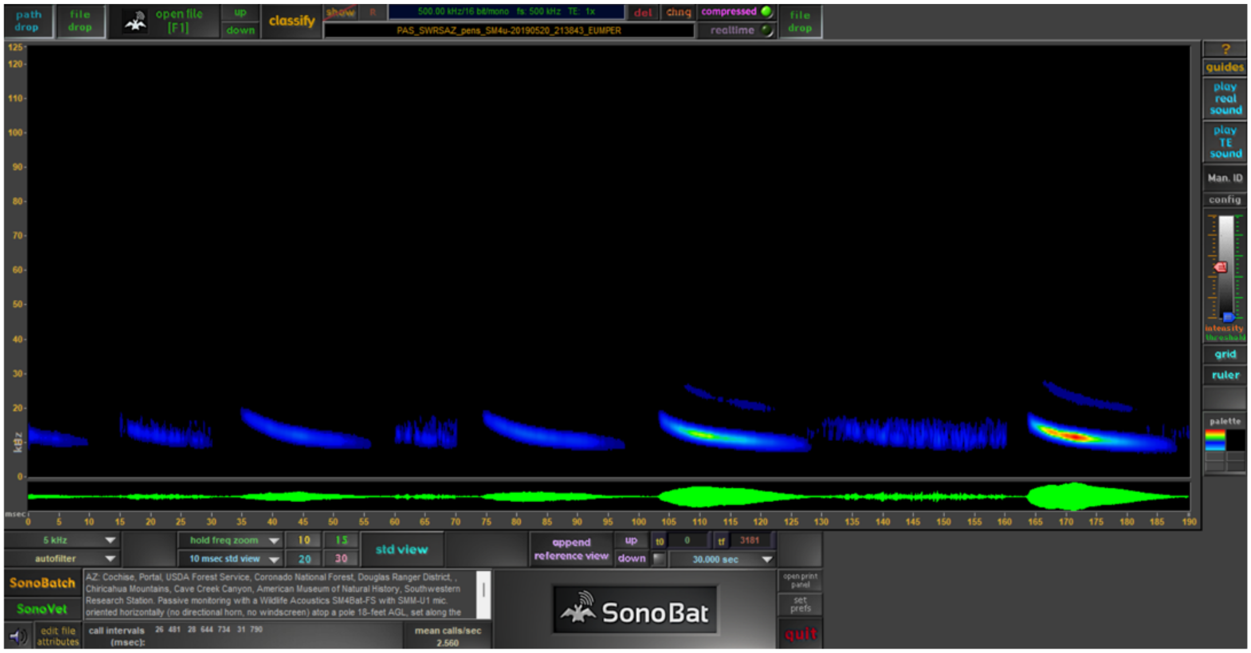
Three subspecies of *Eumops perotis* are recognized, but only one occurs in North America. *Eumops perotis californicus* is distributed from Mexico north into Nevada and from California east into Arizona.

4.19.4. Population Status

The population status of the western mastiff bat in Nevada is currently unknown but is considered imperiled within the state (S1). Current records are limited to the southeastern portion of the state. Species occurrence in Nevada was previously based on a single specimen found dead in Las Vegas in 1966 (Bradley and O'Farrell 1967). More recent acoustic detections have been verified along the Colorado River, Las Vegas Wash, Spring Mountains, Meadow Valley Wash and as far north as Panaca in Lincoln County. M.J. O'Farrell and J.A. Williams (2000) detected this species acoustically in the Spring Mountains of southern Nevada. A second specimen was collected in Pahrump, Nye County, in October 2018. Population trends for this species are difficult to assess due to the apparent rarity of the species and a lack of known roost locations. However, in neighboring California, acoustic surveys have confirmed presence in the northern and central part of that state, including the Sierra Nevada Range (Pierson and Rainey 1998a).

4.19.5. Flight Characteristics and Acoustic Niche

Western mastiff bats emit loud, shrill calls as they emerge from their roosts, and make distinctive high-pitched 'chirps' every two to three seconds while in flight. Calls have a characteristic frequency around 10 kHz and are often more than 10 ms in length. These low frequency calls are audible to the human ear.



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The acoustic call sequence and examples above provide a limited sample for the species listed and should be considered insufficient for manual vetting purposes. It is important to understand that bats vary their acoustic calls to suit different areas and activities. Manual vetting entails understanding the full repertoire of call types presented by each species, and which of those overlap with other species and which types provide species-discriminating characteristics. Acoustic file provided by Janet Tyburec.

4.19.6. Habitat

These bats utilize a wide variety of habitats in low to mid elevations. Desert scrub, chaparral, oak woodlands and ponderosa pine, desert washes, and riparian areas in proximity to cliffs and rugged canyons with adequate crevices for roosting are utilized by this species. Due to its large size, the western mastiff bat requires water sources at least 30 m (98 ft) in length to drink. The species may range from 350 m to over 3,000 m (1,148-9,842 ft) in elevation.

4.19.7. Roosts and Roosting Behavior

The western mastiff bat is known as a cliff and crevice obligate species, relying on significant rock features such as columnar basalt, consolidated sandstone formations, or large granite features for suitable roosting sites. Roosts are usually found in vertical or horizontal crevices, are rarely shallow, and must have unobstructed openings due to the large size and low maneuverability of the species. Generally, 2-3 m (7-10 ft) above the ground, roost locations must provide adequate height for this species to drop and unfurl their wings to gain enough lift for flight. This species is unable to fly from ground level and will climb up vertical objects to drop into flight if necessary. Western mastiff bats are very active within their roosts throughout the day, especially during warmer months. Roosts vary greatly in size from a few bats to upwards of a hundred individuals. Males may occupy maternity roosts may along with females and pups.

4.19.8. Reproduction

Unlike most bats in Nevada, this species breeds in the spring rather than the fall. Gestation is 80-90 days (Ammerman et al. 2012), and dull black pups are born from June to as late as September. A single pup per female is typical, but twin embryos have been documented. Juveniles typically become volant between early September and late November.

4.19.9. Food Habitats and Foraging

The western mastiff bat will eat a wide range of insects but prefer large moths. Foraging may occur in proximity to roosting habitat, but this bat can travel long distances greater than 25 km (16 mi) to forage in riparian corridors, montane meadows, mixed conifer forests, and near large lakes or reservoirs. This aerial hawker typically forages 100-200 m (328-656 ft) above ground but has been known to forage at upwards of 2,000 m (6,561 ft).

4.19.10. Seasonal Movements

It is currently not known if the western mastiff bat breeds or winters in Nevada. This species does not undergo deep hibernation but may enter daily torpor during extended periods of cooler winter weather (Leitner 1966). Though not known to migrate long-distances, western mastiff bats may move relatively short distances and use alternate roost sites seasonally.

4.19.11. Threats

Due to their reliance on tall rock features and cliffs, western mastiff bats may be at risk of disturbance from recreational climbers. Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.19.12. Research Needs

There are no species-specific research needs for the western mastiff bat in Nevada, but research into distribution, population status, habitat use, and seasonal movements is needed for all Nevada bat species. Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

4.20. Western Red Bat (*Lasiurus frantzii*)

4.20.1. Conservation Status

Federal	
BLM	S
USFS	None
State	
NDNH	G4 S2
NDOW	PM, SGCN

*Conservation status definitions can be found in Appendix 7.2

Western red bat - Scott Altenbach © Nevada Department of Wildlife. Used with permission.

4.20.2. Description and Morphology

The western red bat is a medium-sized (7-15 g) vesper bat with a forearm length of 35-45 mm and wingspan of 29-33 cm. Dense rusty red to reddish-brown fur distinguishes this bat from all other western species. Dorsal fur is gray to yellow with a white collar around the shoulders and neck. Wings are narrow and long with black membranes. The short round ears, large blunt tragus, and muzzle are pink to reddish brown.

4.20.3. Taxonomy

There are likely two subspecies of western red bat, but recent genetic studies have created some uncertainty as to which exists within Nevada.

Western and Eastern Red Bats

Previously believed to be allopatric, with *Lasiurus frantzii* (LAFR; western red bat) occurring in the western U.S. and *L. borealis* (LABO; eastern red bat) in the eastern U.S., recent genetic research indicates more overlap with *L. borealis* found as far west as coastal California (Haidar 2023). While only *L. frantzii* has been documented in Nevada, genetic analysis of additional samples may change this status.

Field distinction of these two species is very challenging as no morphometric differences are known, aside from cranial measurements. Research into pelage differences with genetic confirmation found some distinguishing features (Haidar 2023). *L. borealis* typically has both white shoulder and thumb patches, and fully furred dorsal tails and fur lining the ventral forearm. *L. frantzii* in Arizona and southern California showed reduced contrast between the thumb and shoulder patch against the dorsal and ventral fur, and less fur density on the tail and wing membranes. However, *L. frantzii* showed greater variability across its range, and increasing fur density with latitude.

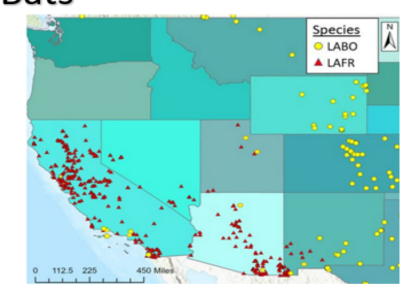
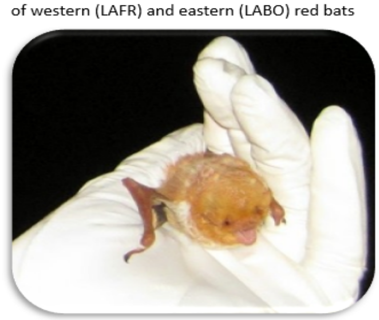


Figure from Haidar 2023 representing the locations of western (LAFR) and eastern (LABO) red bats



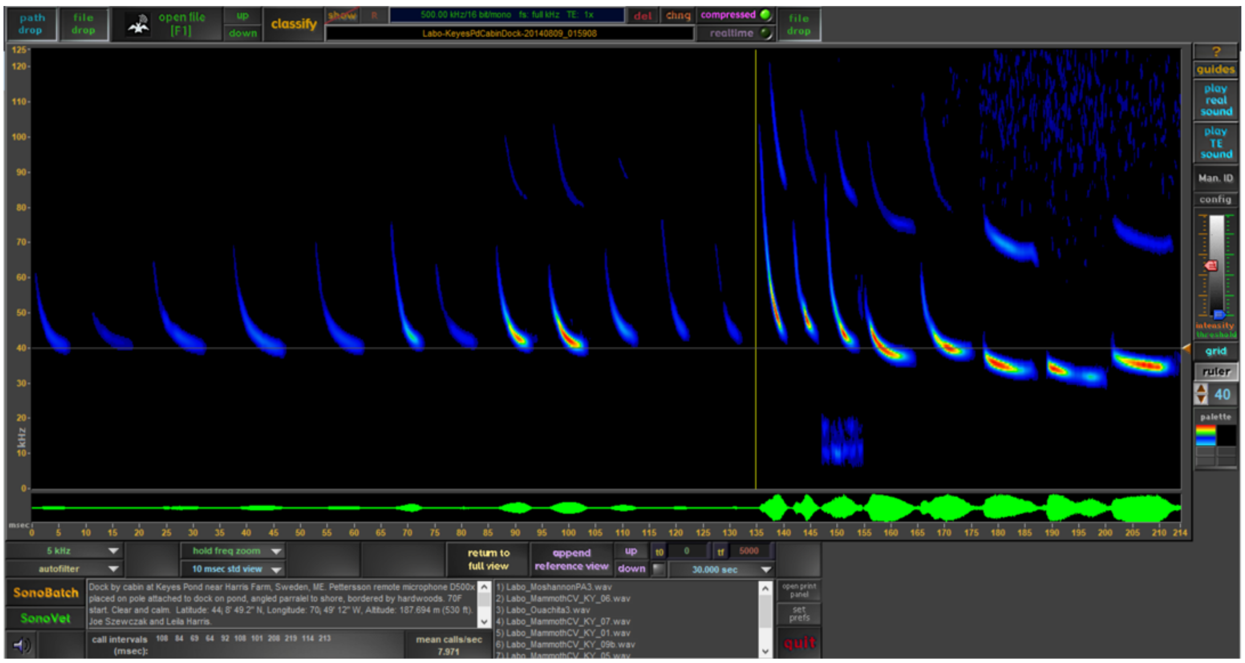
Eastern red bat (*Lasiurus borealis*) -Julia Hoeh

4.20.4. Population Status

The population status of western red bats in Nevada is not well understood but it is considered rare within the state (S2).

4.20.5. Flight Characteristics and Acoustic Niche

Western red bats are fast, high-flying clutter specialists. Diagnostic search-phase calls ‘bounce’ as characteristic frequency and shape alternates between pulses, though always around 40 kHz.



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**Lasiurus frantzii* was previously *Lasiurus blossevillii* (species code LABO)

4.20.6. Habitat

The western red bat is most often observed in western and southern Nevada (Williams 2001, O’Farrell 2009, Kenney and Tomlinson 2005). Acoustic detections have been made throughout the state, including Sheldon National Wildlife Refuge (Barnett and Collins 2019) to the northwest. Current Nevada records indicate this species is distributed between 420-2,010 m (1,377-6,593 ft). Western red bats are primarily found in wooded habitats with deciduous trees including, mesquite bosque, riparian areas with cottonwood and willow, fruit orchards, and areas with other non-native trees such as maple and ash (Constantine 1959).

4.20.7. Roosts and Roosting Behavior

The western red bat roosts in tree foliage and is closely associated with riparian areas in the western U.S. (Shump and Shump 1982a, Adams 2003). Day roosts preferred by both males and females include older age class cottonwood trees with dense foliage, between 132-183 cm (52-57 in) diameter at breast height (dbh), and an average height of 13 m (43 ft) based on a tracking study conducted in 2012 by Nevada Department of Wildlife on the Carson River (NDOW JPR 2012). This species roosts in dense foliage singly or in small groups of two to three (Anderson and Geluso 2018, LCRMSCP 2016).

Roost sites are from 1-12 meters (3-39 ft) high and heavily shaded above but open below to allow the bat to drop into flight (Harris, No Date; LCRMSCP 2016). Western red bats had low roost fidelity during a telemetry study on the Carson River in Nevada (NDOW JPR 2009). In this study a single male switched roost trees four times during the 20-day tracking period, while two females in a Fallon fruit orchard switched roost trees three times during a 45-day observation period after their pups were volant. Leaf litter may provide more optimal conditions for hibernation (Perry 2013), and individuals have been observed hibernating in ground leaf litter at several locations in the Fallon area over the winter.

4.20.8. Reproduction

Mating occurs from August to September, but insemination is delayed until the following spring (Harris, No Date). After a gestation of 60-90 days, a single litter of two to five pups is born in June (LCRMSCP 2016). Lactation lasts 5-6 weeks and young become volant between 3-6 weeks (Pierson and Rainey 1998c). Reproduction was confirmed for this species in a private fruit orchard, a non-native ash tree in Fallon (NDOW JPR 2009), and an intact cottonwood gallery along the Carson River in Lyon County (NDOW JRP 2012).

4.20.9. Food Habitats and Foraging

The western red bat emerges after dark and may forage well into morning. This species has been known to hunt 550-915 m (1,804-3,001 ft) from summer roost sites. Foraging flight patterns begin with slow erratic wing beats high above the ground before flying in straight lines or circles over the same area between treetops or close to the ground (Harris, No Date). Western red bats may change their proximity to vegetation while foraging depending on light availability (Jung and Kalko 2010). In California, this species is most active over 20°C (68°F) but has been seen at temperatures as low as 7°C (44°F) (Harris, No Date).

The western red bat catches insects using its wing membranes and less often its uropatagium. Food items consist of a wide variety of insects. In Arizona, moths appear to be one of the more important prey items (Hinman and Snow 2003); they also take cicadas, leaf hoppers; beetles; wasps; flies; crickets and grasshoppers (Shump and Shump 1982a).

4.20.10. Seasonal Movements

The seasonal behavior of western red bats is not well understood. Previously this species was thought to be a migrant in Nevada, but recent studies indicate it may be a year-round resident in the Fallon and Moapa areas (NDOW JPR 2009, 2012 and Hammond 2020). Peak activity in Ash Meadows National Wildlife Refuge followed spring and fall migratory periods, but western red bat was detected throughout the summer months (O'Farrell 2009), further supporting summer resident status. This species is known to be a year-round resident in California (Cryan 2003).

4.20.11. Threats

Intensive use of pesticides in fruit orchards may reduce prey populations for roosting bats, in addition to direct mortality of young pups or adults from short or long-term exposure. Controlled burns and the burning of ground leaf litter may be another significant mortality factor for red bats that hibernate in ground cover. Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.20.12. Research Needs

Further research into the impacts of burning dead leaf litter and wood piles during the fall and winter on hibernating red bats and the effects of pesticide use in orchards is needed. Genetic work is also needed to determine the subspecies or species (eastern vs western red bat) present in Nevada. Research into distribution, population status, habitat use, and seasonal movements is needed for all Nevada bat species. Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

4.21. Western Small-footed Myotis (*Myotis ciliolabrum*)

4.21.1. Conservation Status

Federal	
BLM	S
USFS	None
State	
NDNH	G5 S3S4
NDOW	SGCN

*Conservation status definitions can be found in Appendix 7.2

Western small-footed myotis - Scott Altenbach © Nevada Department of Wildlife. Used with permission.

4.21.2. Description and Morphology

The western small-footed myotis is the one of the smallest bats in Nevada (3-5 g) with a 30-36 mm forearm, wingspan of 21-25 cm, ear length of 11-16 mm, and a tiny hindfoot (6 mm). Dorsal fur is light brown with a lighter-colored tan venter, while the ears, facial mask, and wing membranes are black. The tragus is slender and tapers at half the ear length. The calcar is keeled, distinguishing this species from all myotis but the California myotis and the long-legged myotis.

4.21.3. Taxonomy

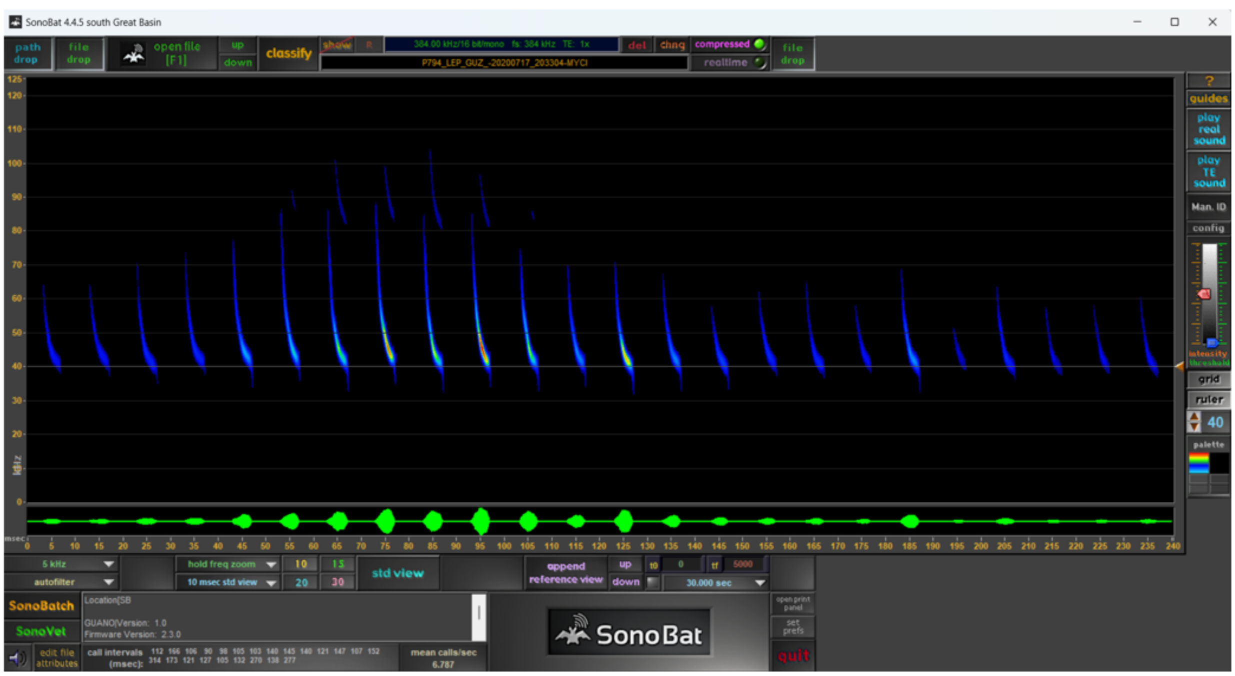
There are two recognized subspecies of *Myotis ciliolabrum*, but only one, *M. c. melanorhinus*, can be found in Nevada.

4.21.4. Population Status

The population status of the western small-footed myotis is unknown throughout its range, including within Nevada. It is believed to be common in middle to higher elevations of south-central Nevada (Hall 2000, Hansen et al. 2008). This species is currently ranked as vulnerable to apparently secure within the state (S3S4).

4.21.5. Flight Characteristics and Acoustic Niche

The western small-footed myotis is a slow, maneuverable, low-flying bat with low aspect and wing loading ratios. It has a characteristic frequency at 40 kHz and downward ‘toes’ at the end of call pulses. In Nevada, there is considerable overlap in acoustic niche between little brown myotis, long-legged myotis, and small-footed myotis as the 40 kHz myotis guild.



© Joe Szewczak

The acoustic call sequence and examples above provide a limited sample for the species listed and should be considered insufficient for manual vetting purposes. It is important to understand that bats vary their acoustic calls to suit different areas and activities. Manual vetting entails understanding the full repertoire of call types presented by each species, and which of those overlap with other species and which types provide species-discriminating characteristics.

4.21.6. Habitat

The western small-footed myotis is known to inhabit desert scrub, grasslands, sagebrush steppe, blackbrush, greasewood, pinyon-juniper woodlands, pine-fir forests, agricultural, and urban areas (Chung-MacCoubrey 1996, Szewczak 1998, Holloway and Barclay 2001). Current Nevada records indicate this species occurs at elevations between 510-2,760 m (1,673- 9,055 ft). In southern Nevada, this species is primarily found at middle and higher elevations above 1,500 m (4,921 ft) but has also been found as low as 450 m (1,476 ft) (Hammond 2020). In the central and northern part of the state, it is more common at valley bottoms between 1,050-1,800 m (3,445-5,905 ft).

4.21.7. Roosts and Roosting Behavior

Caves, mines, and trees are known roost sites for the small-footed myotis (Holloway and Barclay 2001) and they display considerable fidelity to their roosting area within a season, moving 30-347 m (98-1,138 ft) between roosts (Rodhouse and Hyde 2014). Reproductive females roost solitarily or in small groups (Holloway and Barclay 2001) and may form small maternity colonies, generally with fewer than 30 individuals.

This species hibernates individually or in medium-sized colonies throughout most of its range. Hibernacula sites include abandoned mines and caves as well as crevices or holes drilled into rock. Whiting (2021) observed that when aroused from hibernation, western small-footed myotis would forage at lower temperatures, higher wind speeds, and greater changes in barometric pressure compared to larger bat species.

4.21.8. Reproduction

Western small-footed myotis give birth to a single young per year between May and July (Hall 1964).

4.21.9. Food Habitats and Foraging

Western small-footed myotis emerge early in the evening, shortly after sunset (Fenton et al. 1980, Whitaker et al. 1981, Rodhouse and Hyde 2014). These aerial hawkers usually hunt in irregular circles above water, ground, or canopy, and feed on a variety of flying insects, including moths, flies, bugs, and beetles (Warner 1985). Rodhouse and Hyde (2014) observed small-footed myotis traveling over 12 km (7 mi) from roosts to foraging sites near agricultural fields.

4.21.10. Seasonal Movements

The western small-footed myotis is believed to be a resident bat in Nevada, hibernating during the cold winter months. In south-central Nevada this species remained active acoustically year-round (Hansen et al. 2008).

4.21.11. Threats

There are no species-specific threats in Nevada for the western small-footed myotis, however all bat populations are threatened by multiple factors including climate change, habitat loss, roost disturbance, environmental contaminants, energy development, abandoned mine closures, mining and mineral exploration, and WNS. Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.21.12. Research Needs

There are no species-specific research needs for the western small-footed myotis in Nevada, but research into distribution, population status, habitat use, and seasonal movements is needed for all Nevada bat species. Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

4.22. Western Yellow Bat (*Lasiurus xanthinus*)

4.22.1. Conservation Status

Federal	
BLM	None
USFS	None
State	
NDNH	G4 S1
NDOW	PM

*Conservation status definitions can be found in Appendix 7.2

Western yellow bat - Scott Altenbach © Nevada Department of Wildlife. Used with permission.

4.22.2. Description and Morphology

The western yellow bat is medium-large vesper bat (9-23 g) with a forearm length of 45-50 mm and a wingspan of 33-36 cm. As implied by the common name, its fur is pale yellow except for a light brown tint around the eyes and a darker ring around the short, triangular ears. While the ears, muzzle, and forearms are reddish-brown, wing membranes are dark except for lighter areas around phalanges. The upper portion of the uropatagium is densely haired and bright yellow, while the lower portion is nearly hairless. This species is not morphologically distinguishable from the southern yellow bat which is not known to occur in Nevada. Where their ranges overlap genetic confirmation is required for species identification.

4.22.3. Taxonomy

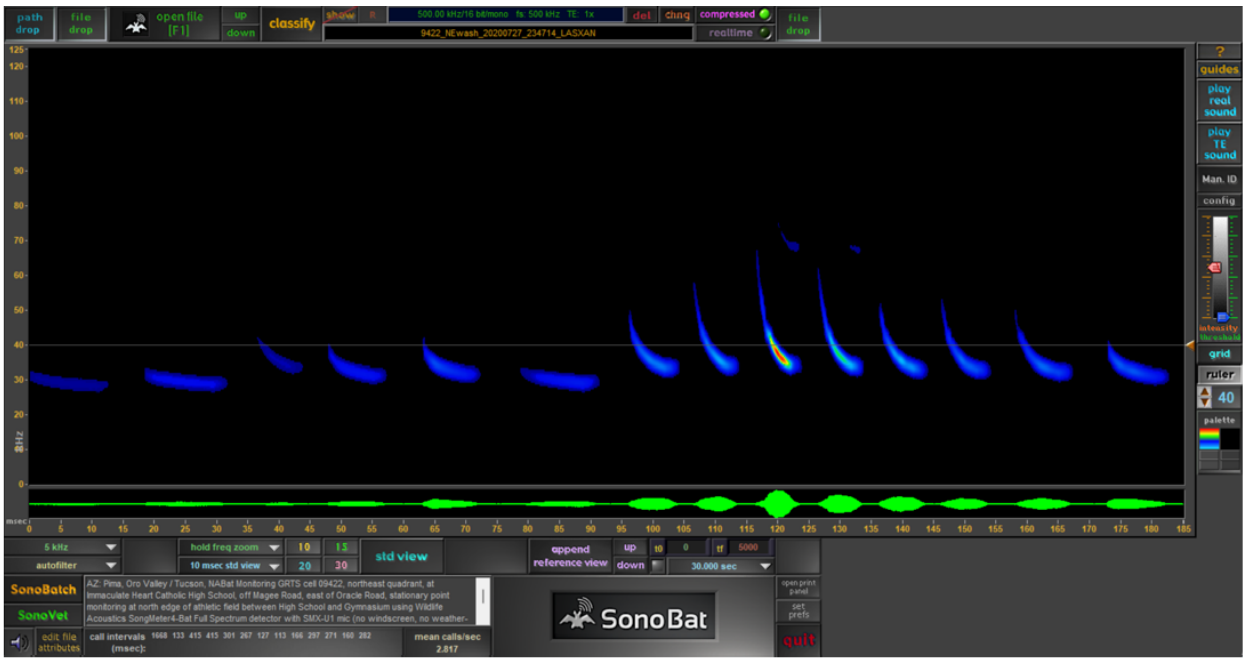
The western yellow bat was formerly considered a subspecies of *Lasiurus ega* (southern yellow bat), but subsequent genetic work resulted in the acceptance of *L. xanthinus* as a separate species. There are no recognized subspecies of *L. xanthinus*.

4.22.4. Population Status

The western yellow bat occurs in southern Nevada and is either primarily or completely restricted to the Colorado River drainage. This species appears to be expanding its range in the southwestern U.S. due to increased use of ornamental palms in landscaping (Constantine 1998) and is most often observed in stands of ungroomed ornamental palms within Nevada. It may be common in suitable habitat. A study conducted between May 2000 and July 2002 found evidence that it was the second most common species of bat in the northern Moapa River Valley (O'Farrell et al. 2004, Williams et al. 2006). The western yellow bat is ranked as critically imperiled within the state (S1) and its population status in Nevada is unknown.

4.22.5. Flight Characteristics and Acoustic Niche

The western yellow bat is a fast, maneuverable edge specialist with high wing aspect ratio and low wing loading ratio. Characteristic frequency often changes between call pulses, resulting in 'bouncy' sequences with characteristic frequencies between 30-35 kHz. Call sequences may look extremely similar to western red bats but are usually around 10 kHz lower.



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The acoustic call sequence and examples above provide a limited sample for the species listed and should be considered insufficient for manual vetting purposes. It is important to understand that bats vary their acoustic calls to suit different areas and activities. Manual vetting entails understanding the full repertoire of call types presented by each species, and which of those overlap with other species and which types provide species-discriminating characteristics. Acoustic file provided by Janet Tyburec.

4.22.6. Habitat

The western yellow bat is closely associated with palms and desert riparian habitats, with observations in the Las Vegas Wash and Moapa Valley (Eckberg and Foster 2011, O'Farrell et al. 2004, Williams et al. 2006). In other parts of its range, western yellow bats have been found in savannas, secluded woodlands, pasture and cropland, and even residential areas. This species is most often captured in open grassy areas or near water sources such as stock tanks, ponds, swimming pools, streams, and rivers. In the Lower Colorado Desert, bats were more likely to roost at higher elevation palm oases with a range of skirt lengths and evidence of new palm growth.

4.22.7. Roosts and Roosting Behavior

Western yellow bats roost solitarily or in small groups. Preferred day roosts include the "skirt" of dead fronds on fan palm trees or in the foliage of deciduous trees (Cockrum 1961, Kurta and Lehr 1995). Some research also suggests the potential use of hackberry, sycamore, and even yucca (Higginbotham et al. 2000). Western yellow bats are not known to hibernate, but acoustic data in Nevada suggests that they may engage in bouts of torpor throughout the winter (O'Farrell et al. 2004).

4.22.8. Reproduction

Little reproductive information is available specific to the western yellow bats. The closely related eastern yellow bat is believed to mate in the fall, and pregnant females have been observed between April and June. One to four young are born during June-July (Kurta and Lehr 1995).

4.22.9. Food Habitats and Foraging

Western yellow bats are aerial hawkers that take a variety of prey including beetles, flies, bugs, moths, crickets, and grasshoppers (O'Farrell et al. 2004). This species will often forage near day roosting sites.

4.22.10. Seasonal Movements

Western yellow bats have been observed in Nevada year-round but activity declines sharply during the winter months, suggesting some of the population may migrate while a small resident population remains (O'Farrell et al. 2004, Williams et al. 2006). Data from other areas at the northern extent of their range suggest this species may experience seasonal sex segregation during parturition, but no evidence has been found for this behavior in Nevada (O'Farrell et al. 2004).

4.22.11. Threats

In the U.S., cosmetic thinning of palm fronds, removal of invasive palms, pesticide spraying, and loss of riparian habitat are primary threats to the western yellow bat. Williams et al. (2006) implies that replacement of palms by large woodland tree species might off-set some of the roosting tree habitat loss where invasive palm trees are removed. Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.22.12. Research Needs

Western yellow bats show a strong preference for ornamental palms, and the extent to which palm trimming and pesticide use in orchards impacts this species requires further study. Research into distribution, population status, habitat use, and seasonal movements is needed for all Nevada bat species. Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

4.23. Yuma myotis (*Myotis yumanensis*)

4.23.1. Conservation Status

Federal	
BLM	S
USFS	None
State	
NDNH	G5 S3
NDOW	SGCN

*Conservation status definitions can be found in Appendix 7.2

Yuma myotis - Scott Altenbach © Nevada Department of Wildlife. Used with permission.

4.23.2. Description and Morphology

The Yuma myotis is a small vesper bat (3-6 g) with a forearm length of 32-38 mm, a wingspan of 21-25 cm, and an ear length of 11-15 mm. The dorsal hairs are gray to brown or pale tan, short, and bicolored with lighter tips. The fur is dull (lacking a glossy sheen) which can differentiate this species from the morphologically similar little brown myotis. Ventral fur is lighter in color, ranging from white to cream. Wings are short with rounded tips. Membranes, ears, and muzzle are pale brown to gray. The tragus is large and triangular with a rounded tip. The calcar is not keeled.

4.23.3. Taxonomy

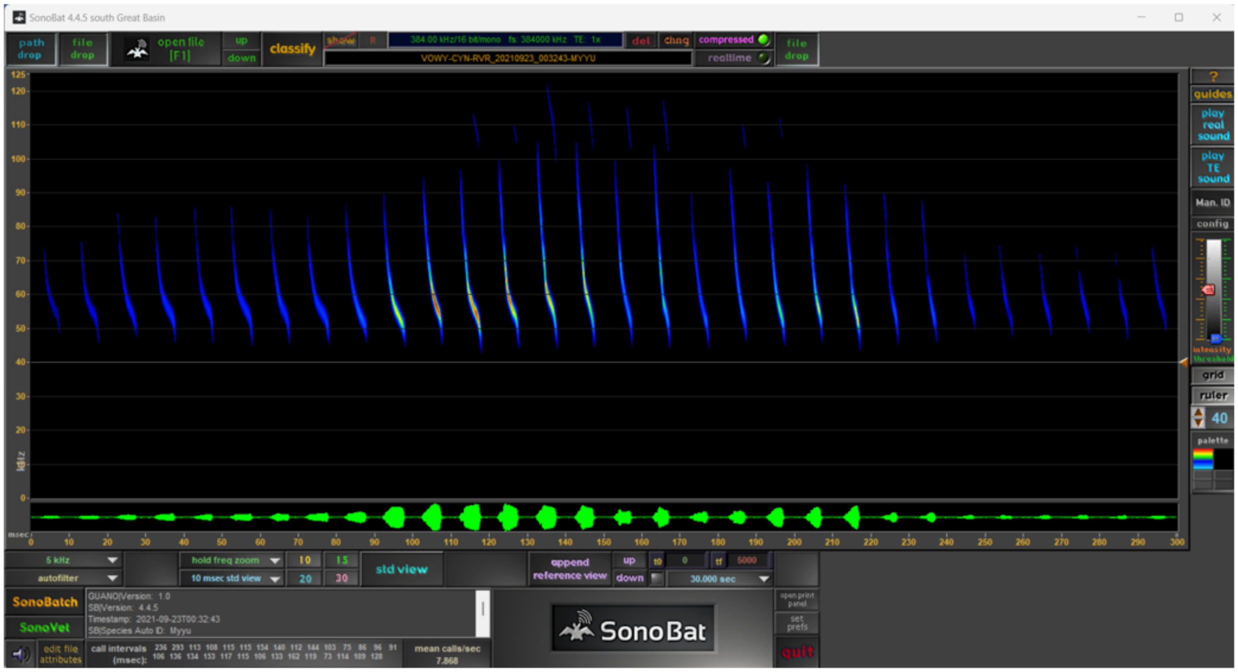
There are six recognized subspecies of *Myotis yumanensis*. *Myotis y. yumanensis* is a subspecies found in the southern tip and eastern edge of Nevada, while *M. y. sociabilis* may be found in the Tahoe region as well as a small area of north-central Nevada (Braun et al. 2015). Dalquest (1947) references a population of over 5,000 *M. y. yumanensis* living in the belfry and attic of a church in Wadsworth, Nevada.

4.23.4. Population Status

The population status of the Yuma myotis in Nevada is currently unknown. This species is currently listed as vulnerable within the state (S3).

4.23.5. Flight Characteristics and Acoustic Niche

Yuma myotis is a slow, low-flying bat with a high wing loading ratio and a low wing aspect ratio (Farney and Fleharty 1969) which allow considerable maneuverability (Aldridge 1986, Norberg and Rayner 1987). Yuma myotis calls have a characteristic frequency of 50 kHz or more. There is overlap in call repertoire between Yuma myotis and the only other 50 kHz myotis in Nevada, the California myotis.



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The acoustic call sequence and examples above provide a limited sample for the species listed and should be considered insufficient for manual vetting purposes. It is important to understand that bats vary their acoustic calls to suit different areas and activities. Manual vetting entails understanding the full repertoire of call types presented by each species, and which of those overlap with other species and which types provide species-discriminating characteristics.

4.23.6. Habitat

Yuma myotis occurs in a wide variety of habitats from low to mid-elevations including sagebrush, salt desert scrub, agricultural, playa, and riparian habitats. Current data indicates Yuma myotis is distributed throughout the state (O'Shea et al. 2016, Barnett and Colins 2019, Morrison and Fox 2009). This species is very closely associated with open water and therefore riparian vegetation (Frick et al. 2007, Braun et al. 2015, Brigham et al. 1992, Williams et al. 2006).

4.23.7. Roosts and Roosting Behavior

While Yuma myotis will often roost in buildings, abandoned mines, and bridges, it is recognized as a crevice-dwelling species and will also utilize rock crevices and caves. In California, Yuma myotis have been observed roosting in large-diameter trees under bark and within damaged trunks (Evelyn et al. 2004). The same study estimated an average roost fidelity of 4.8 days and a maximum distance of 1.1 km (0.7 mi) between roosts. They are known to roost with other bats including myotis and non-myotis species (Braun et al. 2015).

Though males remain solitary or roost in small groups, maternity colonies may consist of over 100 reproductive females. Yuma myotis selected for high relative humidity in abandoned mines (Braun et al.

2015) and this is likely true in caves as well. Distance from water is a major factor influencing habitat use and therefore roost selection (Dalquest 1947, Duff and Morrell 2007, Evelyn et al. 2003). It is not currently known if the Yuma myotis migrates to roost for the winter.

4.23.8. Reproduction

Mating occurs in fall, but sperm is stored until the following spring (Dalquest 1947). Yuma myotis gives birth to a single young per year in late May-June (Braun et al. 2015). After approximately one month, young become volant and leave the nursery roost. Females are reproductively active the season after their birth (Aldridge 1986). Though records confirming this reproductive timeline exists in California, Idaho, and New Mexico. The reproduction habits of Yuma myotis in Nevada have not been specifically studied.

4.23.9. Food Habitats and Foraging

Yuma myotis is an aerial forager (Fenton and Bogdanowicz 2002) which tracks and captures prey in open air but can also trawl for insects close to the water surface (Norberg and Rayner 1987). This species forages over open water and in riparian corridors. Their diet includes beetles, flies, moths, and other soft-bodied insects. There may be resource partitioning between adults and subadults, which consume more flies (Herd and Fenton 1983). Yuma myotis is an opportunistic generalist and prey selection varies with insect availability (Fenton and Morris 1976, Vaughan 1980, Brigham et al. 1992). Though Yuma myotis and little brown myotis have considerable overlap in diet, interspecific competition for food resources does not appear to occur in southern British Columbia (Aldridge 1986, Herd and Fenton 1983), but the dynamic between these species in Nevada is not well understood.

4.23.10. Seasonal Movements

The seasonal movements of the Yuma myotis in Nevada are not currently known. Dalquest (1947) suggested the species was unlikely to be a migrant in California and probably experienced partial hibernation during the winter months. Yuma myotis has been observed in Arizona during the winter, but rarely. According to USFWS, the Yuma myotis is a year-round resident in New Mexico.

4.23.11. Threats

Yuma myotis may be vulnerable to contamination of waterways due to their dependence on riparian areas (Frick et al. 2007). Please see Section 6 (Conservation Strategies) to learn more about threats to bats.

4.23.12. Research Needs

Further research into the impacts of chemical contamination on the Yuma Myotis is needed. Research into distribution, population status, habitat use, and seasonal movements is needed for all Nevada bat species. Please see Section 6 (Conservation Strategies) for more detailed research needs for Nevada bats.

5. BAT SURVEYS

Survey methods are constantly changing, therefore specific methodologies are not included in this document. Instead, a summary of methodologies and resources to consult when determining the best methods to use for surveys are provided. Specific protocols can be found on the Nevada Bat Working Group website (https://www.pacwestbats.org/nbwg). The NBWG recommends consulting local biologists with experience working with or surveying for bats in Nevada when determining appropriate survey goals and methods.

Table 3: Best Known Observation Methods for Surveying Nevada Bat Species*

Species		**Best Observation Method**			
Common Name(s)	**Scientific Name**	**Acoustic Survey****	**Capture Survey**	**Roost Survey**	**Undetermined**
Allen's big-eared bat	*Idionycteris phyllotis*	X		X	
Big brown bat	*Eptesicus fuscus*	X	X		
Big free-tailed bat	*Nyctinomops macrotis*				X
California leaf-nosed bat	*Macrotus californicus*			X	X
California myotis	*Myotis californicus*	X			
Canyon bat, western pipistrelle	*Parastrellus hesperus*	X	X	X	
Cave myotis	*Myotis velifer*	X		X	
Fringed myotis	*Myotis thysanodes*	X			
Hoary bat	*Lasiurus cinereus*	X	X		
Little brown myotis	*Myotis lucifugus*	X			
Long-eared myotis	*Myotis evotis*	X			
Long-legged myotis	*Myotis volans*		X		
Mexican free-tailed bat, Brazilian free-tailed bat	*Tadarida brasiliensis*	X	X	X	
Pallid bat	*Antrozous pallidus*	X	X	X	
Pocket free-tailed bat	*Nyctinomops femorosaccus*				X
Silver-haired bat	*Lasionycteris noctivagans*	X	X		
Spotted bat	*Euderma maculatum*	X			
Western big-eared bat, Townsend's big-eared bat	*Corynorhinus townsendii*		X	X	
Western mastiff bat, greater bonneted bat	*Eumops perotis*	X	X		

Common Name(s)	Scientific Name	Acoustic Survey**	Capture Survey	Roost Survey	Undetermined
Western red bat	*Lasiurus frantzii*	X	X		
Western small-footed myotis	*Myotis ciliolabrum*	X			
Western yellow bat	*Lasiurus xanthinus*	X			
Yuma myotis	*Myotis yumanensis*	X			

*"Best known observation method" indicates when targeting specific species during surveys, this method is most likely to detect the species. Other methods can be used for all species and may result in detections. Species with morphological overlap within the state are not included under "capture" as the best method for detection and species with acoustic overlap are not included under "acoustic" as the best method for detection. See "Morphologically Ambiguous Bats" below.

**There is significant overlap in call features for Nevada bat species, the Nevada Bat Working Group recommends manual vetting of acoustic bat calls by an experienced professional.

Optimal survey methods for bats in Nevada vary due to roosting and foraging habits, echolocation volume (quiet bats vs loud bats), and species morphology. There are many morphologically or acoustically ambiguous bats within the state. Morphologically ambiguous pairs may vary in identifying features across the state, especially between southern and northern Nevada.

Morphologically Ambiguous Bats of Nevada

Photos above illustrate identifying morphological features used to differentiate California myotis and small-footed myotis. The top photo illustrates the tail extending slightly farther past the uropatagium of small-footed myotis (right). The bottom photo illustrates gently sloping forehead and extended fur onto the snout of small-footed myotis (right). Contact the Nevada Bat Working Group or your local Nevada Department of Wildlife Diversity Biologist for keys differentiating all of these species. Note that differentiation is very difficult, and many researchers indicate they were unable to differentiate during trapping.

Nevada has three pairs of bats known to be morphologically ambiguous:

1. long-eared myotis and fringed myotis
2. little brown myotis and Yuma myotis
3. California myotis and small-footed myotis

Acoustically, these pairs may have less ambiguity

1. Long-eared myotis and fringed myotis in Nevada are believed to have significant overlap in acoustic call shape and frequency, voucher calls for fringed myotis should be 25khz or lower.
2. Little brown myotis has call frequencies around 40khz and Yuma myotis has call frequencies around 50khz, which allows researchers to generally differentiate between these two species acoustically (though other 40 and 50khz myotis species may have acoustic overlap).
3. California myotis has call frequencies around 50khz and small-footed myotis has call frequencies around 40khz, which allows researchers to generally differentiate between these two species acoustically (though other 40 and 50khz myotis species may have acoustic overlap).

5.1. Bat Survey Data

Bat survey data are essential to determining bat species status, population size, demographics, as well as roost and habitat use. These data are necessary components of informed conservation and management decisions. The Nevada Bat Working Group encourages biologists to contribute bat survey data to the following databases:

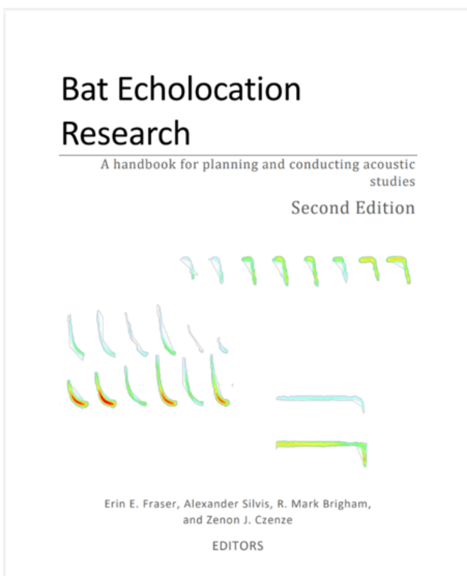
1. **Nevada Department of Wildlife Database**
   Any individual with a Scientific Collection Permit from the Nevada Department of Wildlife (NDOW) is required to provide specific details regarding species handled, captured, or salvaged in an annual report. This data is incorporated into NDOW's Wildlife Occurrences Database. Although NDOW does not require a permit for acoustic or roost surveys (unless the animals are being touched or handled), the agency will accept acoustic and roost survey submissions to improve management efforts. Data can be submitted directly to NDOW. If data for a project is already being provided to NABat, it is recommended to coordinate and add appropriate NDOW staff as project members within the NABat Portal.
2. **The Nevada Division of Natural Heritage (NDNH): Biotics Database**
   Nearly every state has a Heritage Program/Conservation Data Center for maintaining biodiversity data for the states' At-Risk plant and animal species to inform land use and conservation planning decisions. All bats in Nevada are state protected and considered special status by NDNH. All data, with the exception of bat acoustic data, should be submitted to this database in Nevada. Many projects within the state are required to submit data to NDNH, but submission is encouraged regardless of project requirements to help determine species status and state ranking.
3. **North American Bat Monitoring Program (NABat)**
   The NABat Program is a multi-agency, multi-national, long-term monitoring program designed to assess the status and trends of North American Bat species (see Section 5.6). The mission of the Program is to improve the state of conservation science for bats through standardized protocols, a unifying sample design, and integrated data analysis. The primary goal is to provide regular analyses and reporting to inform managers and policymakers so that they can manage bat populations effectively. Any bat-related data can be submitted to the NABat Program through a web portal. Using the NABat sampling design and protocols is recommended for data analysis purposes; however, any data, regardless of adherence to the NABat sampling design and protocols, can be submitted to the NABat Database. Data from the NABat database can be requested by any party. In some instances, datasets are immediately available to third-party requests, while some projects require the evaluation of requests before data are released. The NBWG highly recommends participating in the NABat Program and submitting appropriate acoustic data to this database.
4. **BatAMP**
   The BatAMP database only supports acoustic data submissions but will accept any acoustic data regardless of methodology.

5.2. Acoustic Survey


Acoustic detector set-up at Great Basin National Park - Joseph Danielson

The collection of acoustic calls to determine bat species assemblages has rapidly become the most popular method of obtaining bat survey data. With advanced ultrasonic microphones, full spectrum recorders, and automated species identification software, processing and analyzing these data has never been easier. Both active and passive acoustic data collection provide insight on species presence and habitat use, but understanding the limitations of the equipment and software is essential. Though the collection of passive acoustic calls is an excellent tool for determining bat species richness in an area, not all bats are represented equally when using this method (see Table 3).

Acoustic surveys alone require more time to detect true species richness in an area. Reporting on bat occupancy using only passive acoustic methods requires 6-8 nights of effort to obtain the most accurate species occupancy results. This has been tested across many different geographical regions and habitat types (Diaz-Frances and Soberon 2005, Moreno and Halffter 2000, Weller and Lee 2007). Mobile acoustic transects, however, provide species occupancy data for the survey route, though reaching desired species richness for the route likely requires surveys over multiple nights or seasons.



The Nevada Bat Working Group highly encourages researchers and biologists to consult *Bat Echolocation Research: A Handbook for Planning and Conducting Acoustic Studies* (Fraser et al. 2020) before conducting bat acoustic surveys. This document overviews the best practices for collecting bat acoustic data.

When analyzing acoustic calls to determine species diversity, advanced analysis and auto-ID software are excellent tools to verify species presence. The Nevada Bat Working Group encourages researchers and biologists to obtain training to appropriately use these software packages, and to manually vet acoustic bat calls to confirm species presence. In Nevada, some bat species lack the extensive acoustic call libraries necessary for identification, necessitating review by specialists. In addition, several Nevada bats are difficult to record, making the manual vetting of call files essential for the documentation of acoustically cryptic species (see Table 3).

Despite the known limitations of acoustic data, passive recording remains an excellent method for obtaining bat presence and use information. The availability of acoustic detectors has made the collection of bat survey data possible without traditional permitting for bat handling and capture.

5.3. Capture Survey


Bat capture using mist-nets near Ely, Nevada - Joseph Danielson

Capture and handling of bats in Nevada requires special permitting through the Nevada Department of Wildlife (NDOW). Permitted individuals must adhere to specific decontamination protocols to prevent the spread of WNS (see Section 6.7). The NBWG recommends individuals handling bats should have a rabies pre-exposure vaccine, rabies titers checks a minimum of every 2 years, and booster vaccinations when necessary following CDC recommendations (https://www.cdc.gov/rabies/hcp/prevention-recommendations/pre-exposure-prophylaxis.html).

Commonly-used methods for capture involve mist nets or harp traps and require trained biologists to safely handle and identify bats. Capture data provides information on the species, age, condition, sex, and reproductive status of individuals, contributing to demographic datasets. Physical handling also allows researchers to collect samples for genetic work or other testing, including hair, wing punches, or feces.

Like acoustic monitoring, physical capture has limitations. Capture surveys alone require more time and effort to encounter all species present within an area and can be dependent on habitat type and season. Some bats are difficult to capture in nets and are therefore underrepresented in capture datasets (see Table 3). Bats can detect and avoid nets and recaptures are often rare, suggesting bats learn to avoid nets in frequently trapped areas.


Setting up bat mist-nets near Ely, Nevada - Almeta Helmig

5.4. Combining Acoustic and Capture Surveys

Despite improving acoustic technology, combining survey methods is recommended to obtain more accurate species richness results (Flaquer et al. 2007, Schratz et al. 2017). Combining survey methods has been shown to increase the likelihood of obtaining true species richness while decreasing sampling effort (Tyburec et al. 2016). Acoustic methods alone may require a minimum of 6-8 nights to obtain 90% species occupancy, but combining capture and acoustic methods reduces the minimum survey effort by nearly half (3-5 consecutive nights) (Tyburec et al. 2016) because both acoustically cryptic and difficult to net species are accounted for.

Harp Trap at roost site - Janet Tyburec

Species accumulation curves provide information about survey completeness and the minimum sampling effort required to obtain a confident species richness estimate (Fraser et al. 2020). Habitat complexity and seasonal variation influence the amount of sampling effort required to obtain species richness (Moreno and Halffter 2000). Seasonal species variation, habitat complexity, and capture method should be considered when planning survey efforts aiming to obtain the most accurate species richness results.

5.5. Roost Survey

Roost surveys can provide information on the number bats using a roost site, species assemblages, and microhabitat preferences. Through roost surveys, researchers can additionally determine if bats are using a site for hibernation, rearing young, or day/night roosting. These surveys are important to consider before: closing or altering abandoned mine lands; demolishing, altering, or maintaining buildings, bridges, culverts, and associated structures; removing or trimming trees; or any other activities that may impact roosting bats (see Section 6 Conservation Strategies). Roost surveys are also the best method for determining presence of specific bat species in Nevada that are difficult to observe through acoustic or capture methods (see Table 2).

Roost surveys are often the best tool for detecting WNS while bats are hibernating (see Section 6.7). Completing internal roost surveys in caves and abandoned mines in Nevada requires coordination through NDOW. Decontamination procedures are also required when encountering or surveying a bat roost to reduce the spread of WNS (https://www.whitenosesyndrome.org/static-page/decontamination-information).

Swabbing bats for WNS - Almeta Helmig

Internal roost surveys can be limited by access, safety, and personnel training. It is not always possible to determine how many bats are using the site with internal survey methods. In these instances, a roost exit count may be more appropriate. Roost exit counts provide an estimate of bats using the site by tracking the number of bats entering and exiting the roost. This survey method does not provide opportunity to document species, use, or microhabitat preference information. Exit counts are a great tool for determining the effectiveness of artificial roosts (bat houses or hotels) or estimating the number bats within roosts which should not be disturbed (maternity roosts with pups). Combining acoustic, night vision, and capture surveys near roosts provides information on species use, sex, reproductive and health status, and an approximate number of bats using the roost.

The NABat Program has information and protocols on conducting both internal roost surveys and exit counts (https://www.nabatmonitoring.org/collect-data).

5.6. NABat

The NABat Program is a landscape-scale monitoring effort which gathers bat survey data from across North America. The NBWG recommends participating in the NABat Program. Since 2020, biologists throughout Nevada have contributed to the NABat program, focusing on stationary and mobile acoustic surveys. Contributing data to nation-wide survey efforts is essential to obtaining information about bat use across administrative boundaries. NABat protocols were designed so surveys could be completed by novice biologists, bat enthusiasts, or citizen scientists. The NABat Program has created protocols and datasheets in addition to a web portal where data can be uploaded and displayed. The sampling design includes priority areas within all land ownership types. Both private and public lands in Nevada are considered priority areas for data collection.

NABat Supported Survey Methods

- **Stationary Acoustic Surveys**
- **Mobile Acoustic Surveys**
- **Internal Roost Counts**
- **External Roost Counts**
- **Bat Capture**

Setting up an acoustic detector for NABat sampling - Almeta Helmig

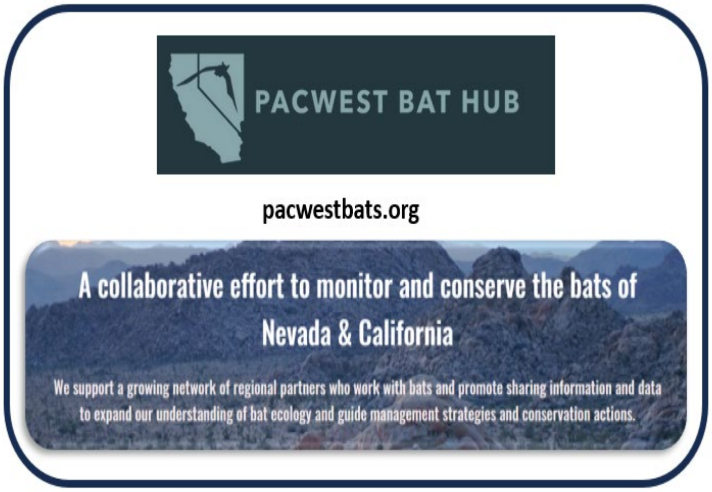
The listed methods have associated protocols, datasheets, and data portals for project partners on the NABat website.

The NABat protocols are not appropriate for all sampling efforts in Nevada. Though, when overlap occurs, data should be submitted to this program.

Acoustic detector setup for NABat on playa near Pyramid Lake, Nevada - Kaylie Wilmot

NABat sample design is based on a the spatially balanced randomization of 10 x 10 km (6 x 6 mi) survey cells covering North America, which allows for statistically robust analysis at the continental scale. Cells are ranked within the sampling schema, and higher ranked cells should be prioritized for sampling when possible.

Despite being an excellent protocol for a continent-wide dataset, NABat does not necessarily provide the rigorous data required for other projects. NABat protocols represent the recommended minimum for data collection. More extensive or rigorous data collection procedures exceeding the minimum set by the NABat protocols can be used to meet both project needs and the data standardization goals outlined by the NABat Program.



The PacWest Bat Hub supports a network of regional partners in Nevada and California and promotes sharing information and data to expand the understanding of bat ecology and guide management strategies and conservation actions at the regional level. This support includes a website with links to resources within the broader bat community, services like a lending library of bat detectors, community meetings and forums, trainings, support for project development, and opportunities for people within the community to connect and collaborate.

5.7. Telemetry

Telemetry relies on battery powered radio transmitters which are affixed to bats and subsequently followed using antennas and receivers to track individual movements. Telemetry can also be used to search for roosts. This survey method can be labor intensive, particularly when triangulation is required to fulfill objectives, but automated telemetry stations can also be installed to assist with tracking (see Section 5.8 Motus). Bat telemetry can be challenging; bats travel easily over rough terrain and the material of roosts sometimes blocks radio signal. Even so, radio telemetry is an effective method to find maternity and hibernation roosts, as well as day and night roosts for solitary bats.

5.8. Motus

The Motus Wildlife Tracking System is a collaborative research network supported by Birds Canada (https://motus.org/about/) which allows researchers connect to cooperative, stationary automated radio telemetry stations to track tagged animals. After a radio transmitter is placed on a bat, the Motus station can pick up the transmission signal from up to 20 km (12 mi) away. Motus tracking tags may be

Mexican free-tailed bat with motus tag - Almeta Helmig limited by battery life. While stationary automated telemetry does not require connection to the Motus system, collaborative efforts allow tracking information to be collected at a broader scale. This system provides landscape-scale movement data for resident or migratory bats which can be used to make informed management and conservation decisions. There are few Motus towers currently installed in Nevada, but more are being currently being considered for installation.

5.9. PIT-Tagging

Passive integrated transponders (PIT tags) are a useful tool for monitoring movements of individual bats and monitoring colony health at roost sites. It is an effective way to conduct capture-mark-recapture studies, and because the PIT tag does not rely on a battery, it lasts for the life of the bat. Handheld PIT tag readers can be used when trapping bats on the landscape, but when paired with an automated PIT tag reader and antenna system, bats do not need to be recaptured and are recorded each time they pass the antenna at a fixed point. This may be useful for determining daily timing of emergence and return, or arrival and departure date at migratory, maternity, or hibernation roosts. Extensive pit-tagging efforts have been made in eastern Nevada to monitor occupancy and movement of western big-eared bats between roosts to provide insight into roost connectivity.

Lehman Caves

Historically, western big-eared bats (*Corynorhinus townsendii*) were regularly seen in Lehman Caves. But in 1959 the cave entrance was sealed shut, excluding bats from the cave (left). Lehman Caves remained closed for 40 years until 1998, when a bat compatible gate was installed over the natural entrance (right). By 2014, western big eared bats had rediscovered the cave entrance. Today, about 50 mothers each raise a pup in Lehman caves each year. The return of bats to Lehman Caves shows the resilience of bats and the effectiveness of active conservation. The cave entrance now has a bat friendly cupola installed along with a pit tag reader to track the tagged bats entering and exiting here.

Photos of Lehman Caves entrance after being sealed shut in 1959 (left- unknown photographer) and western big-eared bats (*Corynorhius townsedii*) that have rediscovered the cave entrance (center - Bryan Hamilton) after a bat compatible gate was installed in 1998 (right - Bryan Hamilton).

6. CONSERVATION STRATEGIES

The Conservation Strategies below are intended to provide guidance for biologists, land managers, and bat enthusiasts to protect Nevada bats and their habitats. Background information and conservation recommendations can be used to identify gaps in knowledge, inform project planning activities, manage bat populations and habitats, or mitigate common threats to bats. Conservation Strategies are supported by scientific research, peer-reviewed literature, and conservation plans developed for other states. When possible, existing BMPs are referenced and cited.

Each Conservation Strategy contains an Introduction, Goal, Objectives, Management Recommendations, and Research Needs. Where appropriate, Survey Recommendations are also included.

Introduction: A summary of the topic and literature supporting the conservation strategy.

Goal: A broad objective developed to reduce impacts to bats.

Objectives: A detailed breakdown, in order of importance, of specific objectives which can be used to meet the Goal.

Management Recommendations: Specific actions, supported by literature, BMPs, and other bat conservation plans, which can be taken to accomplish the Objectives.

Survey Recommendations: Best methodologies to generate the data required to address the Objectives and Management Recommendations. Survey Recommendations are only provided where topic specific methodologies exist.

Research Needs: Information required to fill data gaps for bat conservation.

6.1. Natural Habitat

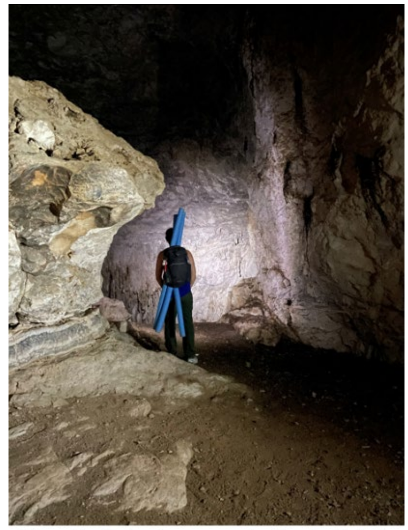
6.1.1. Caves, Rock Crevices, and Talus Slopes

Many bat species in Nevada utilize caves, crevices, and talus slopes for roosting. Variability in caves size and structure provides large roosting sites with multiple microclimates for bats, while rock crevices and talus slopes often provide more individual roosting sites, though any of these habitat types can support populations of bats that roost solitarily or as groups. These sites may be occupied year-round as day/night roosts or seasonally as maternity colonies or hibernaculum. They may also be periodically occupied, with gaps in use between years or seasons.

Myotis roosting in crevice - Kristin Szabo

Caves provide protection from predators, a thermally regulated environment, and shelter from inclement weather (Furey and Racey 2016). Caves have been documented as swarming locations, providing space for this social or reproductive activity. Little is known about hibernation in Nevada, as few hibernacula have been documented. More roost locations need to be found to determined how caves, crevices, and talus are being utilized by bats, but locating these roost sites is notoriously difficult due to the ease with which bats navigate the landscape and the impact of rock on signal transmission.

In Nevada, abandoned mines create artificial cave-like habitat for bats. These sites are often used by roosting bats in the same way caves are used (see Section 6.6). Rock crevices provide ideal roosting habitat for many bat species, including those known to roost solitarily or in large colonies. Because rock crevices vary in temperature, height, and sizes, bats can select their desired roost conditions (Lausen and Barclay 2003). Many bats have been documented using rock crevices to optimize their reproductive strategy by maximizing energy reserves through thermoregulation (Chruszcz and Barclay 2002). Big brown bats have been documented in multiple studies using rock crevices as maternity roosts (Lausen and Barclay 2003, Lausen and Barclay 2006a, Neubaum et al. 2006). Pallid, big brown bats, and long-eared myotis have both been documented using rock crevice roosts of varied sizes and temperatures during different reproductive stages (Lausen and Barclay 2003). Big brown bats also use rock crevice roosts at high elevation for hibernation (Neubaum et al. 2006).



Observing bats at cave roost - Almeta Helmig

Swarming

Bats exiting an abandoned mine roost – Joey Danielson

What is swarming?
An intense flight display, where bats circle around the entrance to a roost site throughout the night [1]

When does swarming occur?
A behavior bats are known to exhibit between August and October, with peak swarming times 1-2 months prior to entering hibernation[1,2,3]

Why do bats swarm?
To facilitate mating and gene flow between bats otherwise isolated in summer colonies, to determine the suitability of hibernaculum, and communicate hibernaculum location information to other bats[1,4,5,6,7,8,9,10]

Where are swarming sites in Nevada?
Specific swarming sites have not been identified in Nevada but are likely to be found at hibernation sites for *Myotis* species, especially little brown myotis, and big brown bats.

Why are swarming sites important?
Swarming sites are an important to bat mating systems and for locating suitable hibernacula. Locating and protecting swarming sites in Nevada is a high research priority.

References: 1. Fenton 1969, 2. Parsons et al 2003, 3. Horacek and Zima 1978, 4. Kerth et al 2003, 5. Rivers et al 2005, 6. Furmankiewicz and Altringham 2007, 7. Hall and Brenner 1968, 8. Veith et al 2004, 9. Humphrey and Cope 1976, 10. Jaap van Schaik et al. 2015

GOAL

Maintain and protect bat roosts at caves, rock crevices and talus slopes

OBJECTIVE 1: Understand bat use caves, crevices, and talus slopes and locate important roosting areas.

OBJECTIVE 2: Reduce impacts to caves and crevices utilized by bats by practicing cave management and protecting nearby habitat.

OBJECTIVE 3: Educate the public about potential impacts to bat habitat and public safety concerns

MANAGEMENT RECOMMENDATIONS

- Locate cave, talus, and crevice roosts supporting bat populations; and identify season, level, and type of use by bats. Require any bat roost observations to be recorded at https://www.pacwestbats.org/nbwg (see Section 5. Bat Surveys).
- Monitor populations of bats roosting in caves, talus, or crevices.
- Protect foraging and drinking areas associated with cave, talus, and crevice roosts.
- Promote seasonal closures of maternity roosts, hibernacula sites, or other vulnerable sites to protect them from visitation and disturbance. Permanently close roosting sites when no other option is available.
- When permanent closure is required to protect habitat, avoid vandalism, or protect other resources, utilize bat compatible closures (Section 6.6 Historical and Renewed Mining), road closures, or trail closures to limit access.
- Regularly monitor functionality and effectiveness of bat compatible closures, making changes or improvements to closures when necessary.
- Require land managers to use guidelines that maintain critical cave resources for bats.
- Engage recreational communities to educate them on the importance and protection of bat habitat. Gain knowledge of bat observations from these communities.
- Educate the public about WNS and its danger to bat populations to insure WNS decontamination protocol is used, reducing the spread of WNS (Section 6.7).
- Install educational warning signs and seasonal closure information at recreational areas used by bats (caves, climbing areas, trails, etc.).
- Prohibit altering natural drainage resulting in the flooding and dewatering of cave habitats (Section 6.5 Mining and Mineral Exploration and 6.6 Historical and Renewed Mining).
- Minimize disturbance in talus slope areas where roosting bats may be present.
- Map known cave systems to preserve their integrity.
- Use buffer zones to protect the surface area, and reduce noise and artificial lighting around known cave, crevice, and talus roosting sites when there are potential impacts to the area.

SURVEY RECOMMENDATIONS

- Require multiple surveys during different seasons of use.

- Use a combination of survey techniques (Section 5. Bat Surveys) including capture, acoustics, exit counts, and internal roost surveys to determine species presence and type of use.
- Ensure all surveys adhere to the most recent WNS decontamination protocol.

RESEARCH NEEDS

- Determine appropriate safe buffer zones around caves, talus, and crevice roosts.
- Inventory and document cave sites throughout Nevada.
- Monitor for WNS presence in caves that are known bat hibernacula.
- Determine optimal roost conditions and factors important for bats.
- Research fidelity to roosting sites.
- Determine effectiveness of bat compatible closures using pre-installation and post-installation surveys.
- Document and monitor roosting sites using the "Report a Bat Roost" form (https://www.pacwestbats.org/nbwg).

6.1.2. Forest and Woodlands

Forests and woodlands provide valuable roosting and foraging habitat for Nevada bat species. Within forests and woodlands, bats may roost in foliage, under bark, inside cavities within live or dead trees (Taylor et al. 2020), and in leaf litter (Flinn et al. 2021). Some bats are associated with specific trees, such as the yellow bat, which roost primarily in palm tree groves in southern Nevada (O'Farrell et al. 2004). While tree-roosting bats require forests and woodlands to roost and hibernate, many bats utilize wooded areas for cover, foraging, or as navigation corridors or flyways.

Pinyon Juniper woodland near Ely, Nevada – Kristin Szabo

Forests and woodland types in Nevada include aspen, cottonwood (see Section 6.1.4 Riparian and Wetland), pinyon-juniper, bristlecone, mesquite bosque, ponderosa pine, spruce-fir, mountain mahogany, and many more. Some forest types in Nevada are associated exclusively with higher elevation sites. Though bats are highly mobile, climate change is shifting these habitats upward, and highest elevation habitats such as ponderosa or bristlecone woodlands may be lost (see Section 6.3.3 Climate

Change). These forests face unique threats in the form of insects, disease, recreational use, fragmentation, and wildfire (see Section 6.3.4 Fire and Fuels Reduction).


Road flyway through aspen woodland habitat near Elko, Nevada - Almeta Helmig

Forest management practices like prescribed burns, chaining, or thinning may negatively impact bats by destroying roosts, disrupting hibernation or maternity colonies, or directly causing mortality (Perry and McDaniel 2015). However, these treatments also benefit bats by opening flight paths, reducing understory clutter, and increasing insect populations (Taylor et al. 2020). A diverse mosaic of different forest types in varied successional stages should result in the greatest bat use and diversity. To avoid negative impacts, bat seasonality and use should be factored into the timing and location of forest management practices, especially avoiding harvest or thinning during maternity season or pre-volancy (Borkin et al. 2011).

Though timber harvest is an uncommon public land use within Nevada, bats should be considered before removing large live or dead trees. In Nevada trees are often removed during fire and fuels reduction projects (Section 6.3.4 Fire and Fuels Reduction). When possible, standing dead trees should be left on the landscape, as the removal of snags reduces roost abundance and diversity within a forest (Lindenmayer and Noss 2006). Older age class trees are important habitats for bats providing sloughing bark, cracks, crevices, and cavities for roosting (Vonhof 1996, Fisher and Wilkinson 2005, Hayes and Loeb 2007). They may also support diverse and abundant insect populations (Fuentes-Montemayor et al. 2013).


Mesquite bosque near Las Vegas, Nevada - Matt Flores

In Nevada, tree age is not always closely associated with size, so common methods of determining 'old-growth' stands or 'high value' individuals may not apply when identifying priority areas for conservation. Conservation and restoration needs may vary by specific project or species goals. For example, in some areas, concern about the loss of aspen forests may necessitate the artificial cessation of successional encroachment by spruce-fir woodlands. Healthy forests will look different depending on the woodland type. Appropriate canopy cover, stand density, understory composition, and species diversity will vary, but generally, trees in good physical condition, free from infestation, disease, and damage from ungulates or browse, are ideal for bats.

GOAL

Protect forest and woodland habitats for foraging and roosting

OBJECTIVE 1: Maintain and protect roosts in snags and trees.

OBJECTIVE 2: Maintain healthy forests and woodlands (see Sections 6.3.5 Insects and Tree Disease and 6.3.4 Fire and Fuels Reduction).

OBJECTIVE 3: Maintain healthy woodlands associated with riparian areas (see Section 6.1.4 Riparian and Wetland).

MANAGEMENT RECOMMENDATIONS

- Factor forest health and bat use into forest management, grazing practices, recreation, and resource management (include in USFS and BLM Resource Management Plans).
- Continue long-term forest monitoring programs to ensure forest health (e.g. USFS Forest Inventory and Analysis Program).
- Avoid forest fragmentation when possible.
- Maintain healthy understory of coniferous forests.
- Promote healthy riparian woodlands and aspen forests for tree and cavity roosting bats.
- Consider bat ecology for timing of forest management practices to avoid impacts to hibernation or maternity roost sites (see Section 6.3.4 Fire and Fuels Reduction).
- Incorporate known methodologies to identify and maintain appropriate snag densities and types within forested areas for bat use.

RESEARCH NEEDS

- Determine insect abundance and diversity in different forest types, at different seral stages, or under different management practices.
- Investigate bat use of bristlecone/whitebark pine/other protected trees.
- Investigate bat use (e.g. foraging), diversity, and abundance in forests at various seral stages in Nevada.

6.1.3. Open Water

Bats require open, slow moving, or still water for drinking. Open water includes natural and artificially created water sources with exposed surface area for drinking. Artificial open water sources like tanks, troughs, guzzlers, and reservoirs, designed to provide water for wildlife and livestock, benefit bats most when they are maintained as a perennial water source. The scope and intensity of this benefit scales with the features of the resource. Wide, clean pools with limited obstructions have greater value for a wider variety of bat species than small, deep-set, or covered sources (Taylor and Tuttle 2012). Metal support braces or fences, used prevent cattle damage to stock tanks, may be necessary to protect the longevity of artificial water sources under heavy animal use, but they also force bats to attempt a greater number of passes to drink (Tuttle et al. 2006).

Even when bats are unable to drink at water sources, these areas may attract insects and provide important foraging habitat. Razgour et al. (2010) found that bat species richness and activity significantly increased with pond size, and that manipulations decreasing pond size reduced bat species richness and activity. Access to artificial open water is likely most important during the hottest months of the year, when natural ephemeral sources dry out and bats have increased water demands for reproduction.

Setting up mist nets over a cattle tank near Las Vegas, Nevada - Kristin Szabo

Irrigation ditches and leach ponds can provide water access for bats but may pose a safety risk to drinking and foraging individuals (see Section 6.5.2 Environmental Waste). Swimming pools also provide habitat for bats to drink and forage (McGee et al. 2023, Nystrom and Bennett 2019), though different pool characteristics attract bats to varying degrees (Bennett and Apalgo 2022). Public education is critical to ensure interactions between humans and bats, or livestock and bats, remain peaceful. Land and livestock owners may fear bats themselves or associated disease (see Section 2.5 Public Health).

Setting up bat mist-nets near Ely, Nevada - Almeta Helmig

Reservoirs may attract bats in numbers, but Hintze et al. (2016) found rare and endangered bats were detected more often in intact stream habitat than in areas with artificial pooling. Natural stream habitat, without human alterations, will generally consist of areas with high and low flow. Areas with low flow provide drinking habitat, while the stream system and associated riparian vegetation provides foraging habitat (see Section 6.1.4 Riparian and Wetland). Natural, perennial spring pools also provide excellent drinking and foraging habitat for bats.

Some natural open water features, like alpine lakes and tinajas, lack associated riparian habitat but are still valuable water resources for bats. Rabe and Rosenstock (2005) captured bats more frequently, and a greater number of species, at tinajas (e.g. rock tanks) as opposed to nearby wildlife guzzlers.

Providing or maintaining safe drinking water at these open sources, whether natural or artificially created, will support bats. In general, land managers should always prioritize the protection of existing natural water sources over artificial supplementation. However, if natural water sources disappear, it may be necessary to supplement with artificial sources (see Section 6.3.3 Climate Change).

Mist nets at ponded spring near Elko, Nevada - Mike Swink

GOAL

Promote sustainable bat use of natural and artificially created water sources

OBJECTIVE 1: Maintain and protect existing natural and artificial water sources on landscape to ensure bat access.

OBJECTIVE 2: Consider bat impacts when designing and installing artificial water sources.

OBJECTIVE 3: Preclude bats from unsafe artificial water sources.

MANAGEMENT RECOMMENDATIONS

- Protect alpine lakes and desert tinajas.
- Limit over-water structures in tanks and troughs when possible.
- Install wildlife escape ramps in artificial water sources (troughs, swimming pools, fountains, etc.).
- Avoid sudden removal of open water sources, especially during the maternity season or migration periods.
- Maintain clean, algae-free, open water.
- Educate the public about the ecosystem services bats provide to facilitate bat use of artificial water sources on private land.
- Inform the public about human-bat interactions or livestock-bat interactions and common misconceptions.

- Limit access to artificial water sources containing harmful contaminants (see Section 6.5.2 Environmental Waste).
- Prevent access to artificial water sources that may harm or entrap bats or install wildlife escape ramps.

RESEARCH NEEDS

- Determine primary season of bat use at artificial water sources.
- Determine if bats ignore new artificial water sources in favor of long-standing surface water.
- Identify which species use artificial water sources and for what purpose.
- Determine bat use of swimming pools and potential impacts to bat health.

6.1.4. Riparian and Wetland

Nevada is the driest state in the nation, which makes the existing wetland and riparian habitat essential for drinking and foraging bats. Riparian habitat is the transitional zone between aquatic and terrestrial habitat. Wetland habitat may have water covering the soil surface or near the soil surface either seasonally or perennially. Riparian and wetland areas support vegetation dependent on hydric soils to thrive and are typically associated with springs, seeps, ponds, streams, lakes and other natural or artificial water sources.

Setting up mist nets in a riparian flyway near Wildhorse, Nevada - Jessica Brooks

This habitat is less likely to be associated with artificial open water created by tanks, troughs, and reservoirs (see Section 6.1.3 Open Water). Natural, open water sources with associated wetland or riparian habitat are known to support more bat diversity than open water areas without these associated features (Razgour et al. 2010, Hintze et al. 2016). Nevada is believed to have over 20,000 perennial springs that provide water for drinking, habitat for foraging, and in some cases trees for roosting. Fine-scale riparian habitat characteristics may influence bat activity more than broad, landscape-scale features (Ober and Hayes 2008a). Riparian and wetland areas fulfill a wide variety of needs for a broad range of species, including water access, foraging opportunities, cover from predators, and trees for roosting.

Many Nevada bat species show a preference for riparian woodlands, and activity is often higher in riparian woodland than adjacent habitats (Williams et al. 2006, Rogers et al. 2006). This is likely due to the presence of appropriate roosting trees or snags. Common riparian woodland trees in Nevada include


Mary's River riparian habitat supporting herbaceous and woody vegetation near Wells, Nevada - Kristin Szabo

aspen, cottonwood, willow, and mesquite. Riparian and wetland areas without woody vegetation may not offer the same commuting features and roosting benefits, but still act as important drinking and foraging habitat. The size and accessibility of open pools likely influences bat species richness at pools, as larger or less mobile bats require a larger surface area to successfully drink (Taylor and Tuttle 2012). Razgour et al. (2010) found species richness and activity significantly increased with pond size, and that manipulations decreasing pond size reduced species richness and activity. When springs or seeps are manipulated, designs with smaller surface areas of exposed water benefit from reduced evaporative water loss but are used by a smaller suite of bat species (Rabe and Rosenstock 2005).

Light pollution has been shown to reduce feeding activity and alter foraging timing in bats (Hooker et al. 2022; see Section 6.3.2 Artificial Light). Sources of artificial light should be removed or limited in riparian corridors or at wetland sites whenever possible. If long-standing natural wetlands, springs, or streams dry


Setting up mist nets in riparian habitat near Austin, Nevada – Kristin Szabo

due to drought or dewatering, bat-friendly alternative water sources should be created, especially near maternity colonies, though natural sources have been shown to attract a greater diversity of species in arid environments (Davie et al. 2012, Laverty and Berger 2020). Failure to respond to water loss within perennial riparian areas may cause declines in both insect and bat activity, as seen in Arizona (Hagen and Sabo 2012).

Prioritizing conservation and restoration of existing riparian areas and promoting healthy management practices by public and private landowners is essential for bat conservation. Polluted waters may poison bats directly or via bioaccumulation (see Section 6.5.2 Environmental Waste). Invasive plant species can crowd open water or draw excessively from the aquifer, reducing available surface water and riparian plant diversity, which then impacts insect abundance and diversity. Overgrazing can denude riparian and wetland vegetation, alter water quality, introduce invasive species, and create pools unsuitable for drinking. Degraded natural water sources should be restored and monitored, prioritizing areas where water availability is limited.

GOAL

Maintain, protect, and enhance riparian areas and wetland habitats for bat use

OBJECTIVE 1: Promote healthy riparian and wetland areas through land management and restoration practices.

OBJECTIVE 2: Maintain riparian woodlands to preserve roosting habitat.

OBJECTIVE 3: Prioritize maintenance and enhancement of natural open water sources for drinking.

MANAGEMENT RECOMMENDATIONS

- Provide landowners with updated BMPs for maintaining and enhancing riparian and wetland systems in areas with livestock grazing.
- Factor wetland and riparian health into grazing management, recreation practices, and land use planning.
- Prevent and eradicate invasive species which reduce water availability and degrade riparian/wetland habitat.
- Protect, maintain, and restore springs, seeps, and wetlands for drinking and foraging habitat.
- Prioritize preservation and restoration of riparian woodland complexes, including snag trees when possible.
- If perennial water sources subside or are removed or obstructed, provide alternate water access.
- Avoid or reduce light pollution around water sources to accommodate foraging (see Section 6.3.2 Artificial Light at Night).
- Maintain healthy water free of pollutants (see Section 6.5.2 Environmental Waste).

SURVEY RECOMMENDATIONS

- Monitor isolated riparian areas/wetlands to determine bat use and prioritize monitoring before and after projects to improve habitat.
- Avoid placing acoustic microphones directly over open water sources.
- Prioritize riparian/wetland areas for capture and acoustic surveys to obtain species richness information.

RESEARCH NEEDS

- Investigate bat use of springs and seeps where water does not form large pools.
- Determine bat use of ephemeral/seasonal water sources.
- Identify difference in use between lentic and lotic systems.
- Determine if the creation of large open-water reservoirs negatively impacts bats.

- Investigate bat use of thermal springs.

6.1.5. Shrubland

Shrublands are the dominant vegetation type in Nevada, covering a wide elevational, climatic, and latitudinal gradient across multiple land management agencies, land uses, and jurisdictions. Major shrubland types include creosote bush (southern third of state, Mojave Desert), blackbrush (transitional between Mojave and Great Basin deserts), salt desert (valley bottoms), sagebrush steppe (several species covering most of Nevada, middle to high elevation), mountain brush (mid elevation between pinyon-juniper woodlands and aspen-conifer forest), and alpine shrublands (high elevation).


Shrubland habitat near Wendover, Nevada - Almeta Helmig

Although shrublands are common throughout the state, little information is available concerning bat use in these habitats. Essential habitat features such as roosts (e.g. abandoned mines, buildings) and water sources are prevalent in shrublands, and many studies have documented bat activity at these features, but it is most likely these features that attract bats to these areas rather than the shrubland habitat. Most shrublands occur in wide open areas with little vertical structure and do not provide good roosting habitat. Conversely, shrublands that are surrounded by forest or woodlands provide good edge habitat that some bat species prefer. Shrublands may offer bats foraging opportunities tied to insect production and availability that varies considerably based on plant phenology, season, temperature, and climate among other factors (e.g. ephemerally inundated greasewood flats with large insect hatches, fall blooms of rabbitbrush with abundant moth production).


Setting up mist nets in shrubland habitat near Elko, Nevada - Almeta Helmig

Radiotelemetry studies provide the best methods to determine how bats are using the landscape. While some information has been obtained from previous radiotelemetry and light tagging studies, more studies are needed on a wide variety of bat species in shrubland habitats to better understand how bats use different shrublands. Currently, the best management approach is to maintain existing healthy shrublands or restore degraded shrublands to provide a diverse shrub community with a strong native perennial forb and grass understory to maximize insect production, especially around potential or known important roosts and water sources. Although bats are known to fly long distances from roost sites to forage, minimizing commuting distances through healthy shrublands can be energetically beneficial, especially to already energy-depleted lactating females.


Mojave Desert shrubland in southern Nevada - Derek Hall

The biggest threat to shrublands in Nevada is conversion to annual grasslands (e.g. cheatgrass, red brome, Arabian schismus), primarily from wildfires. Sagebrush and blackbrush communities seem to be impacted the most (see Section 6.3.4 Fire and Fuels Reduction). Not much is known about how bats use annual grasslands. One study (2019 Mojave Bat Blitz) found several species of bats using water sources within and adjacent to burned creosote bush and blackbrush habitat that had largely converted to an annual grassland comprised of red brome and cheatgrass with scattered shrubs that had resprouted (Klinger 2020). It is unknown if bats were using the area only because of the water or if they were actively foraging in the burned area. More work needs to be done to determine how bats use these annual grasslands and shrublands in general.

GOAL

Maintain or restore shrublands to provide foraging habitat for bats

OBJECTIVE 1: Preserve healthy shrubland habitat to provide foraging opportunities for bats.
OBJECTIVE 2: Prioritize maintenance of healthy shrublands around known or potential roost sites.
OBJECTIVE 3: Maintain healthy shrublands associated with riparian areas (see Section 6.1.4 Riparian and Wetland).

MANAGEMENT RECOMMENDATIONS

- Continue long-term shrubland monitoring programs to ensure shrubland health (e.g. Assessment Inventory and Monitoring Program).
- Avoid conversion of shrubland habitat to annual grasslands or pinyon-juniper woodlands.
- Factor shrubland health and bat use into shrubland management, grazing practices, recreation, and resource management (include into USFS and BLM Resource Management Plans).
- Maintain diverse assemblage of native grasses and forbs within shrubland interspaces.

- Maintain seasonal flooding of ephemerally inundated shrublands (e.g. greasewood flats, salt desert shrubs on playa edges, etc.).
- Consider bat ecology for timing of shrubland management practices to avoid impacts to hibernation or maternity roost sites (see Section 6.3.4 Fire and Fuels Reduction).
- Consider State and Transition Models and Natural Resources Conservation Service, Ecological Site Descriptions when developing restoration plans for degraded shrublands.
- Prioritize conservation of shrubland areas adjacent to wetlands, springs, and other wetted or riparian areas.

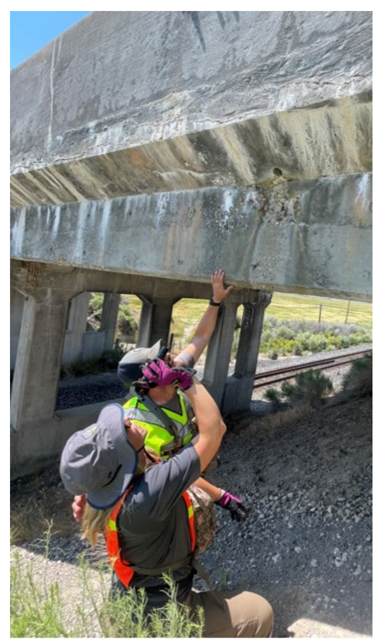
RESEARCH NEEDS

- Investigate seasonal bloom periods in shrublands and associate with bat use of related insect booms (e.g. rabbitbrush blooms in the fall associated with moths).
- Research bat use of shrublands that have been converted to invasive grasslands.
- Determine effects of vegetation management of shrublands on insect populations and bat use.
- Research bat use of shrublands and determine the importance of different shrubland communities to bats, including unique shrublands (e.g. blackbrush and alpine sagebrush communities).

6.2. Urban Habitat

6.2.1. Bridges and Transportation Structures

Transportation structures such as bridges, culverts, and drainage features (e.g. rip-rap) provide habitat for roosting bats. Bats have been documented using these features for day, night, and maternity roosting in structures made of concrete, wood, and steel (Hendricks et al. 2005). These manmade roosting sites become more important when natural roosting areas are no longer available due to habitat loss and degradation. Transportation structures can provide stable, temperature-regulated man-made roost sites. Bridges and culverts are also often adjacent to foraging and drinking habitat, creating an excellent location for rearing young. Bats have been documented roosting under bridges, in drainage pipes, bolt cavities, openings created by concrete spall, creases between concrete, swallow nests, pipe collars, behind insulation boards, between beams and deck, and behind timber guardrails to name a few locations (White-nose Syndrome Conservation and Recovery Working Group 2018). One study in Montana found bats using 75.9% of concrete structures, 37.5% of steel structures, and 31.6% of wooden structures throughout the state (Hendricks et al. 2005). Despite a common misconception that bats will not roost in a culvert at or near ground level, culverts provide roosting habitats for bat regardless of height. One report from New Mexico found western big-eared bats in



Bat roosting in weep hole near Wells, Nevada - Almeta Helmig

77% of occupied culverts. Culverts 1-4 m (3-13 ft) above ground or water have been found to serve as roosts for many bat species (Hendricks et al. 2005) found in Nevada.

Bats are also known to roost in mud nests built by swallows, often on transportation structures including bridges and culverts. Even when transportation structures don't inherently provide structural features associated with bat use, these mud-built bird nests provide roosting habitat. Bats have been documented using swallow nests for day, night, maternity, and hibernation roosts.

Maintenance on transportation structures may threaten roosting bat populations through noise, vibrational or light disturbance, if the roost is exposed by the removal of material, if materials such as water, tar, or gravel are inserted into the roost, or if swallow nests are removed from the structure. Misconceptions about bat roosting preferences in bridges and other transportation structures may result in the dismissal of survey requirements causing unintentional roost loss or bat mortality from maintenance activities. Even with no visible sign of roosting bats, bats may still reside within transportation structures both within and outside of the anticipated season of use. Bridge and culvert structures may still be inhabited even if characteristic features of a bat roost are not present. For example, busy roadways or noisy areas do not always deter bat roosting (Conservation and Recovery Working Group 2018). Many sources recommend prioritizing maintenance to transportation structures between November 1 and February 1 to minimize potential impacts to bats, though bats may be present during this timeframe and clearance surveys are recommended (Keeley and Tuttle 1999).

Surveying swallow nests on bridges for roosting bats near Wells, Nevada - Almeta Helmig

At least 20 of the 23 Nevada bat species have been documented roosting in transportation structures (White-nose Syndrome Conservation and Recovery Working Group 2018, Wetzel and Roby 2023). Examples of significant bridge roosts that have been documented include maternity colonies of approximately 300 little brown myotis in Idaho, colonies of more than 1.5 million Mexican free-tailed bats in Texas, and big brown bat colonies (Keeley and Tuttle 1999) throughout North America. McCarran Bridge in Reno, NV has roost counts averaging 25,000-30,000 Mexican free-tailed bats each summer over the last 10 years (typically late summer; Jenni Jeffers, personal communication, September 2024). Bridges, culverts, and other transportation structures play an essential role in providing habitat to maintain and stabilize bat populations (Keeley and Tuttle 1999). Because these structures are nationally recognized to provide essential bat habitat across North America, the Association of Fish and Wildlife Agencies released a statement (Resolution 2023-05-07) encouraging wildlife departments to work with transportation departments to ensure conservation of bats and their habitats while limiting construction delays and standardizing survey protocol to coincide with required bird surveys.

To prevent impacts to bat populations while maintaining or deconstructing transportation structures, recommended actions include 1. Survey/Inspection; 2. Minimize/Avoid/Exclude; and 3. Mitigation. Inspection of transportation structure sites is essential. Many states have established survey protocols and required trainings, especially in areas where bat species known to roost in transportation structures are listed under the Endangered Species Act. Protocols may include a visual survey of the site to document sign of use, use of mist nets and harp traps to capture bats exiting the roost to determine species, acoustic surveys to aid in species identification, and emergence counts to estimate the size/extent of the roost. Although Nevada does not currently have an established protocol for such surveys (as of May 2024), efforts are underway to develop a protocol and assess bat use of transportation structures as a collaboration with Nevada Department of Transportation (NDOT), NDOW, NDNH, and others.

Once surveys are completed, strategies for minimizing impacts by avoiding or excluding bats during maintenance or construction activities can be developed. Avoidance may include conducting a follow-up surveys at the transportation structure to determine where and how bats are using the site, conducting clearance surveys immediately prior to a scheduled activity regardless of anticipated season of use, planning to conduct maintenance between November 1 and February 1, and/or timing maintenance activities for seasons when bats are not expected to be using the structure. Bat exclusion allows bats to exit a roosting site, while blocking re-entry, preventing immediate impacts from maintenance activities.

Surveying bridges for roosting bats near Wells, NV - Almeta Helmig

Mitigation should occur when impacts cannot be avoided and may include habitat preservation, enhancement, restoration, or creation. Habitat creation may include building bat boxes on the bridge or nearby as alternative roost sites, or the development of bat-friendly transportation structures. Creating and maintaining bat-friendly bridges is a common practice in other states, as they provide intentional bat roosting habitat, easy ways to monitor the roost, and provide ways to minimize impacts from maintenance activities on roosting bat populations. These bridges or add-on structures are created to reduce the potential for roost loss, harm to bats during maintenance activities, and reduce unwanted human-bat interactions. Bat-friendly bridges are especially critical for the protection of maternity roost sites and can be put in place when an upgrade to the structure is needed. Both constructing new bat-friendly bridges and retrofitting existing bridges with add-on structures provide an opportunity to create safe roosting habitat for bats in a designated area while allowing maintenance to occur without potential harm to the roost.

GOAL

Manage bat populations within transportation structures and reduce potential for bat harm, harassment, or fatalities

OBJECTIVE 1: Identify transportation structures with roosting bat populations.
OBJECTIVE 2: Maintain bat roosting habitat associated with transportation structures.
OBJECTIVE 3: Promote use of bat-friendly construction and maintenance practices.

MANAGEMENT RECOMMENDATIONS

- Promote bat use of appropriate transportation structures; however, if not possible, implement proper exclusion methodologies.
- Locate significant bat colonies for conservation.
- Promote use of bat-friendly bridge designs to reduce impacts to bats when maintenance occurs.
- When possible, retrofit existing bridges with bat-friendly designs to create bat habitat without creating additional restrictions for maintenance activities.
- Conduct bat surveys at transportation structures and associated roosting features (e.g. swallow nests) before maintenance, construction, or deconstruction.
- Maintain, construct, or deconstruct transportation sites when bats are not present.
- Avoid any work on transportation structures during maternity season or hibernation if surveys are not possible.

SURVEY RECOMMENDATIONS

- Work with appropriate agencies (NDOT, Railroad, BLM, USFS, County, etc.) to obtain appropriate permits to conduct surveys in or around bridges or other transportation structures.
- When using acoustic detectors or roost loggers at bridges for survey purposes, clearly mark units with contact information and survey name to prevent the public from mistaking the units for dangerous materials.
- Ensure survey protocols align with the rapidly-developing guidance from the USFWS and other bat working groups and consider the use of various tools for surveys, such as borescopes, thermal cameras, acoustic recorders, and genetic identification (e.g. "feces to species").

RESEARCH NEEDS

- Determine what types of transportation structures are preferred by bats in Nevada.

- Determine what structures (e.g. rip-rap, swallow nests, road culverts, etc.) are used by colonies and the season and purpose of use.

6.2.2. Buildings

Bats have species-specific roost needs and preferences that vary by season, region, and activity (e.g. maternity, hibernation) (BCI 2024). Occupied and unoccupied buildings provide a wide range of suitable roosting habitat for many species of Nevada bats, and urban environments provide other habitat features such as water and increased insect production that attract bats. Buildings provide bats with protection from predators, stable temperatures, and safe shelter to rest and raise their young. Because of the potential conflict between people and bats, it is integral that steps are taken to ensure both can coexist with minimal negative impacts. It is also important to remember that all bat species are protected by Nevada state law (Section 1.2 Bat Species Protection in Nevada).

Report a Bat Roost!

Nevada Department of Wildlife is collecting information about bat roosts in Nevada.

The roost reporting form is available at https://www.pacwestbats.org/nbwg and includes:

- Bat colony info including structure and estimated size
- Bat colony location details
- Optional photo upload

More info @ https://www.pacwestbats.org/nbwg

Bat roosting in a building -Julia Hoeh

Bats provide many beneficial services to humans as vital pollinators, natural pest controllers, and seed distributors (BCI 2024). Educating the public about the importance of bats can improve human-bat relationships in urban spaces. When circumstances require the removal or exclusion of bats from buildings, the extrication should be performed safely and humanely. Many online resources exist to facilitate this process, such as https://www.batcon.org/about-bats/bats-in-homes-buildings/. Specially trained bat rehabilitators or bat rescuers (Bat World Sanctuary provides a nationwide list), NDOW biologists, and reputable pest control companies are all options for bat removal and exclusion without causing bat mortality.

Unoccupied or seasonally occupied (e.g. summer cabin) buildings provide good roosting habitat for bats. If abandoned buildings are to be torn down, remodeled, or repaired, bat surveys should be done to ensure bats are not present, especially during critical maternity and hibernation periods. Bat houses can be installed around homes to attract bats to roost outside of the home, or to accommodate bats displaced by exclusion. Bat houses can be purchased or made, but proper design, installation, and placement are essential to avoid harm to bats. Some suggested online resources are found at https://www.batcon.org/about-bats/bat-gardens-houses/ or https://www.nwf.org/Garden-for-Wildlife/Cover/Build-a-Bat-House).

GOAL

Maintain stable populations of bats using buildings while promoting safe measures to resolve human and bat conflicts

OBJECTIVE 1: Identify and preserve important roosting habitat.
OBJECTIVE 2: Promote the use and construction of bat houses in suitable areas.
OBJECTIVE 3: Require the use of exclusion methods, incorporating seasonal timing to execute a safe and humane relocation or exclusion of bats from the building.

MANAGEMENT RECOMMENDATIONS

- Coordinate with local wildlife professionals immediately when bats are discovered roosting in a building.
- Preserve important hibernating or maternity habitat in buildings and report roost information to https://www.pacwestbats.org/nbwg.
- Require exclusions of state protected species (Section 1.2 Bat Species Protection in Nevada) avoiding extermination practices.
- Utilize BMPs (WNS Response Team) for prioritizing proper exclusion techniques when habitat cannot be protected.
- Require exclusion of bats to take place outside of the season of use (maternity and hibernation), using one-way venting at primary entries and exits, then sealing entry and exit points (Bats in Buildings, WNS Response Team).
- Create alternative habitat for roosting and hibernating bats using bat houses, bat hotels, and alternative roosting structures where appropriate.
- Modify existing structures to maintain bat habitat and reduce human-bat interactions in unoccupied structures.
- Prohibit establishment of feral cat colonies in urban areas where bat roosts are known to exist.
- Require bat surveys and exclusion methods for abandoned or unoccupied buildings prior to demolition, human occupation, remodeling or major roof repairs.
- Require communication/education between pest control companies and wildlife agencies to promote bat and human safety.

RESEARCH NEEDS

- Identify important roost sites in buildings and report these sites (https://www.pacwestbats.org/nbwg).
- Research roost ecology, habitat use, and seasonal movement of urban bats.
- Investigate the importance of urban habitat as roosting sites for maintaining bat populations.

6.2.3. Roadways

While roads act as flyways, allowing bats to reduce energy costs while navigating the landscape, and provide roosts in the form of transportation structures (see Section 6.2.1 Bridges and Transportation Structures), roads also fragment habitat and cause collision-related mortality. Low-flying species, specifically juveniles, may be more prone to strikes, with a possible bias towards males forced to disperse greater distances or restricted to inferior habitats (Fensome and Matthews 2016). Burthinussen and Altringham (2012) found that bat activity and species richness both increased with distance from roads. Bat responses to roads are influenced by several factors including edge habitat, road type, gap width, and noise level (Bennet and Zurcher 2013, Pourshoushtari et al. 2018). Gap in canopy cover, in addition to noise pollution, increase the barrier effect for bats (Bennett and Zurcher 2013), which is likely to be additionally exacerbated by light pollution (see Section 6.3.2 Artificial Light at Night). Underpasses, overpasses, and 'hop-overs' (tree canopy covering the road) have all been proposed to reduce bat mortality by creating a barrier effect, but their effectiveness is incompletely studied and poorly understood (Altringham and Kerth 2016).

Dirt road flyway with mist nets near Baker, Nevada - Janet Tyburec

GOAL

Protect bats from road-related mortality and habitat fragmentation

OBJECTIVE 1: Reduce collision deaths.

OBJECTIVE 2: Avoid habitat or roost abandonment due to the development of new roads.

MANAGEMENT RECOMMENDATIONS

- Avoid bisecting critical bat habitat, specifically between roost sites and water sources.
- Install safe crossing points for bats along major roads.
- Use Dark Sky Practices when illuminating roadways (Section 6.3.2 Artificial Light at Night).

RESEARCH NEEDS

- Identify how bats use different roadway types within the state.
- Determine if roads as flyways are a net a benefit to bats in forested landscapes.
- Examine bat use of wildlife crossings.

6.3. Habitat Loss and Degradation

6.3.1. Agriculture

Lands converted for agricultural use remain viable foraging, drinking, and roosting areas for bats. Tanks and ponds provide open water, crops and artificial light attract insects, and human structures create roost sites, but certain factors make some agricultural lands more valuable to bats than others. Forest cover along the edge of agricultural areas is associated with higher bat species richness and activity (Heim et al. 2015, Fill et al. 2022). Both richness and activity have been shown to decrease with distance from forest edge (Hunninck et al. 2022), though fragmented woodland preferences vary by species (Fuentes-Montemayor 2013). Maintaining natural habitat islands and linear landscape features is critical, as many bats are highly sensitive to the loss of edge habitat, such as hedgerows (Pocock and Jennings 2008).

Best management practices for bats are location and crop specific, as orchards may be used differently and by a different suite of species than palm plantations, alfalfa farms, etc. Considering bats are estimated to save farmers hundreds of thousands of dollars as a pest control resource (Cleveland et al. 2006, Boyles 2011, Aguiar et al. 2021), encouraging bat use on agricultural lands is a mutually beneficial practice. The installation of bat houses may encourage bat roosting and use in cultivated areas while reducing human-bat interactions. As agriculture is not a common use of federal or state land in Nevada, this threat is most likely to occur on private parcels. Positive relationships with private landowners are integral to implementing the management recommendations listed below.

Bats do face threats from agricultural development beyond habitat loss, including direct and indirect exposure to pesticides (Section 6.3.6), artificial open water (Section 6.1.3) with entrapment features, and broader-scale impacts from depleted groundwater reserves, as water overuse and overdraft may remove surface water from important habitat.

GOAL

Protect bat species from habitat loss associated with agricultural practices and facilitate the use of existing agricultural land by bats

OBJECTIVE 1: Preserve habitat features which promote bat use in agricultural lands.
OBJECTIVE 2: Reinforce the importance of bats as an agricultural pest control source.

MANAGEMENT RECOMMENDATIONS

- Preserve edge habitat, natural habitat islands, and linear features on agricultural land.
- Conduct public outreach to inform landowners about the value bat species bring as a pest control resource.
- Recommend the installation of bat boxes on agricultural landscapes.

- Use bat related BMPs for specific crop types, e.g. performing controlled burns when hibernating bats are less likely to be under leaf litter, trimming palm fronds when bats are less likely to be roosting, etc.
- Maintain healthy open water with safety features which prevent bat mortality (see Section 6.1.3 Open Water).
- Practice responsible water use to avoid depletion of groundwater resources (e.g. smart irrigation practices, irrigating only when necessary based on soil moisture monitoring, etc.).

RESEARCH NEEDS

- Research changes in bat use before and after different agricultural activities (e.g. land clearing, digging irrigation ditches, no-till versus till farming, etc.).
- Determine how bats use agricultural land (e.g. season of use, type of activity, species composition).
- Investigate appropriate levels of water use for agriculture at the basin level to avoid overdraft.

6.3.2. Artificial Light at Night

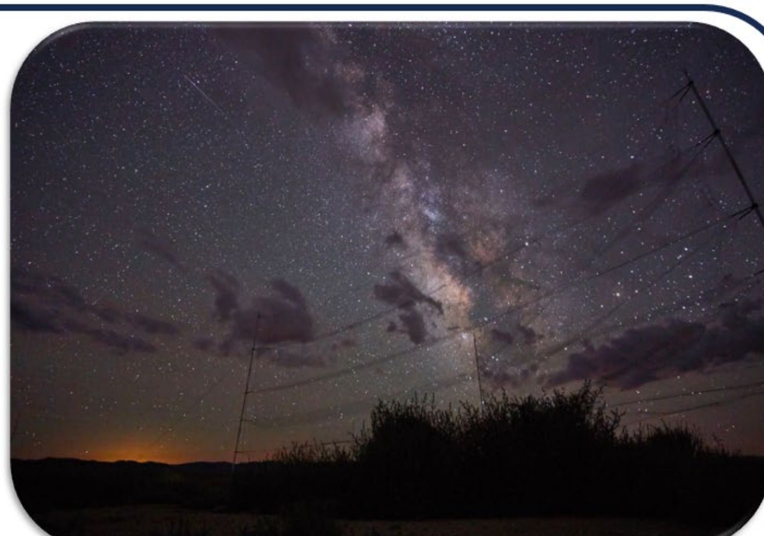
As communities and cities grow, artificial light at night (ALAN) becomes a more consistent feature across the nighttime landscape. Many of the issues related to ALAN impacts to bats and other wildlife can be mitigated by adhering to Dark Sky Principles. The Nevada Dark Sky Initiative promotes the use of Dark Sky Principles throughout the state.

Bats are impacted by the presence, positioning, location and brightness of ALAN in many significant ways including; altered activity patterns, changes in commuting pathways, altering foraging habits, and roost abandonment. Many bats are light-averse species that experience significant habitat loss as ALAN encroaches into dark spaces (Seewagen et al. 2023). Utilization of insects attracted by ALAN is restricted to few species in Nevada and overall species diversity at these sites has been shown to decrease

Dark Sky Principles

1. **Useful**
   Use light only if it is needed
2. **Targeted**
   Direct light so it falls only where it is needed
3. **Low Level**
   Light should be no brighter than necessary
4. **Controlled**
   Use light only when it is needed
5. **Warm-colored**
   Use warmer colored lights where possible

More info @ https://darksky.org



Bat mist net with Milky Way -Joey Danielson

significantly (Gili et al. 2024). Studies on artificial lights have been shown to harm a majority of bat species by reducing desired habitat conditions (Li et al. 2024, Seewagen et al. 2023, Barre et al. 2020).
When lights are installed near the entrance to a roosting site, bats have been documented abandoning the roosting site, including those used for maternity colonies (Voigt et al. 2021). Roosting sites with lights near the entrance show reduced use or complete abandonment over time and, in one study, lower juvenile growth (Voigt et al. 2021).

Artificial light impacts commuting and foraging habitat for bats. Little brown myotis are one of the most impacted species from ALAN encroachment, while big brown bats may be one of the least impacted species (Seewagen et al. 2023). One study found bat activity at bridges with ALAN was 1.7 times lower than bridges without lights (Barre et al. 2020). Bridges with ALAN fragment useable habitat for bats, especially when placed over waterways used for foraging and commuting.

In industrial areas such as mines, solar and wind farms, or other operations requiring industrial lighting, bats foraging under these bright lights can suffer from severe burns if they touch the light (see Section 6.5.3 Industrial Lighting).

GOAL

Reduce impacts to bats from artificial light at night

OBJECTIVE 1: Avoid the use of artificial lighting in areas of high bat use.
OBJECTIVE 2: Assess the need for lighting to reduce unnecessary installation.
OBJECTIVE 3: Use Dark Sky Principles when lighting is necessary.

MANAGEMENT RECOMMENDATIONS

- Avoid artificial lighting impacts to roost sites including installation of new lighting or changes to the environment that increase lighting of a roost entrance.
- Prioritize bridges and waterways as areas to avoid artificial lighting.
- Remove old or unnecessary lighting.
- Promote the conversion of old lighting structures to lighting that adheres to Dark Sky Principles.
- Reduce light use at night, turn lights off, when possible, use motion detectors, and dimming lights.
- Install shields to lights to reduce overall lighting impact and direct light where needed.
- Avoid the use of bright light.

RESEARCH NEEDS

- Continue research on species-specific impacts of artificial lighting.

6.3.3. Climate Change

Land and water surface temperatures have increased globally and within Nevada, with a marked increase in anomalies beginning in the late 1970s. Average annual temperatures within the American Southwest during the early 20th century to the early 21st century rose throughout the region by roughly 1.6°C (2.9°F). Winter low temperatures increased at a higher rate across the same period, with increases in the coldest day of year temperatures of 4.0°C (7.2°F) (USGCRP 2017). Decreases in winter snow accumulation across the western U.S. is widespread and season long, with total decreases in snowpack of 10-20% occurring from 1982-2016 (Fyfe et al. 2017).

Shifts in maximum and minimum annual temperatures, annual precipitation patterns, and soil moisture retention are likely to interact in complex ways which exacerbate drought and soil moisture deficits (Overpeck and Udall 2020), impacting all habitat used by bats. The distribution of resources bats depend on is anticipated to change as water resources used for foraging and drinking dry out. An overall reduction in the annual flow rate of surface water sources is expected. Spring dependent riparian habitat is also predicted to shrink in cover due to reduced recharge and increased evapotranspiration. Potential soil water stress is projected to result in vegetation changes within non-riparian ecosystems including increases in bare ground, decreases in shrub and herbaceous plant cover, and large declines in perennial cool season grass species accompanied by an increase in perennial warm season grass species (Palmquist et al. 2021). Changes in ecosystem functions can facilitate the increase of invasive plants, altering insect behavior, abundance, and distribution. Invasive plant species can also alter soil moisture availability, exacerbating drought conditions and increasing the risk of wildfire.

Warming and drying trends predicted to occur as a result of climate change have been linked to increased wildfire within the western U.S., leading to an estimated doubling of acres burned over the expected baseline (Abatzoglou and Williams 2016). The effects of an increased fire regime may put additional stress on bats through habitat loss and fragmentation (see Section 6.3.4 Fire and Fuels Reduction). The frequency of extreme weather events is expected to increase with climate change, exacerbating drought effects on the landscape further and increasing the frequency and severity of wildfire events. Extreme weather events can result in damage to already affected landscapes, increasing impacts from flooding, erosion, and loss of ecosystem functions.

Warming trends are expected to shift the overall habitat distribution of Nevada's landscape. Habitat associations are anticipated to migrate higher in elevation and latitude. This may disproportionally affect high elevation habitats used by certain bat species. Further shifts in habitats towards more heat and drought tolerant landscapes may have sweeping effects on bat distribution and abundance within the state of Nevada.

Direct effects of climate change on bats and their potential responses are unknown, however, bats are thought to be especially sensitive to climatic changes because of their high surface to volume ratios and low reproductive rates. The ability of bats to adapt to the impacts of climate change are unclear and will differ by species and region of the state. Bats have shown a variety of responses to climate change, including both positive and negative responses, with anticipated changes to ranges and population numbers. Behavioral responses such as changes to migration timing and other aspects of their lifecycle are also anticipated (Festa et al. 2023). Observations of bats response to higher temperatures indicates a reduction in ability to raise pups after the loss of water sources in proximity to maternity colonies (Adams 2010). Warming temperatures affect reproduction by altering the temperature and humidity of maternity colonies (Jones et al. 2009). Changes in extreme temperatures can affect thermoregulation during winter hibernation as well as during day roosting in the summer. Extreme weather events such as intense storms, flooding, heat waves, and drought have been linked to mass mortality of bats (O'Shea et al. 2016) and extreme heat has been linked to multiple mass mortality events of bats across the globe (Pruvot et al. 2019, O'Shea et al. 2016). Extreme heat compounded with a reduction in roost sites and longer distances from roost sites to foraging sites puts additional stress on bats

Bats could serve as an indicator species for the effects of climate change through ecosystem services they provide and as a bioindicator of the overall effects of climate change on insect populations. Additionally, bat numbers or activity can be related to climate change effects (including extremes of drought, heat, cold and precipitation), deterioration of water quality, agricultural intensification, habitat fragmentation, and disease. There is an urgent need to implement a global network for bat population monitoring so their role as bioindicators can be used to its full potential (Jones et al. 2009).

GOAL

Support bats through management actions in response to climate change

OBJECTIVE 1: Anticipate and evaluate climate change impacts to resources important to bats and respond to those impacts through management.

OBJECTIVE 2: Prioritize resources most at risk from climate change and most important to bat populations.

MANAGEMENT RECOMMENDATIONS

- Maintain natural water sources for drinking and foraging (Sections 6.1.3 Open Water and 6.1.4 Riparian and Wetland).
- If open water sources are drying, develop supplemental water catchments (e.g. guzzlers) with designs to allow use by the most bat species.
- Protect existing bat foraging and roosting habitat.
- Protect migratory and commuting flyways.
- Create bat roost structures that buffer temperature extremes to provide roosting habitat.
- Stay up to date with research on how climate change may impact bats locally and adjust management recommendations and priorities accordingly.

RESEARCH NEEDS

- Determine guzzler designs that are best for drinking bats and if guzzler designs influence species of bats that are able to drink from these sources.

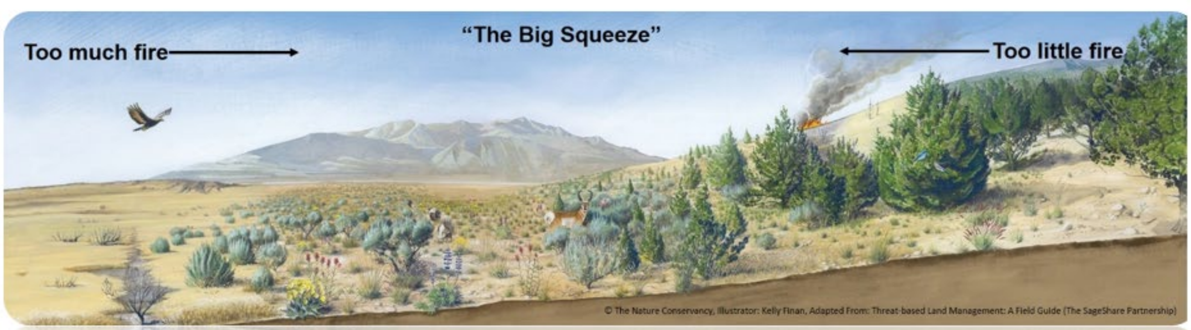
- Research habitat shifts and the changes in species ranges (e.g. which species ranges decrease vs. increase in size; an increase is not necessarily good if species have to search a wider area for food).
- Determine how changes in water availability impact maternity roost locations.

6.3.4. Fire and Fuels Reduction

Thousands of years of fire history in Nevada are recorded in tree rings, lake core sediments, and pack rat middens (Mensing et al. 2006, Cooper et al. 2021). Nevada's ecosystems are complex, spanning a wide elevational, climatic, and latitudinal gradient, across multiple land management agencies, land uses, jurisdictions, vegetation, and fuel types. Historically, fires in Nevada were more frequent at higher elevations and on mountains than in lower elevation valleys. Historical fires were ignited by lightning and Native Americans, who used fire extensively (Kitchen 2016) as a land management tool.

Mountains are cooler, wetter, and more productive than valleys, providing conditions that create more fuels and support more fire. In ponderosa pine ecosystems, fires occurred every 10-25 years (Kitchen 2012). These frequent, low intensity fires burned grasses, shrubs, and small trees, maintaining open stands of large, old growth ponderosa pine trees, which can live over 900 years. In aspen ecosystems, low intensity fires occurred every 10-20 years, with stand replacing fires occurring every 60 years (Heyerdahl et al. 2011). Fires stimulated aspen sprouting and regeneration while killing conifers like white fir, that eventually outcompete aspen for water, nutrients, and sunlight. Sagebrush followed a similar pattern, with more frequent fire in higher elevation, mountain sagebrush and less fire in lower elevation, Wyoming sagebrush.

Great Basin Fire Ecology



Fire ecology in sagebrush ecosystems historically varied by elevation. Today sagebrush is squeezed between conflicting fire regimes. Too much fire at lower elevations converts sagebrush to annual grasslands, while too little fire at higher elevations has allowed pinyon and juniper to outcompete sagebrush. Fuels reduction projects should be site specific and target achievable goals based on local soils, climate, and vegetation (Tausch et al. 2009).

In the hotter and drier valleys and Mojave Desert ecosystems, fires were infrequent. Plant communities like creosote bush, Joshua trees, blackbrush, and greasewood were effectively "fireproof". Shrubs, widely separated by bare ground, were incapable of carrying fire. Large fires were rare, occurring every 500 to 1,000 years.

Colonization drastically altered Nevada’s fire ecology. By 1900, Native American fire use ended, and lightning ignited fires were aggressively suppressed. Disrupted fire return intervals resulted in greater live and dead fuel loading (tons/acre) and tree mortality dramatically increased in montane and mesic ecosystems. When combined with higher temperatures and severe drought from climate change Nevada’s ecosystems are vulnerable to high intensity, catastrophic wildfires. Due to fire exclusion, resultant conifer encroachment, and accumulation of heavy woody fuels, Nevada’s forests and woodlands today are hotter, drier, less productive, and less resilient (Roundy et al. 2014).

Superscooper plane dropping water on a fire - Stefan Goehring

Europeans also introduced invasive plants. Cheatgrass and red brome are annual grasses which fill in spaces between shrubs allowing large fires to spread across sagebrush, salt desert, creosote bush, blackbrush, and Joshua tree ecosystems. Annual grasses also increase fire frequency, as abundant fine fuels, creating an annual grass fire cycle (Crist et al. 2023) that over time converts shrublands to annual grasslands. This irreversible transition permanently reduces the value of shrublands (Weltz et al. 2014). Other introduced species, like Russian olive and tamarisk, are phreatophytes; plants with deep roots that tap into groundwater. These species have outcompeted native riparian vegetation, lowering water tables, and altering fire regimes in highly productive, mesic systems (Bateman et al. 2008).

Fire exclusion and invasive plants have made Nevada’s ecosystems hotter, drier, less productive, and less resilient, which negatively affect bats and bat habitat. Fires are more frequent at lower elevations and more intense and larger at higher elevations. Historical fire regimes supported old growth forests with high plant and insect diversity. These forests, which provided valuable foraging and roosting habitat, are now vulnerable to high

Pinyon-Juniper Encroachment

Historic photos show a dramatic increase in trees and a decrease in open sagebrush grasslands at Great Basin National Park between 1930 and 2022. Photos are looking up Baker Creek canyon towards Doso Doyabi peak.

Fire exclusion and fuels accumulation have left this area vulnerable to high intensity wildfire, post fire flooding, and annual grass conversion.

intensity, catastrophic wildfires. Aspen and riparian cottonwood galleries are also highly productive for bat foraging and roosting. Fire exclusion, high intensity wildfires, and post fire flooding and downcutting have reduced the extent of these habitats (Kitchen et al. 2017). Conversion of shrublands to annual grasslands have reduced insect biomass and diversity, resulting in reduced bat foraging opportunities on millions of acres (Smith et al. 2021).

Though fire management often prioritizes protecting human life and property (Stephens and Ruth 2005) or benefiting wildlife such as sage-grouse (Bates et al. 2017) and mule deer (Long et al. 2008), fuels management can maintain and restore healthy, native ecosystems, improving bat habitat at large scales. Fire management planning begins years or even decades before projects are implemented. Therefore, it is critical for bat biologists to engage early in the planning and compliance process.

Fuels management includes mechanical fuels reduction, prescribed fire, herbicides, and seeding. Mechanical fuel reductions techniques include conifer removal with chainsaws and heavy equipment, such as chaining, bullhogs, feller bunchers, and masticators. Slash generated from mechanical fuel reductions can be lopped and scattered on site, chipped, or piled and burned. Prescribed fire includes broadcast burning which is used to reduce tree cover and increase herbaceous vegetation; understory burning where tree canopy remains in-tact; and jackpot burning where areas of dense fuel loading are targeted. Pre and post emergent herbicides can control invasive plants and reduce annual grass germination rates, benefiting native species. Seeding with helicopters and drill seeders is used to establish desirable forbs, shrubs, and perennial grasses following wildfires and fuels treatments. Natural wildfires are managed at higher elevations to re-establish historical fire regimes. In sagebrush, salt desert, blackbrush, creosote bush, and Joshua tree ecosystems, aggressive fire suppression can prevent permanent conversion of shrublands to annual grasslands.

Prescribed fire, understory burn - Stefan Goehring

The effects of fire and fuels management on bats is poorly understood. Most research has focused on prescribed fire in the eastern U.S. (Loeb and Blakey 2021). Direct fire effects on bats include immediate mortality, carbon monoxide poisoning, and roost abandonment. Indirect effects include foraging and roosting habitat changes and changes to the insect prey base. Responses vary in relation to the ecological and morphological characteristics of the bat community. In general, bats respond positively or neutral to prescribed fire. Bat response to wildfire is less understood. There is little evidence suggesting bats are directly killed by fires. Bats likely respond to fires by leaving their roost, presumably in response to smoke.

Prescribed fires in Nevada generally occur in fall, winter and spring; and preferred conditions for prescribed fire are often when bats are hibernating. Direct impacts are expected to be minimal during these times. Wildfires are most likely to occur when bats are most active. A significant amount of fuels reduction projects in Nevada target pinyon-juniper in characteristic woodlands and encroached rangelands. While woodlands are important foraging habitat, pinyon and juniper trees are not thought to be important as roost trees according to studies conducted in New Mexico and Colorado (Chung-MacCoubrey 2003, 2005; Snider et al. 2013). Older age classes of trees, especially old-growth forests, have historically been viewed as important habitats for bats (Altringham 1996, Fisher and Wilkinson 2005, Hayes and Loeb 2007) and are likely to contain a greater diversity and abundance of insect prey (Fuentes-Montemayor et al. 2022, Lintott et al. 2014). Prescribed fire may be used to maintain these older forests and maintain bat habitat.

Fire Impacts in Eastern Nevada

Lexington Canyon following the 2013 Black Fire. This fire resulted in post fire flooding, stream incision, and cheatgrass establishment. Following the fire many areas have recovered, stream and spring flows have increased, and riparian vegetation and stream flows and riparian vegetation have increased. Overall impacts on bat communities are unknown.

GOAL

Maintain and restore healthy, resilient ecosystems to support Nevada's bats

OBJECTIVE 1: Improve and maintain bat habitat and bat populations through active fire management.
OBJECTIVE 2: Minimize direct and indirect impacts to bats from fire exclusion, invasive plants, and fuels management.

MANAGEMENT RECOMMENDATIONS

- Participate early in land management planning process to optimize the effects of fire management on bat populations.
- Suppress wildfires in creosote bush, Joshua tree, sagebrush, blackbrush, and salt desert habitats. Aggressive suppression prevents the conversion of shrublands to annual grasslands.

- Following fuels treatments and wildfires, minimize the establishment of invasive plants, and re-establish native species. Several years of herbicide treatments and re-seeding may be necessary to re-establish native vegetation.
- Encourage active restoration of bat habitat following wildfires through Burned Area Emergency Response (BEAR) and Burned Area Rehabilitation (BAR) funds to recover habitat.
- Use native shrubs, forbs, and perennial grasses for reseeding following wildfires and fuels treatments.
- Use Ecological Site Descriptions to inform fuels treatments based on site specific soils, climate, and vegetation (https://www.nrcs.usda.gov/getting-assistance/technical-assistance/ecological-sciences/ecological-site-descriptions).
- Encourage active restoration of riparian, sagebrush, and aspen habitat through site appropriate fuels treatments.
- Protect roost trees and hibernacula from direct impacts of treatments.
- Avoid fire at cave and mine entrances where possible to protect roosting and hibernating bats.
- Maintain and protect old-growth forests through fuels reductions, prescribed fire, and managed wildfires.

SURVEY RECOMMENDATIONS

- Require manual vetting of all acoustic data (see Section 5.2 Acoustic Surveys).
- Require post-treatment monitoring of fuels projects to ensure treatment objectives are met.
- Identify large-diameter, high value roost trees to retain during prescribed fires and fuel reductions.

RESEARCH NEEDS

- Investigate bat use, diversity and abundance in pinyon-juniper and sagebrush systems.
    - How do bats use pinyon-juniper and sagebrush ecosystems?
    - Are pinyon-juniper important roost trees in Nevada?
- Monitor bat response to wildfires, mechanical fuel reductions, and prescribed fire treatments in Before After Control Impact study design (BACI).
    - How does bat foraging change in response to chaining, herbicide application, mastication, prescribed fire, and wildfire?

6.3.5. Insects and Tree Disease

Deciduous and coniferous tree species known to provide roosting habitat in Nevada are threatened by insects and diseases which weaken or kill affected trees (Trouillas and Gubler 2016, Philips 2020, McMillin et al. 2017, Wang and McKie 2008), but direct impacts and interactions between bats and infested trees have not been well studied within the state. Habitat loss and degradation is generally thought to have a negative impact on bats (Seltmann et al. 2017, Garcia-Moralez et al. 2016), however, entire dead trees (snags) create habitat for cavity-roosting species (Taylor et al. 2020). In most cases, diseases or insects are host-specific, meaning that infestations can influence tree species composition within a forest or woodland. Additionally, infestations which do not kill trees can still influence roost quality by altering foliage amounts, limbing trees, or facilitating cavity creation.

Mountain pine beetle larvae Jarbidge, Nevada - Stefan Goehring

Both native and invasive insects, along with tree diseases, impact forests. Major insects of concern native to Nevada include the mountain pine beetle*,* western pine beetle, pinyon engraver beetle, and western balsam bark beetle. Invasive insects of concern include the white satin moth and red palm weevil. Major tree diseases of concern include white pine blister rust, pinyon blister rust*,* and cytospora canker (Phillips 2020). Identification materials for common invasive pests and diseases can help land stewards identify emerging infestations within the state. As climate change alters temperature and precipitation trends, ranges of pests and tree diseases may change, increasing the need for monitoring (Dudney et al. 2021; see Section 6.3.3 Climate Change).

Insect/disease killed trees near Jarbidge, Nevada - Stefan Goehring

The best way to protect roosting trees from insects and disease is to prevent infestation entirely. Eliminating firewood transport and cleaning equipment used for camping, surveying, or harvesting can help prevent the spread of insects or diseased wood. Appropriate forest management will also reduce opportunities for invasion by maintaining appropriate stand densities. Once an infestation has occurred, the identification of affected individuals is critical to timely response and treatment. Costly treatment may necessitate the protection of individual trees with the highest roosting quality. If die-offs occur because of infestation, specific high-quality snags should be preserved for roosting habitat whenever possible. Programs such as DecAID: Decayed Wood Advisor may be useful for determining where snags should be maintained and at what number. Species with soft wood are more likely to entice birds which create cavities, but harder wood increases snag longevity. Species which retain bark longer after death may also be more desirable for bat species that roost under peeling bark (Taylor et al. 2020).

GOAL

Protect roost trees, snags, and valuable forest habitat from insect infestation or disease resulting in death or degradation

OBJECTIVE 1: Prevent exposure to invasive insects and infectious disease.
OBJECTIVE 2: Identify areas of infestation or infection.
OBJECTIVE 3: Limit spread once infestation or infection has occurred.

MANAGEMENT RECOMMENDATIONS

- Monitor areas with symptomatic trees to determine cause and potential impacts to bat species.
- Coordinate with USFS Forest Inventory and Analysis program for early detection of disease outbreaks.
- Implement threat-specific methodologies to limit the spread of insects and diseases which reduce tree health or cause tree mortality.
- Reduce the chances of exposure whenever possible by eliminating firewood transport and cleaning gear after visiting infested areas.
- Conserve snag trees when possible, considering fire risk, human safety, and the possibility of further spreading insects or disease.
- Provide informational material to aid in the identification of areas of infestation or infection.
- Report symptomatic trees to relevant agencies.

RESEARCH NEEDS

- Determine which tree species retain roosting value as snags.
- Examine bat response to large-scale die-offs of a single species within a forest complex.
- Research shifts in the distribution of common tree insects and diseases due to climate change.
- Research emerging disease in critical riparian tree species, such as cottonwood and willow.

6.3.6. Pesticides

Pesticides include insecticides, herbicides, rodenticides, and fungicides. Herbicides are commonly used in Nevada to control invasive plant species or create fuel breaks, but their impacts to bats and their prey are not well understood. Rodenticides have caused mortality bats (Dennis and Gartrell 2015), and chemicals associated with both fungicides and rodenticides have been detected in North American bats (Secord et al. 2015).

Insecticides are a commonly used pest control method in agricultural or sylvicultural practices. Bats can be exposed to insecticides directly through contact or indirectly by consuming contaminated water or treated insects. Many chemicals are known to accumulate at higher trophic levels and can be found in mammalian tissue, and elevated amounts cause a wide variety of symptoms which may lower fitness or even cause mortality in bats (Sandoval-Herrera et al. 2022, Oliviera 2021; see Section 6.5.2 Environmental Waste). It is critical to use insecticides that do not bioaccumulate or which kill insects on contact, and to prevent treated insects from being consumed by bats.

Herbicide spraying of noxious species near Jackpot, Nevada - Steph Frederick

Bats can serve as a natural control for insects and can reduce the need for chemical insecticide application. They are estimated to save farmers hundreds of thousands of dollars as a pest control resource (Cleveland et al. 2006, Boyles et al. 2011, Aguiar et al. 2021). Installing bat boxes for roosting and maintaining natural habitat islands which provide edge, cover, and clutter, may increase bat activity and richness (Fill et al. 2022, Heim et al. 2015), and therefore pest reduction effects.

GOAL

Reduce direct and indirect impacts of pesticides to bats

OBJECTIVE 1: Reduce pesticide use.
OBJECTIVE 2: Promote ecologically sustainable methods of insect reduction, reinforcing the importance of bats as a pest control source.
OBJECTIVE 3: Prevent secondary contamination by pesticides.

MANAGEMENT RECOMMENDATIONS

- Encourage foraging by bats in areas where reduction of pests is desired using bat boxes/houses and natural habitat islands.
- Prioritize pesticides that do not bioaccumulate in mammalian tissues.
- Recommend insecticides that kill on contact to prevent consumption of treated insects.
- Avoid application of pesticides during periods of high bat activity (seasonal and temporal).

- Avoid application of pesticides in areas with high bat use, prioritizing roosting sites and maternity colonies.
- Develop statewide educational programs on pesticide use impacts and the value of bats as a natural pest control resource.
- Evaluate bat use in human structures and use rodenticides as a last resort when bats are present.
- Limit pollution of water from pesticide runoff (point source and non-point source).

RESEARCH NEEDS

- Research direct and indirect impacts of pesticides on bats.
- Determine how pesticides impact bat fertility.
- Explore call baiting as a bat attractant to promote foraging for pest control.
- Identity potential impacts of rodenticides on roosting bats and roost abandonment.

6.4. Energy Development

6.4.1. Oil and Gas

Although oil exploration in Nevada has occurred for more than a century, with the first oil well drilled in Washoe County in 1907 (Garside et al. 1988), oil and gas development has been minimal compared to other western U.S. states. Of the 32 U.S. oil and natural gas producing states, Nevada ranked 26th for oil as of 2021 and 31st for natural gas as of 2020 (USDOE 2022). Two oil producing areas occur in the eastern part of the state. These include Railroad Valley (Nye and White Pine Counties) with nine oil fields, and Pine Valley (Elko and Eureka Counties) with two oil fields. The oil produced is a heavy crude and most is sent to Nevada's only refinery in Nye County, where it is processed into asphalt tiles for roofs, asphalt for roads, and some diesel. There has been an increase in oil leasing in Monitor Valley and the Ruby Mountains, but there are no emerging plans for development in these new areas (USDOE 2022).

Given the current trend towards renewable sources of energy (e.g., solar, wind, and geothermal) it is unlikely that oil and gas development will have a large or growing impact on bat populations in Nevada. Nevertheless, understanding and mitigating the negative impacts to bats is critical. Potential negative impacts may include habitat destruction and fragmentation from drill pads and pipelines during oil and natural gas exploration and production operations, the creation of contaminated water sources (see Section 6.5.2 Environmental Waste), increased artificial lighting (see Section 6.3.2), and noise pollution (see Section 6.5.4). The Nevada Division of Minerals (NDOM) is the state's regulatory authority for all oil and gas wells drilled in Nevada, and any wells drilled on either private or federally managed lands must be permitted by NDOM.

GOAL

Minimize negative impacts or fatalities to bats related to oil and gas development

OBJECTIVE 1: Evaluate potential development areas for bat use and habitat quality and avoid areas of high bat use and good quality habitat.

OBJECTIVE 2: Limit access to contaminated water sources with bat-friendly measures.

OBJECTIVE 3: Reduce negative impacts to bats from increased artificial lighting and noise pollution.

MANAGEMENT RECOMMENDATIONS

- Conduct multiple acoustic surveys, search for new and known roost sites and water sources, and identify important foraging habitat in the development areas prior to siting decisions.
- Recommend the use of closed-loop systems to reduce the likelihood of bats drinking from contaminated water.
- Do not use mesh netting to prevent access to water sources due to entrapment issues.
- Construct alternative freshwater sources to provide wildlife with an alternative safe water source and contribute to dietary dilution of toxic compounds.
- Consolidate drilling operations in an area, both spatially and temporally, so impacts occur at the same time, leaving other areas undisturbed.
- Work collaboratively with state and federal agencies (NDOM, BLM, USFS, etc.) to require oil and gas companies to implement protective measures minimizing negative impacts to bats.

RESEARCH NEEDS

- Conduct research to understand the impacts of increased artificial lighting and noise pollution on bats from oil and gas development and production.
- Develop appropriate mitigation measures based on research findings (e.g., acoustic deterrents, sound barriers).

6.4.2. Transmission Lines

Electrical transmission lines are defined in this document as any overhead transmission line consisting of a series of support structures with a wire “line” or multiple lines strung between them. Transmission lines can either be short generation tie (gen-tie) lines connecting a facility to the existing electrical grid, or long transmission lines spanning hundreds of miles. Support structures vary in design, size, disturbance footprint, and height of the lines above the ground. The number of wires making up a transmission line can vary, as can the size of the line, and the voltage carried. Multiple transmission lines can be stacked vertically along a power pole or aligned horizontally (APLIC 2012). Classification of overhead transmission lines is determined by the voltage the line carries, with low voltage lines carrying less than 1 kV to high voltage lines carrying more than 800 kV. Usually, transmission lines terminate at a power substation where they connect to the larger power grid. Power lines (e.g. conductors) strung between support structures usually take the form of insulated electrical lines, commonly occurring in multiples of three. Other features such as insulators, ground wires, dampers or aviation obstruction markers can also be associated with transmission lines.

Transmission lines exist as linear features on the landscape, passing through a variety of habitats with different impacts to each. These lines are generally located in utility rights-of-way (ROW) on public lands. Little is currently known about direct impacts to bats through strikes or electrocutions. Recommendations from the Avian Power Line Interaction Committee have primarily focused on avoiding and minimizing impacts to birds (APLIC 2012) but may also benefit bats. Although minimal data exists on bat collisions with transmission lines, it is presumed that bat mortality through strikes is at least similar to avian mortality. Whenever possible, support structures should be monopole and free of guy-wires to prevent strikes (USFWS 2013). Towers greater than 61 m (200 ft) above ground level are preferred to taller structures because they require aviation lights which can attract bats. If towers require lights, flashing lights that do not attract insects are preferred over continuous light sources which can attract bats (Pauwels et al. 2019).

Transmission lines can cause significant impacts on the environment adjacent to their location both during the construction and operational phases. During the construction phase vegetation may be removed for construction in the ROW. During operation, trees and other vegetation may be removed indefinitely. Maintenance roads may also be constructed in the ROW and may attract other users. These habitat alterations can generate edge effects within intact habitat altering the biological function of the landscape (Biasotto and Kindel 2018). While these effects can be broad and habitat dependent, minimizing these impacts can be achieved by locating new transmission lines in existing ROWs where disturbance has already occurred. Whenever possible transmission lines should be constructed away from important habitat features used by bats such as roosting sites, maternity colonies, hibernacula, foraging areas, and migratory corridors.

GOAL

Reduce potential mortality from transmission lines

OBJECTIVE 1: Reduce bat strikes at transmission lines, transmission structures, or guy wires.
OBJECTIVE 2: Locate transmission line ROWs outside of important bat habitat.
OBJECTIVE 3: Minimize duplicate ROWs on the landscape to minimize the overall footprint.

MANAGEMENT RECOMMENDATIONS

- Reduce the overall number of ROWs on the landscape by locating transmission lines in existing ROWs.
- Locate transmission lines away from important bat features (e.g. maternity colonies, hibernacula, roosts, and foraging areas).
- Reduce light around transmission lines to prevent insects from attracting bats.
- Discourage vertically oriented transmission lines which can increase the risk of strikes and electrocution in favor of horizontally oriented lines.

RESEARCH NEEDS

- Investigate impacts of transmission lines on bats.
- Investigate bat attractants to transmission lines such as edge affects in pinyon juniper woodland areas.

- Investigate how electromagnetic fields produced by large transmission lines effect migrating bats and insects.
- Identify important migration corridors for bats.
- Identify important bat features to determine their use and level of importance.

6.4.3. Geothermal

Nevada holds the largest amount of untapped geothermal resources in the U.S. with an estimated potential of 2,500 to 3,700 megawatts (MW) of electricity (NREL 2001). Wells and springs exist over the entire state, offering extensive opportunities for development of low- and high-temperature resources for direct use or power generation. The northwestern part of the state has high temperature potential while the remainder of the state has low to moderate temperature potential (NREL 2001). With government mandates to increase the use of renewable energy resources, geothermal energy development will likely increase dramatically in Nevada over the next few decades.

Geothermal projects can result in habitat disturbance impacting bats including: (1) habitat fragmentation; (2) introduction of invasive vegetation affecting species' food supplies as well as habitats; (3) direct injury or mortality caused by vehicle collisions, harassment, and illegal takings; (4) noise potentially interfering with bat behavior; and (5) potential releases of hazardous materials to the air, soil, or water (BLM 2008). Fortunately, geothermal plants have a relatively small footprint of 0.4-3 (1-8 ac) per MW compared to 2-4 ha (5-10 ac) per MW for coal and 7.7 ha (19 ac) per MW for nuclear (Reimer and Snodgrass 2010). Slimhole and directional drilling can be utilized to minimize disturbance. Slimhole drilling is simply drilling holes with a smaller diameter when exploring for geothermal resources which results in smaller drill pads and narrower roads for drilling equipment access. Directional drilling is drilling several wells diagonally from the same point on the surface. This allows for the exploration of many geothermal resources from a single location, thus minimizing the footprint of a geothermal plant (Reimer and Snodgrass 2010).

Geothermal energy development may result in drawdown of surface and groundwater resources, decreasing drinking and foraging opportunities for bats. Impacts on water resources and subsequent impacts to bats should be considered when developing areas for geothermal energy. Recycling or re-injecting geothermal fluids into the ground can help mitigate water loss. A comprehensive surface and groundwater monitoring program should be developed and implemented at the site and surrounding water sources to detect decreasing water levels. If water levels are found to be decreasing, appropriate mitigation measures should be implemented to avoid permanent loss of water resources.

Discharged water from geothermal facilities, though cooled, may still be warmer than surrounding surface water. Many aquatic and riparian species are intolerant to significant changes in water temperature. Temperatures changes can negatively impact in-stream species populations and may cause population die-offs. Geothermal waste fluid also contains high mineral concentrations, potentially adding dissolved metals to surface water. This can change the mineral and chemical concentration of the stream, and negatively affecting in-stream species (Kochan and Grant 2007).

GOAL

Minimize impacts to bats and bat habitat from geothermal development and power generation

OBJECTIVE 1: Evaluate potential development areas for bat use and habitat quality and avoid areas of high bat use and good quality habitat when possible.

OBJECTIVE 2: Maintain existing surface and groundwater levels to avoid permanent loss of water resources.

OBJECTIVE 3: Limit access to contaminated water sources with bat-friendly measures.

OBJECTIVE 4: Reduce negative impacts to bats from increased artificial light (see Section 6.3.2) and noise pollution (see Section 6.5.4).

MANAGEMENT RECOMMENDATIONS

- Conduct multiple acoustic surveys, search for new and known roost sites and water sources, and identify important foraging habitat in the development areas prior to siting decisions.
- Use drilling techniques, such as slimhole or directional drilling, that minimize the disturbance footprint.
- Utilize methods that minimize the use of surface and groundwater resources.
- Monitor surface and groundwater levels and implement mitigation measures before excessive drawdown occurs.
- Recommend the use of closed-loop systems to reduce the likelihood of bats drinking from contaminated water and help mitigate water loss.
- Do not use mesh netting to prevent access to water sources due to entrapment issues.
- Construct alternative freshwater sources to provide wildlife with an alternative safe water source and contribute to dietary dilution of toxic compounds.

RESEARCH NEEDS

- Develop appropriate mitigation measures based on research findings (e.g., acoustic deterrents, sound barriers).
- Study impacts of changes in discharged water temperature on invertebrate abundance and diversity.

6.4.4. Wind Energy

Replacing fossil fuels with renewable energy sources like wind is critical to reducing the impacts of climate change. Carbon emissions from wind energy are considerably lower than energy generated from fossil fuel combustion. In 2022, wind generated 10% of energy in the U.S. There are currently more than 71,000 onshore wind turbines with approximately 3,000 added annually. As larger turbines are more efficient, height and rotor diameter are increasing. The largest turbine towers are 152 m (500 ft) tall with a rotor diameter of 250 m (820 ft).

Unfortunately, in the U.S., an estimated 880,000 bats are killed annually by wind turbines. Most mortality is caused from direct strikes by rotors (Arnett et al. 2016). Barotrauma may occur when a bat enters a low pressure area around the rotor blade, causing internal hemorrhaging and death (Baerwald et al. 2008), but recent studies suggest that barotrauma is rare relative to direct rotor strikes (Lawson et al. 2020). Tree roosting bats, such as hoary bat, western red bat, and silver-haired bats, are most vulnerable to rotor strikes, although other species, including Mexican free-tailed bats and little brown myotis, are also killed in large numbers (Arnett et al. 2008). Without mitigation, continued wind energy development could result in the near extinction of hoary bats (Frick et al. 2017, Rodhouse et al. 2019). Most bats in North America are killed by turbines during late summer and fall migrations on low wind nights with speeds of less than 6 mps (13 mph), and before storm fronts (Arnett et al. 2008).

Three mitigation strategies are used to reduce bat mortality by turbines: avoidance, curtailment, and deterrence. Avoidance, the preferred strategy, prioritizes the development of wind energy in areas with low bat activity which fall outside migration corridors and are far from known roosts (Arnett et al. 2016). Curtailment requires slowing or stopping of turbine blades at lower wind speed, which can reduce bat mortality but has economic impacts (Barclay et al. 2017). Curtailment may be required as a mitigation measure to keep bat mortality below and appropriate threshold. Deterrence uses ultrasonic noise or ultraviolet light to discourage bats from approaching wind turbines, but efficacy testing has yielded mixed results (Romano et al. 2019). Deterrence is the least preferred mitigation with limited success in reducing bat mortality.

Spring Valley wind, in eastern Nevada, viewed from a bat roost - Bryan Hamilton

Currently, Spring Valley Wind is the only wind energy facility in Nevada. Located in White Pine County, this facility consists of 66 turbines. Each 2.3 MW turbine is 122 m (400 ft) tall with a rotor diameter of 95 m (313 ft). Spring Valley Wind is 6 km from the largest bat roost in Nevada (Danielson et al. 2022), where an estimated two million Mexican free-tailed bats use the roost as a maternity colony and migration stop. There are no other known industrial scale wind energy facilities with such close proximity to a heavily used bat roost in North America.

Mitigation at Spring Valley Wind happens in the form of "smart curtailment" (American Wind Wildlife Institute 2018) based on bat outflight data collected in real-time from the cave roost via an infrared beam break system. These data are used to determine when to slow (i.e. tether) or stop turbine blades on nights of high bat activity. On nights when risk to bats is predicted to be high, a cut-in speed of 5 mps (11 mph) would be implemented. Implementing this change in operations reduced bat fatalities from 533 to 133 per year, a 75% reduction (Bureau of Land Management - Ely District 2018). Wind energy development in Nevada is expected to increase. In Nevada, 50% of all energy use must be from renewable sources by 2030, and 100% by 2050. Therefore, reducing mortality from wind energy is critical to bat conservation.

GOAL

Minimize the number of bats killed in Nevada by wind energy turbines.

OBJECTIVE 1: Develop wind energy facilities in locations far from bat roosts or with minimal bat activity (i.e. avoidance).

OBJECTIVE 2: Slow or stop turbine blades at lower wind speeds (i.e. curtailment through increasing cut in speed of turbines).

OBJECTIVE 3: Deter bats from wind energy facilities using noise or light (i.e. deterrence).

MANAGEMENT RECOMMENDATIONS

- Identify areas where wind energy development is likely and collect data on bats to determine potential for bat interactions and mortality.
- Require baseline studies pre-construction with post-construction monitoring to quantify bat usage of sites and to determine fatality rates and BMPs including any surrounding habitat or roosting sites.
- Avoid siting wind energy facilities near bat roosts.
- Use project area buffers to account for bat movement, considering habitat types adjacent to project areas.
- Use curtailment to reduce bat mortalities.
    - Use smart curtailment to track bat activity (beam break, acoustic detectors, or radar) to adjust operations during periods of high bat activity.
    - Reduce turbine use during migratory periods (late summer/fall), low wind nights and other periods of high bat activity.
- Determine mortality thresholds during the planning process.
- Consider ultrasonic, radar, and ultraviolet light deterrents.

- Monitor for post development mortality to determine whether mortality thresholds are being exceeded and quantify the effectiveness of curtailment and deterrents.

SURVEY RECOMMENDATIONS

- Require manual vetting of all acoustic data (see Section 5.2 Acoustic Surveys).
- Require acoustic detector placement on meteorological towers with detector microphone at turbine height for two years before construction to determine bat activity.
- Mist netting, hibernacula, and harp trap surveys are recommended for some projects, discuss necessary survey types with local biologists.
- Require mortality monitoring once project is in place to determine effectiveness of cut-in speeds
- Require data sharing of survey results to improve future projects in regard to bat conservation.
- Install Motus towers two years before construction and maintain towers during life of the project to track bat movements and use of project area to help determine if area is used for migration.
- When important bat habitat is near the project area, deploy Motus tags to determine bat movement.

RESEARCH NEEDS

- Determine the effectiveness of ultrasonic deterrents and ultraviolet lighting
- Map bat migration corridors
- Determine how height of turbines impact bat mortality
- Develop a reliable prediction tool for impacts on bats from wind energy facilities

6.4.5. Solar Energy

Solar energy development on public lands in Nevada is expected to increase in the future as the demand for green energy increases. Large scale solar development in Nevada has the potential to convert existing desert habitat into utility scale solar facilities. Current utility scale solar facilities can collect solar energy in two ways; photovoltaic collection and concentrated solar. Photovoltaic (PV) collection relies on solar panels that directly collect energy and store it in a battery storage facility on site or nearby. Concentrated solar (CS) also known as solar thermal plants, use mirrors or lenses to concentrate sunlight into a receiver located on site. To date, Nevada has only one CS generating plant located in central Nevada near the town of Tonopah. Most of the utility scale solar facilities currently operating use PV as a means of energy production. Small scale solar exists in the form of roof-top solar or small sites on residences, industries, and businesses. Investment in solar energy has increased significantly in Nevada since 2010, with energy production by PV increasing from 217-megawatt hour (MWh) in 2010 to 6,382 MWh in 2023. Over 81% of this amount is generated by utility scale PV facilities (EPM 2024).

Solar facilities generate power by directly harvesting solar energy on arrays of photovoltaic panels. The height above the ground can vary between and across sites. The vegetation below the panel arrays can be completely removed or can be preserved but trimmed to an acceptable height. Arrays can be stationary or shift during the day with the movement of the sun, this process tilts the panels to maximize light exposure. In the evening the panels do not move and during periods of high winds, the panels are oriented perpendicular to the ground.

Most utility scale solar facilities in Nevada are subject to analysis under the National Environmental Policy Act (NEPA), similar to other forms of disturbance on public lands. Solar energy development on BLM lands has been evaluated at a programmatic level across eleven western states, including Nevada (BLM 2024). The proposed Utility-Scale Solar Energy Development plan designates BLM lands across the eleven western states where utility-scale (i.e. less than 5 MW) solar energy facilities may be developed based on proximity to existing and planned transmission lines, designated energy corridors, or previously disturbed lands. It also outlines where solar development is excluded, based on certain exclusion criteria, like protected lands. This proposed Utility-Scale Solar Energy Development Plan supersedes a previous programmatic evaluation of utility-scale (less than 20 MW) solar development across BLM lands in six southwestern states, including Nevada (BLM 2012). The previous plan designated solar energy zones (SEZ) as priority areas for solar development. It also defined other BLM lands outside of the SEZs where solar energy development could be evaluated through a variance process.

Solar facilities alter the existing environment in several ways. In Nevada, the majority of utility scale solar facilities are located on flat ground, in valley bottoms, and within desert scrub habitats on lands managed by the BLM. Solar facilities use gen-tie lines to transmit their power to the transmission grid. These lines are generally short (less than 6 km (1 mi) in length) and tie into an existing substation. Gen-tie lines are project specific and can be longer (greater than 32 km (20 mi) in length). This often places solar facilities near existing power infrastructure, specifically in close proximity to a large transmission line (see Section 6.4.2 Transmission Lines). During construction of most solar facilities in Nevada, the area underneath the panels is graded, removing vegetation entirely. This alters habitat bats could potentially use for foraging. Bats have been known to alter their behavior when flying and feeding under solar panel arrays, by flying faster with straighter trajectories, and is associated with less successful feeding attempts (-18% to -39%) (Barre et al. 2023). Some solar facilities permitted more recently in southern Nevada, did not grade the entire area under the solar panels, but retained vegetation by mowing instead, and in some cases allowed wildlife to reenter the site during production.

Areas previously open to bats for migration, foraging, or short distance travel become altered by the presence of solar arrays. Bats using these areas would be forced to either fly around or through solar facilities, exposing them to conflicts with arrays or fences. Bats have been observed altering their behavior in response to the construction of solar sites with avoidance or altered flight behavior (Barre et al. 2023). Habitat converted to solar facilities or altered by the construction of panel arrays over them, may produce fewer insect prey than unimpacted desert scrub thereby impacting bats negatively. This is poorly understood in desert ecosystems and remains unquantified as to how the construction and operation of solar facilities affects insect populations on site.

Direct mortality of bats at PV sites can occur but is poorly understood. Bat mortality at PV sites have been observed underneath the arrays and along permitter fences, associated with collisions occurring during flight. Bat mortality numbers vary across sites, however the moralities have been shown to increase if a project uses a solar evaporation pond to store energy which bats may be attracted to. Birds are known to mistake flat solar panel surfaces for water, causing injury or mortality when attempting to land (Kosciuch et al. 2020) and it is possible bats are impacted similarly. Bat mortality has also been observed at CV towers, however mortality rates dropped significantly during the first five years of operation (Smallwood 2022). Seasonal migration patterns of migrating species may affect mortality rates at solar sites as can migration routes, however this is poorly understood (Huso et al. 2016).

Solar facilities can function as heat islands, trapping hot air under solar arrays and increasing the temperature as much as 3°-4° C (37-39° F) above surrounding natural habitats at night (Barron-Gafford et al. 2016). It is unknown how the increased nighttime temperature may affect bats or their prey, but it is presumed to have a negative impact overall.

The use of water at solar facilities can be substantial during the construction process for dust control and other industrial practices. Water demands continue at a lesser degree during the operational phase of the facility for washing panels, dust control, herbicide application, and other logistic uses. Water may be provided by a well dug on site or from an existing water right. The increase in water usage due to solar facilities has the potential to impact groundwater levels and surface flow at nearby springs, negatively affecting foraging and drinking habitat areas important to bats.

Surface flow across sites can be altered, which could redirect surface water and deplete/dewater downstream habitat. Maintaining natural surface flow on site can mitigate these impacts. Bats are presumed to follow desert washes during migration and during trips from roosts to foraging and drinking areas. Preservation of these washes across solar sites should be maintained.

GOAL

Identify and minimize negative impacts to bats from solar development both for concentrated solar (CS) and photovoltaic (PV) facilities and additional solar power generation

OBJECTIVE 1: Site solar energy development in areas with less bat activity.

OBJECTIVE 2: Consider bat habitat within adjacent landscape features that may support bat colonies, roosts, drinking/foraging areas or migration corridors when siting solar projects.

OBJECTIVE 3: Prioritize data collection to understand the impacts of solar development on bats and their habitat.

OBJECTIVE 5: Provide beneficial habitat improvements to bats in areas adjacent to important habitat lost from solar installation.

OBJECTIVE 6: Prioritize maintenance of bat habitat on site or implement avoidance measures to prevent exceeding mortality thresholds.

MANAGEMENT RECOMMENDATIONS

- Participate early in land management planning process to avoid zoning solar energy projects in high priority bat habitat, roosting areas, and migration corridors.
- Use project area buffers to account for bat movement, considering habitat types adjacent to project areas.
- Require baseline studies pre-construction with post-construction monitoring to quantify bat usage of sites and to determine fatality rates and BMPs including any surrounding habitat or roosting sites.
- Create mortality thresholds for PV and CS sites.
- Identify invertebrate populations both pre-construction and following construction and recommend maintaining an effective population size.
- Require the preservation of existing topography of natural drainage patterns to maintain natural infiltration rates and desert wash habitats used by bats.
- Include strips of undisturbed habitat along the edges of solar facilities to allow for bats to avoid solar sites.
- Require monitoring of water usage and preservation of natural water resources at solar sites to prevent loss of important foraging/drinking areas within the drawdown zone for all associated wells providing water to solar sites.
- Preserve native vegetation below solar panels for PV sites.
- Use bi-faced solar panels to prevent heat-island effects at PV sites.
- Limit the use of all pesticides at solar sites (see Section 6.3.6 Pesticides).
- Limit night-time lighting at solar sites to reduce wildlife attractants (see Sections 6.3.2 Artificial Light at Night and 6.5.3 Industrial Lighting).
- Limit wildlife access to solar evaporation ponds through the use of physical deterrents such as shade balls, ultrasonic, or other deterrents.

SURVEY RECEOMMENDATIONS

- Require manual vetting of all acoustic data (see Section 5.2 Acoustic Surveys).
- Complete desktop analysis of all bat data within and surrounding the project area including foraging and roosting habitat for necessary surveys.
- Require acoustic detector monitoring within impacted areas for two years before construction to determine bat activity and migration patterns, prioritizing important habitat types within a project boundary (water sources, edge habitat, near roosting habitat, etc.).
- Require long term monitoring and mortality surveys during the life of the project to determine impacts to bats and their habitat.
- Mist netting, hibernacula, and harp trap surveys are recommended for some projects, discuss necessary survey types with local biologists.

- Require data sharing of survey results to improve future projects in regard to bat conservation.
- Install Motus towers two years before construction and maintain towers during life of the project to track bat movements and use of project area to help determine if area is used for migration.
- When important bat habitat is near the project area, deploy motus tags to determine bat movement.

RESEARCH NEEDS

- Conduct fatality studies to determine mortality thresholds at solar facilities.
- Monitor bat use and behavior at operational solar facilities.
- Determine how bats are using solar sites to develop BMPs and mitigation strategies.
- Map bat migration corridors.
- Test avoidance methods, including acoustic or other deterrents.
- Determine impacts to invertebrate communities from solar development.
- Determine potential impacts of rooftop solar arrays on bats.
- Determine if bat and bird impacts from solar panels (mistaking panels for flat water surface) are similar.

6.5. Mining and Mineral Exploration

6.5.1. Impacts to Bat Habitat

Active mining operations and mineral exploration have the potential to impact bat populations and habitats. Clearing vegetative cover, constructing roads, blasting, erecting support buildings, digging pits, and/or developing underground facilities are frequent activities at these operations. Groundwater extraction and land cover changes due to mining activity can affect bat habitat use both directly and indirectly. These industrial development activities affect important habitat features including trees (see Section 6.1.2 Forest and Woodlands); caves, rock crevices, and talus slopes (see Section 6.1.1); and wetland and riparian areas (see Section 6.1.4).

Bat mortality or roost abandonment may occur if occupied trees, caves, rock crevices, or talus slopes are destroyed or exposed during mine development or road construction. When drilling in historical mining districts, equipment may break into underground workings, altering air flow, temperature, or causing cave-ins at existing roosting sites, leading to direct mortality or roost abandonment. General alteration of temperature, air flow, and drainage patterns has been documented to reduce or eliminate roost site use (Sheffield et al. 1992, Watson et al. 1997). Loss and degradation of native vegetation can create habitat fragmentation and affect insect population abundance and prey availability.

Active mining operations can occur below the water table, which requires pumping groundwater out of the mining operations area. Wetland areas and open water areas may be destroyed during mine construction or dewatered during operation, lowering the water table and impacting foraging and drinking habitat (see Sections 6.1.3 Open Water and 6.1.4 Riparian and Wetland). Large water diversion projects can modify the landscape through diverting stream channels or increasing surface water with reservoir or pit lake creation and groundwater recharge efforts.

Waste rock dumps, tailings piles, or tailings ponds may influence surface water flow through physical disruption or by leaching potential toxins into open water sites (see Section 6.5.2 Environmental Waste). Blasting activities can directly affect the integrity of underground roosting habitat through inadvertent collapse of features. After disturbance from mining, invasive plants may overgrow the entrance to roosting sites precluding access (the Gerlach and Taylor 2006) or alter the landscape to reduce foraging habitat. The creation of tunnels, underground workings, and site buildings may serve to attract bats, which may pose mortality or contamination risks.

Abandoned mine with roosting bats near Wells, Nevada - Almeta Helmig

Mineral exploration activities normally result in smaller, short-term disturbances when compared to active mine sites, but cause similar impacts to bats and their habitats. Bats are subjected to several types of potential disturbance from earthmoving equipment, drill rigs, and booster compressors (see Section 6.5.4 Noise Pollution). Anthropogenic disturbance from noise, lights, and vehicular traffic can reduce use of nearby roost sites and foraging habitat (see Sections 6.2 Urban Habitat and 6.3.2 Artificial Light at Night).

Collection of baseline data is required to assess impacts to bats for mining and mineral exploration (see Survey Recommendations for Section 6.5). Once the data has been obtained for a mine site, BMPs should be developed to reduce impacts to bats. Common strategies include the creation of 'no disturbance' buffer zones around known roosts. Seasonal closures and timing restrictions can also be used to protect bat roosts during periods of high use including maternity, hibernation, migration, or when bats enter and exit roost sites.

Planning for the closure of active mining with bat friendly practices is essential. Operations may happen decades after planning. Resource management agencies (state and federal) can require bat friendly closure procedures. When the NEPA process is required considerations for bats can be included in the terms of commitment. When the NEPA process is not required, commitments considering bats and their habitats can be made during state permitting.

GOAL

Minimize impacts to existing foraging and roosting habitat in areas associated with mining and mineral exploration

OBJECTIVE 1: Identify and conserve critical bat habitat within or adjacent to areas of impact.
OBJECTIVE 2: Prioritize preservation of known bat colonies and habitat.
OBJECTIVE 3: Mitigate impacts to bats from mining and mineral exploration.
OBJECTIVE 4: Monitor to determine success of bat conservation or mitigation measures.

MANAGEMENT RECOMMENDATIONS

- Identify high priority bat habitat within new mining and mineral exploration and create bat avoidance areas during project planning.
- Consider direct impacts to adjacent bat habitat and movement corridors (e.g. migratory corridors, roosting sites, drinking and foraging areas).
- Develop buffers and timing restrictions to protect seasonally important bat habitat.
- Report bat mortalities to appropriate agencies with cause of death if possible.
- Develop BMPs during the permitting process to include protections for bats and their habitat.
- Require data sharing of monitoring and survey results to improve future projects.
- Engage with operators throughout the life of the project and amend bat protections or mitigations when necessary or possible.
- Exclude bats from active mining sites.
- Consider bat habitat needs when developing mitigation measures for mining and mineral exploration.
- When known roosting habitat is within mining or mineral exploration areas and may be disturbed or destroyed, enhance roosting habitat in adjacent landscapes.
- Plan for the mine closure by incorporating bat friendly closure techniques.
- Reclaim impacted habitat from mining and exploration activities.

SURVEY RECOMMENDATIONS

- Require baseline surveys during project planning including acoustic, capture, or other methods to determine use potential and species richness. A minimum of one full year of monitoring is recommended, with the potential to increase to two years if more sufficient data is needed to develop BMPs.
- Require manual vetting of all acoustic data (see Section 5.2 Acoustic Surveys).
- Mist netting, hibernacula, and harp trap surveys are recommended for some projects, discuss necessary survey types with local biologists (see Section 6.6 Historical and Renewed Mining).
- Require data sharing of survey results to improve future projects in regard to bat conservation.

- Install Motus towers two years before construction and maintain towers during life of the project to track bat movements and use of project area to help determine if area is used for migration.
- When important bat habitat is near the project area, deploy Motus tags to determine bat movement.
- Require mortality monitoring once project is in place and determine cause of death.

RESEARCH NEEDS

- Determine the impact of active mining and exploration operations on bat populations.
- Expand knowledge on impacts to bats from non-hard rock mining.

6.5.2. Environmental Waste

The effects of environmental contaminants on bats can be direct through exposure or indirect via ecological impacts that alter insect populations, physical habitat, and water quality. Threats from mining include acid drainage from extraction into groundwater systems and runoff from mine tailings into surface water. Additionally, pit lakes have the potential to maintain high heavy metal concentrations even after mine closure.

Waste water pond at mine site near Elko, Nevada - Nycole Burton

Despite the artificial nature of wastewater impoundments at mines, these structures can present attractive habitat for foraging and drinking bats (see Section 6.1.3 Open Water). Passively recorded bat echolocation data provides evidence of the presence and relative activity of bats above water bodies at mine sites and recorded 'feeding buzz' calls indicate foraging and/or drinking. Plants growing within or adjacent to wastewater ponds may attract insects. Insects with aquatic larval stages may be contaminated with metals and/or organic compounds released through mining processes, directly impacting prey availability and potentially exposing foraging bats to bioaccumulated toxins (Axtman et al. 1997, Saiki et al. 1995, Wickhan et al. 1987). Surveys have shown bats are among the most numerous mammals found dead at wastewater sources (Clark 1919, Clark and Hothem 1991).

Cyanide solution, sometimes required in mining processes, accumulates in tailing dumps and ponds. Protective measures exist to reduce the risks of environmental contamination at these sites, such as concentration limits on toxins and the use of physical barriers such as bird balls, netting, and plastic covers on open leachate ponds (Eisler et al. 1999). Bird balls are black plastic 25 cm (10 in) diameter balls that serve a dual purpose: reducing evaporation and preventing wildlife from accessing potentially hazardous water. Bird balls are preferrable to netting, which can cause bat mortality via entanglement. While bioaccumulation of toxins from insect prey is the primary concern in wastewater impoundments, the possibility of poisoning from cyanide, which is believed to detoxify quickly without biomagnification (Eisler et al. 1999), is currently being researched.

Leach pad at mine site near Elko, Nevada - Nycole Burton

The Mineral Mining and Processing Effluent Guidelines or Ore Mining Effluent Guidelines (40 CFR Part 436 and 40 CFR Part 440) established by the U.S. Environmental Protection Agency (EPA) cover wastewater discharges from mine drainage, mineral processing operations, and stormwater runoff. These guidelines apply to construction materials, minerals used in chemicals, and miscellaneous minerals. However, the specific impact of these guidelines on bats, or wildlife in general, is not directly addressed in the regulations. The Clean Water Act and U.S. Fish and Wildlife Service provide legal guidance and management policies addressing contaminants from mining. The Nevada Department of Environmental Quality and Nevada Department of Mining also have guidelines and management policies for wastewater related to mining. When guidelines and management policies are adhered to, contaminants pose a minimal direct risk to wildlife, including bats. However, non-adherence may result in bat mortality.

GOAL

Reduce mortality potential of bats from environmental waste due to mining

OBJECTIVE 1: Preserve clean and healthy drinking and foraging habitat in landscapes with mining activities.

OBJECTIVE 2: Prevent bats from coming into direct or indirect contact with harmful chemicals.

MANAGEMENT RECOMMENDATIONS

- Ensure availability of clean and healthy drinking water by maintaining natural perennial water sources in or near project areas.
- Maintain natural riparian areas in or near project areas to provide healthy foraging habitat.
- Utilize risk-assessment models to evaluate impacts to bats encountering harmful wastewater.
- Work with mining companies during the planning process to reduce bat habitat loss from environmental waste.

- When habitat loss from environmental waste cannot be avoided or excluded from a project, improve nearby lower-quality habitat to compensate for the loss.
- Add wildlife criteria to scheduled surface water monitoring to ensure safe drinking water and determine thresholds with associated responses when thresholds are exceeded.
- Safely exclude bats from contaminated foraging and drinking habitats.
- Incorporate bat protection measures into response protocols for acid mine drainage occurrences.
- Require data sharing to improve future projects for bat conservation.

RESEARCH NEEDS

- Determine if the EPA Mineral Mining & Processing Effluent Guidelines & Standards and the Ore Mining Effluent Guidelines reduce risks to bats.
- Determine the nature and extent of water quality problems and their effects on bat populations.
- Research cyanide toxicosis risk to bats foraging and drinking on active mine sites including impacts on reproductive success.
- Determine impacts to bats foraging in mining areas due to bioaccumulation of toxins associated with leach effluent.
- Research bat use of toxic areas with acoustic or other survey methods.

6.5.3. Industrial Lighting

Lighting near roosting sites can have negative effects on bat behavior (see Section 6.3.2 Artificial Light at Night). Increased lighting may increase insect prey density (Eisenberg 2006, Rydell 2006), but reduce overall insect diversity (Gili et al. 2024), attracting some bats to utilize the localized pockets of forage. But the industrial lighting required at mine sites can cause direct injury or bat mortality. Burns to wing membranes may occur due to accidental contact with these high heat sources. Bat injury or mortality may be reduced or eliminated with the installation of "cooler" LED bulbs and protective features, such as mesh, around fixtures to reduce potential contact with the light. Maintaining natural cover around the mine site, especially between known bat habitat and mine facilities, can decrease effects of disturbance by lighting.

GOAL

Reduce mortality and injury potential of bats from industrial lighting due to mining and mineral exploration

OBJECTIVE 1: Prevent bats from coming in contact with harmful industrial lighting during foraging.

MANAGEMENT RECOMMENDATIONS

- Cover light sources with appropriate shielding to prevent contact burns during foraging.
- Recommend use of lights that do not create high heat when in use.
- Use Dark Sky Principles when possible (see Section 6.3.2 Artificial Light at Night).
- Require mortality monitoring once project is in place and determine cause of death.
- Require data sharing of monitoring and survey results to improve future projects.

RESEARCH NEEDS

- Continue research on species-specific impacts of high intensity industrial lighting.

6.5.4. Noise Pollution

Because bats use echolocation to traverse landscapes without the use of vision, ambient noise influences their navigation. Noise and physical disturbance from blasting, dust accumulation in the air, and vibrations during site preparation, construction, or mine activities, can all affect bats. Research shows a significant decrease in bat activity during active blasting periods (Schaub et al. 2008). When mining activity is near hibernating bats, intense noise and increased lighting impacts survival by arousing bats and increasing energetic costs (Geiser 2004, Thomas et al. 1990, Thomas 1995). High levels of noise also mask acoustic signals, potentially making it more difficult to defend territories, attract mates, and communicate with begging, alarm calls, or distress calls (Jones 2008).

GOAL

Reduce impacts of mining and mineral exploration noise on bat behavior

OBJECTIVE 1: Consider bat use and presence when planning and conducting mining operations.

MANAGEMENT RECOMMENDATIONS

- Consider high traffic area placement during the planning process in relation to existing bat roost sites.
- Avoid placement of generators and other high frequency noise generating machinery near bat roost sites.
- Implement timing restrictions to avoid impacts to known maternity roosts and hibernacula within or adjacent to mining areas.
- Buffer known roost sites from noise impacts by modifying project logistics, using topography, or artificial sound dampening resources.
- Require data sharing of monitoring and survey results to improve future projects.

RESEARCH NEEDS

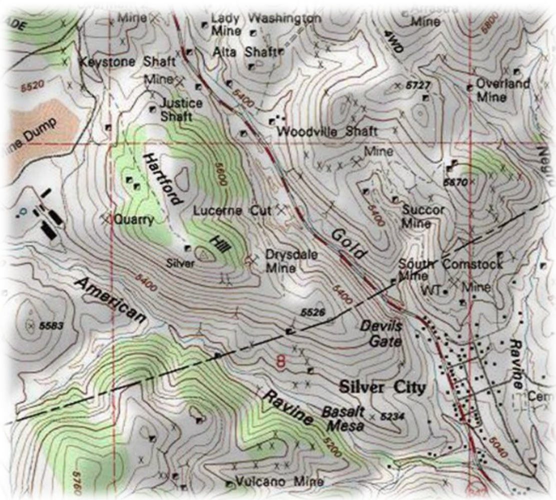
- Determine long- and short-term impacts of mining noise on bat activity and behavior.
- Preliminary findings suggest the need for further exploration of how human-induced noise increases the effects of land-use change to bat diversity and populations.

6.6. Historical and Renewed Mining

6.6.1. Abandoned Mine Land Remediation

Bats are attracted to historical mines with features that mimic natural cave environments. Abandoned mines are often located in remote areas and typically experience low human disturbance. They are also abundant, widely distributed, and offer a range of physical conditions, including consistent temperature and humidity levels required during critical roosting periods. At least 29 of the 45 recorded bat species in the U.S. can be found in abandoned mines (Tuttle and Taylor 1998, Ducummon 1997). Some utilize abandoned mines for a single night as stopover sites during migration, while others, including several endangered and threatened species, use these sites year-round. Abandoned mine features provide roosting opportunities in areas where caves do not naturally exist, expanding available habitat for cave-dwelling bats.

Abandoned Mines in Nevada



USGS Topographic map depicting mine features in Nevada.

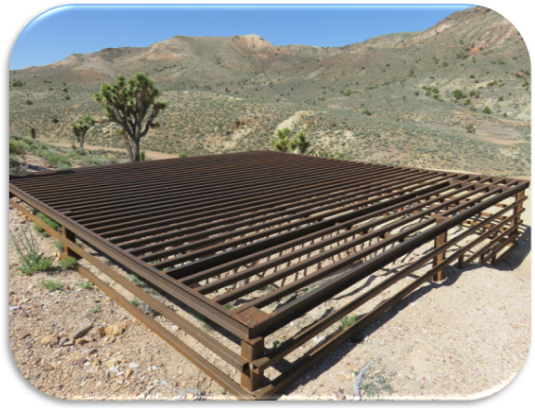
The structures associated with hard rock mining provide critical habitat for cave-dwelling bats, and Nevada is the number one mineral producer in the United States (Department of the Interior, U.S. Geological Survey, Minerals Commodity Summary, April 14, 2017). Nevada's mining industry dates back over 150 years and continues to operate under the jurisdiction of the General Mining Law of 1872. Designed to encourage settlement and economic development of western states, this law allows the public to claim valuable mineral deposits on federal land. Provisions regulating reasonable restoration, or reclamation, of landscapes impacted by mining did not exist under the 1872 law, and prior to the Surface Mining and Reclamation Act of 1975, mines were not required to be reclaimed for alternative uses or closed for public safety. As a result, most mines were simply abandoned (Belwood and Waugh 1991). Because mining claim records were not required until 1976, the exact number of abandoned mines is unknown, but hundreds of thousands of abandoned mines are estimated to exist in Nevada.

Abandoned Mine Lands (AMLs) pose a physical and environmental safety hazard to the public (Lee 2016, Morrison and Fox 2009, Bellwood and Waugh 2020). Potential dangers include cave-ins from loose rock and rotten timber, deep water at the bottom of shafts, poisonous gases, oxygen-deficient "bad air", and abandoned explosives. With hazard and liability abatement in mind, the USFS, BLM, and National Park Service (NPS) began large-scale projects in the 1990s to reclaim abandoned mines on public lands. Addressing the physical hazards associated with abandoned mines is a complex process. Remedies range from simple fencing with signs that meet federal and state minimum requirements for claimant "no liability" to permanent closure. The treatment of each AML hazard is determined on a case-by-case basis with the primary focus being public health and safety.

If agency staff determine an abandoned mine feature warrants permanent closure, surveys are conducted to determine the biological, historical, and physical characteristics of the feature to inform closure decisions. For bats, internal surveys provide the best information on mine use (see Section 6.7 White Nose Syndrome and Section 5.5 Roost Survey). Where internal surveys are not possible due to human safety concerns, external surveys using a combination of night vision optics, acoustic monitoring, and physical trapping efforts are used. Assessment of AMLs in Nevada for bat use as well as bat exclusion methods, should follow protocols identified in the handbook "Managing Abandoned Mines for Bats" (Sherwin et al. 2009).

North American Bats and Mines Project

- Started in 1993 by the Bureau of Land Management and Bat Conservation International to protect bats and bat habitat from mine closures[1].
- Promotes the use of wildlife friendly gates to close abandoned mines with current or potential use by bat colonies.
- Before this program's launch, bats were inadvertently buried during mine-reclamation activities.
- Poorly conducted or inappropriate surveys, exclusions, and closures of mines puts bats at risk of losing roost sites or being entombed.
- Abandoned mines represent a significant liability to land managers; however, AML programs that do not operate in a bat-friendly manner risk destroying roosts and the bats that depend on them[1].
- Provides support to federal, state, and local agencies and the mining industry to:
  - Conduct bat surveys
  - Protect important bat roosts, and
  - Conduct research that will have direct management implications.


Bat friendly mine shaft closure -Julia Hoeh

References: 1. Ducummons 1997, 2. Watkins 2002

AML hazards are typically closed in one of three ways: backfilling, sealing with polyurethane foam, or gating/grating. Backfilling, or "hard closure", is performed on hazards with little historical or habitat value which pose a threat to public health. Because these features will be completely filled, netting is used to allow bats to exit safely while precluding bats from entering/re-entering the mine. Netting is placed at the feature approximately one week prior to closure to ensure bats are not present during closure activities. Foam plugs are utilized when culturally significant features are associated with the AML hazard, but little wildlife habitat potential exits. This allows the historical value of the sites to be preserved while addressing public safety.

If bat use is suspected due to favorable habitat conditions, presence of guano within the mine, or visual confirmation of roosting or exiting bats, Bat Compatible Closures (BCCs) are the preferred closure technique. BCCs are constructed at the portal, or entrance, of adits (horizontal mine openings), and allow bats, birds, and other wildlife to use the mine for habitat while safeguarding the public. For vertical shafts, a grate or a cupola is installed to allow wildlife continued access. Mines with unstable portals may benefit from the installation of a culvert to provide stability for internally constructed grates. Many bats, including several endangered species, will tolerate gates and grates at mine entrances if the dimensions between bars are an adequate size and the gate/grate does not impede airflow or alter climatic stability (Kobilinsky 2018). If AML hazards are not suitable for closure due to inaccessibility, installation of wire fences, cable netting, and bright warning signs can be used to indicate the potential hazard.

Bat Compatible Closures

Bat compatible adit gate - Nycole Burton

Bat compatible shaft grate - Unknown photographer

Bat compatible shaft copula - Unknown photographer

Bat compatible stabilization culvert - Nycole Burton

GOAL

Protect bat habitat in abandoned mine lands while maintaining public safety

OBJECTIVE 1: Preserve important bat roosting sites in abandoned mines.

OBJECTIVE 2: Ensure public safety by utilizing appropriate closure methods at abandoned mines.

MANAGEMENT RECOMMENDATIONS

- Work cooperatively with state and federal agencies throughout the AML closure process to improve conservation potential and public safety awareness.
- Require bat surveys for abandoned mine lands before conducting public safety measures.
- Follow guidelines presented in Managing Abandoned Mines for Bats (Sherwin et al. 2009).
- When bat habitat or presence cannot be confirmed, use BCCs to protect potential habitat and ensure public safety.
- Allow access through BCCs for appropriate agency personnel to monitor bat habitat and populations.
- Use signage to inform the public about dangers of AML sites, the purpose of bat compatible closures, protecting bat habitat, and reducing the spread of WNS.

- Require data sharing of monitoring and survey results to improve future projects.

SURVEY RECOMMENDATIONS

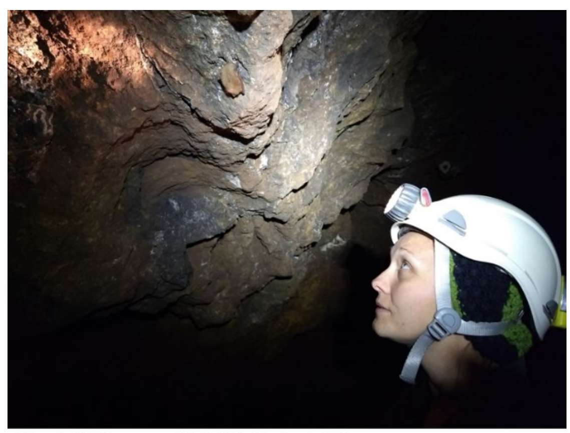
- Biologists should obtain AML specific training, certification, and permits before conducting underground surveys for bats.
- Require surveys to be completed by experienced professionals (Section 5.5 Roost Surveys).
- Require WNS decontamination procedures for internal surveys of AML sites and bat trapping.
- Monitor AML sites before and after closure installation to determine conservation success.
- Prioritize internal surveys of AML sites for bats and important bat habitat when possible.
- Conduct external surveys when internal surveys are not possible which may include bat trapping or roost exit counts.
- If internal surveys, roost exit counts, or bat trapping cannot be conducted, use acoustic survey methods to determine species diversity within the area (this will not indicate AML site specific use). Discuss survey methods with local biologists.
- If using acoustic methods, do not place detectors inside of or directly outside of AML sites (see Section 5.2 Acoustic Survey).

RESEARCH NEEDS

- Determine if BCCs impact use of AML sites in Nevada.
- Determine if there is species variability in tolerance of different bat compatible closures.

6.6.2. Renewed Mining

Renewed mining activity in inactive and historical mining areas is a concern for bat conservation. AMLs and reclaimed historical mining areas provide valuable habitat to bats. Despite previous disturbance from mining in these areas, when renewed mining occurs, wildlife protections and regulations still apply to current habitat conditions (NAC 503.103).



Internal AML Survey near Wells, NV - Mackenzie Jeffress

When renewed mining occurs, AMLs previously gated to protect bats are re-opened, impacting existing bat colonies and removing protected habitat for some species (see Section 6.6.1 Abandoned Mine Land Remediation). Bats should be excluded prior to renewed activity, and/or activities should be delayed until bats are not present. Impacts may be more significant if bats use abandoned mines as summer and winter roosting habitats. Bats may additionally enter mines in winter to forage on hibernating insects. Once mining has been renewed in an area, there are many additional impacts to bats (see Section 6.5 Mining and Mineral Exploration).

Renewed mining within previously closed mine sites does not always require the destruction or modification of all abandoned mine features in the area. Land managers can offset habitat loss by working with mining companies to enhance or conserve remaining habitat on or adjacent to the site. This may include restoration of nearby foraging habitats, such as riparian areas, or installing BCCs on adjacent abandoned mine features. Bat habitat can be conserved within a reopened mine by sectioning off portions of tunneling not needed for current mining or developing artificial roosting sites adjacent to old roost areas (Ducummon 1997).

GOAL

Reduce impacts to bat roosting habitat in areas of renewed mining

OBJECTIVE 1: Preserve or improve bat habitat in or around areas of renewed mining.

OBJECTIVE 2: Reduce potential for bat mortality when reclaiming AMLs.

MANAGEMENT RECOMMENDATIONS

- Work cooperatively with state and federal agencies to determine if existing bat habitat is found in the project area.
- Identify high priority bat habitat within the renewed mining project and create bat avoidance areas during project planning.
- Require bat surveys for abandoned mine sites to determine appropriate habitat conservation measures.
- Develop buffers and timing restrictions to standardize protection of important bat habitat.
- If known roosting habitat within AML sites will be disturbed or destroyed by renewed mining, follow proper exclusion methods and enhance roosting habitat in adjacent landscapes.
- Require data sharing of monitoring and survey results to improve future projects.

SURVEY RECOMMENDATIONS

- Biologists should obtain AML specific training, certification, and permits before conducting underground surveys for bats.
- Require surveys to be completed by experienced professionals (Section 5.5 Roost Surveys).
- Monitor all known and potential roost locations within the project area and surrounding habitat.
- Prioritize internal surveys of AML sites for bats and important bat habitat when possible.
- Conduct external surveys when internal surveys are not possible which may include bat trapping or roost exit counts.
- If internal surveys, roost exit counts, or bat trapping cannot be conducted, use acoustic survey methods to determine species diversity within the area (this will not indicate AML site specific use).
- If using acoustic methods, do not place detectors inside of or directly outside of AML sites (see Section 5.2 Acoustic Survey).
- Monitor important bat roosts at AML sites preserved within areas of renewed mining.
- Require data sharing of survey results to improve future projects in regard to bat conservation.
- Install Motus towers two years before construction and maintain towers during life of the project to track bat movements and use of project area to help determine if area is used for migration.

- When important bat habitat is near the project area, deploy Motus tags to determine bat movement.
- Require mortality monitoring once project is in place and determine cause of death.

RESEARCH NEEDS

- Research bats response to renewed mining.
- If bats are displaced by renewed mining, determine new roost site locations.
- Research distances traveled by displaced bats to new roost sites.

6.7. White-nose Syndrome (WNS)

WNS is a disease caused by the fungus *Pseudogymnoascus destructans (Pd)*, which effects hibernating bats. Considered one of the deadliest wildlife diseases, WNS has killed millions of bats across North America since 2006, decimating entire colonies with over 90% mortality at some sites. This disease does not affect humans or other animals, but small-bodied hibernating bats such as the little brown myotis are highly vulnerable. Other bats, like the western big-eared bat, have been found with *Pd* on their bodies but no symptoms associated with the disease, demonstrating the variability in impact among bat species.

Table 4: Nevada Bat Species with Known Occurrences of WNS or *Pd* within North America

Common Name(s)	Scientific Name	WNS Confirmed*	*Pd* positive**
Allen's big-eared bat	*Idionycteris phyllotis*		
Big brown bat	*Eptuscus fuscus*	X	
Big free-tailed bat	*Nyctinomops macrotis*		
California leaf-nosed bat	*Macrotus californicus*		
California myotis	*Myotis californicus*		
Canyon bat, western pipistrelle	*Parastrellus Hesperus*		X
Cave myotis	*Myotis velifer*	X	
Fringed myotis	*Myotis thysanodes*	X	
Hoary bat	*Lasiurus cinereus*		
Little brown myotis, little brown bat	*Myotis lucifugus*	X	
Long-eared myotis	*Myotis evotis*	X	
Long-legged myotis	*Myotis volans*	X	
Mexican free-tailed bat, Brazilian free-tailed bat	*Tadarida brasiliensis*		X
Pallid bat	*Antrozous pallidus*		
Pocket free-tailed bat	*Nyctinomops femorosaccus*		
Silver-haired bat	*Lasionycteris noctivagans*		X
Spotted bat	*Euderma maculatum*		
Western big-eared bat, Townsends big-eared bat	*Corynorhinus townsendii*		X
Western mastiff bat, greater bonneted bat	*Eumops perotis*		
Western red bat	*Lasiurus frantzii*		
Western small-footed myotis	*Myotis ciliolabrum*		X

Common Name(s)	Scientific Name	WNS Confirmed*	*Pd* positive**
Western yellow bat	*Lasiurus xanthinus*		
Yuma myotis	*Yuma myotis*	X	

WNS/*Pd* has not been detected in Nevada. Species listed in this table have been documented with WNS and/or *Pd* in North America. Blank spaces in this table are intentional and could change. This table is current as of October 2024. More information and updates can be found on the White-nose Syndrome Response Team website (https://www.whitenosesyndrome.org/static-page/bats-affected-by-wns).

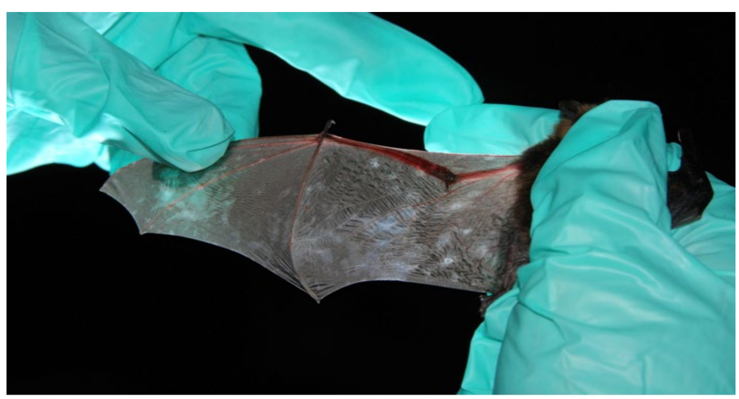
* WNS Confirmed: Species/subspecies identified with diagnostic symptoms of WNS.

***Pd* positive: Species/subspecies on which *Pd* has been detected but no diagnostic signs of WNS.

Myotis with pd fungus - John Chenger

The white fuzz *Pd* creates on the noses of hibernating bats is the namesake of the disease. *Pd* grows in cold, dark, damp environments and can invade the skin tissue of WNS-susceptible species during hibernation. The fungal infestation wakes hibernating bats, leading to mortality from depleted energy stores or exposure. Bats that survive a hibernation period with WNS may be unable to reproduce successfully after emergence. Many infected bats show signs of the disease in the form of wing damage, and the skin tissue may also glow orange under a specific wavelength of ultraviolet light. However, surviving bats that find adequate food and shelter in the early spring are often able to clear the fungus and recover over the subsequent season.

Neither the fungus *Pd* nor the disease WNS has been detected in Nevada, but WNS, first discovered in eastern north America in 2006, is now found in many western states. As of 2024, *Pd* has been confirmed or is presumed present in Utah and Idaho, as well as several California counties along the western border of Nevada.



Wing damage from WNS - John Chenger

Current strategies for monitoring WNS include active surveillance (i.e. sampling bats for *Pd* and looking for signs of the disease at hibernacula and during the spring hibernation emergence period, and bat colony

Roosting myotis with pd fungus - John Chenger

counts for WNS susceptible species) and passive surveillance (i.e. tracking reports of sick and dead bats). Swabbing for WNS should occur at times when the fungal load is highest during late winter inside hibernacula, or within four weeks following emergence in the spring. Spring emergence surveys should ideally be conducted at roosts but can also occur at water sources or other high use areas if roost locations are not known.

Surveillance should occur at appropriate habitat statewide, with an emphasis on areas with the greatest probability of prevalence. Regular surveillance is critical to prevent the spread of *Pd* and WNS and informing a response to any future detections in Nevada. Developing a monitoring network for colonies of WNS-susceptible species, specifically those which can be reliably counted, is also important to evaluate the impact of WNS if the disease arrives in Nevada.

The threat posed by WNS is variable among bat species, but all bat habitats (e.g. roosting and foraging) should be protected to ensure bats have sufficient energy stores upon entering hibernation in fall and emerge to adequate food and shelter in spring. Other sections in this plan address specific strategies to reduce the impacts of WNS by supporting bat habitats and populations.

Conducting internal AML Surveys -Almeta Helmig

White-nose Syndrome Decontamination

If you visit potential bat roosts in caves, mines, bridges, buildings, etc., please decontaminate all clothing and gear between sites to prevent the spread of White-nose Syndrome.

National WNS Decontamination Protocol (updated March 2024)

GOAL

Prevent the spread of White-nose syndrome throughout Nevada

OBJECTIVE 1: Ensure proper implementation of the current National White-nose Syndrome Decontamination Protocol (https://www.whitenosesyndrome.org/static-page/decontamination-information).

OBJECTIVE 2: Provide information to the public to prevent the spread of WNS.

OBJECTIVE 3: Conduct active and passive surveillance for *Pd* and WNS.

OBJECTIVE 4: Identify additional hibernation and maternity roosts of WNS-susceptible species throughout the state.

OBJECTIVE 5: Monitor WNS-susceptible bat populations to collect baseline population data and detect impacts from WNS.

OBJECTIVE 6: Support WNS susceptible bat populations through habitat conservation and restoration.

MANAGEMENT RECOMMENDATIONS

- Provide wildlife professionals working in Nevada with the most current protocols for WNS decontamination generated by the National WNS Response Team (https://www.whitenosesyndrome.org/static-page/decontamination-information) and require adherence to these protocols.
- Prioritize education and dissemination of WNS resources and decontamination protocols to non-wildlife professionals who may encounter bat roosts in caves, bridges, buildings, abandoned mines, and other roosting habitat.
- Ensure roost sites with Pd detections are closed to public use and signed with WNS information.
- Use best practices for *Pd* and WNS surveillance. Contact NDOW and White-nose Syndrome Response Team in the survey planning process. Use an approved lab for WNS detection and analysis.
- Prioritize surveillance for early detection of *Pd* to provide opportunity for rapid response.
- Upon detection of *Pd* increase surveillance efforts at and near infected sites to facilitate treatment or other responses and monitor population impacts (see Section 5 Bat Surveys).
- Identify important roost sites WNS-impacted species and prioritize these roosts for protection and potential treatment (if treatment is appropriate for colony recovery).
- Report bat roosts to: https://www.pacwestbats.org/nbwg
- Establish baseline population data for WNS susceptible species (see Section 5 Bat Surveys) and establish monitoring sites to determine population trends/WNS impacts.
- Provide survey data to the NABat Program to allow for analysis on population status of WNS impacted species.
- Identify and protect habitats important for foraging and drinking to improve potential for survival of WNS.

SURVEY RECOMMENDATIONS

- Survey recommendations may rapidly change for WNS surveillance. WNS and *Pd* surveillance in Nevada should be done in coordination with NDOW and the USFWS WNS Coordinator.

RESEARCH NEEDS

- Determine where roosts in Nevada are more likely to support *Pd* due to microclimatic conditions.
- Determine if roost conditions in Nevada support the development of WNS.
- Determine connectivity of bat roosts and monitor spread of WNS between roosts within and between states

7. APPENDICIES

7.1. Distribution Maps

7.1.1. Distribution Map Data

Distribution maps found in this appendix contain current observations of Nevada bats as of 2022 and inset range maps for each species. Each dataset is described below. As technology improves, it is expected these maps will expand and change. Please reach out to the database hosts listed for more current range information.

Nevada Division of Natural Heritage: Biotics Database

Records include captures, observations, museum specimens, and acoustic detections of bats from 1913-2022. All acoustic records have been manually vetted. Raw data are available by request at: https://heritage.nv.gov/

NABat Database

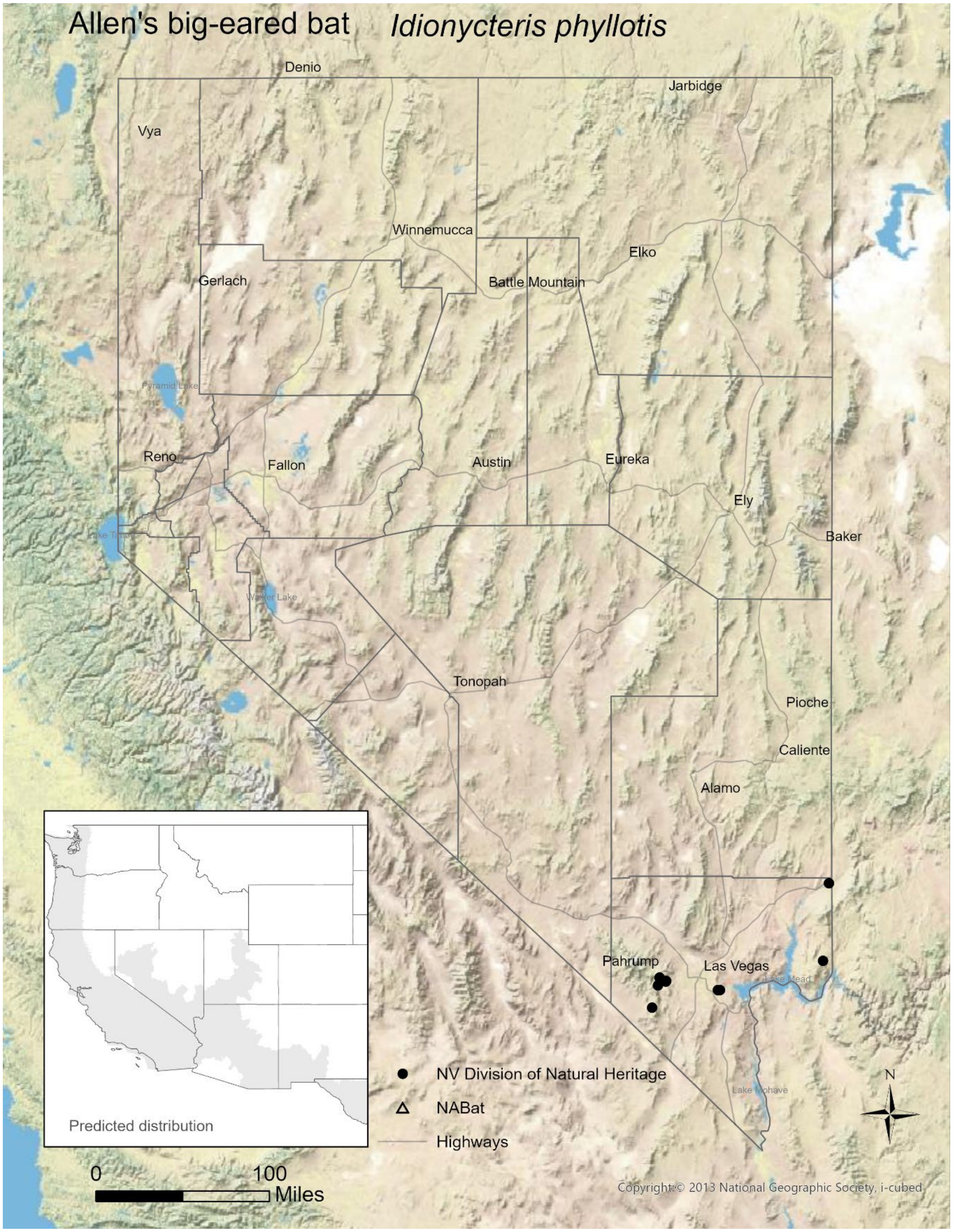
Records include acoustic detections of bats collected as part of the North American Bat Monitoring program from 2001 -2022. All acoustic records have been manually vetted. Raw data are available by request at: https://sciencebase.usgs.gov/nabat/#/results

Predicted Distribution Maps

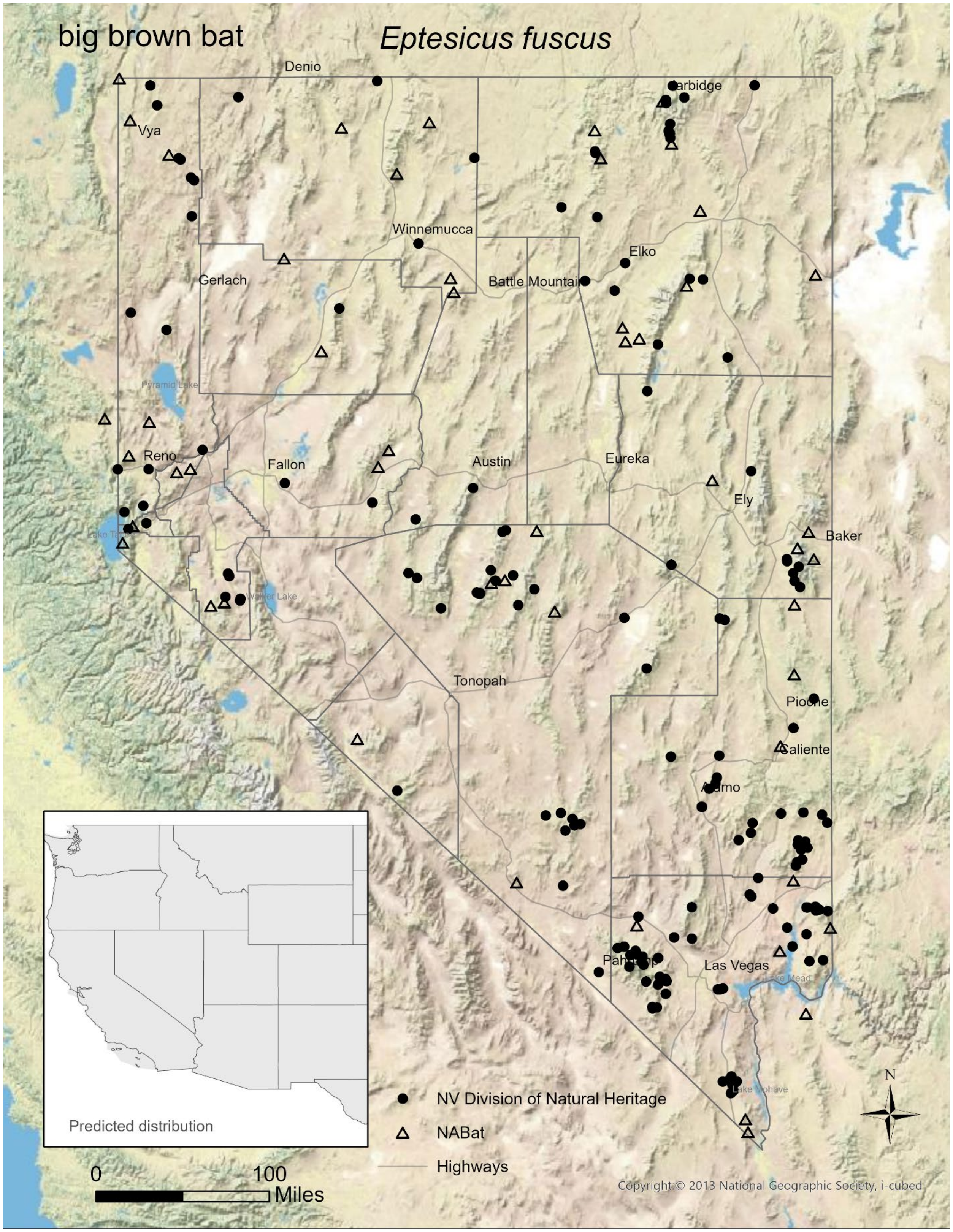
These inset maps are based on known range extent within the conterminous United States (CONUS) based on 2001 ground conditions. Range maps were created by attributing sub-watershed polygons with information of a species' presence, origin, seasonal and reproductive use. See Gap Analysis Project Species Range Maps for more information regarding data creation and user constraints.
https://www.sciencebase.gov/catalog/item/59f5e1e8e4b063d5d307db81

For species specific range information, see the attached Range data.
https://www.sciencebase.gov/catalog/item/5951527de4b062508e3b1e79

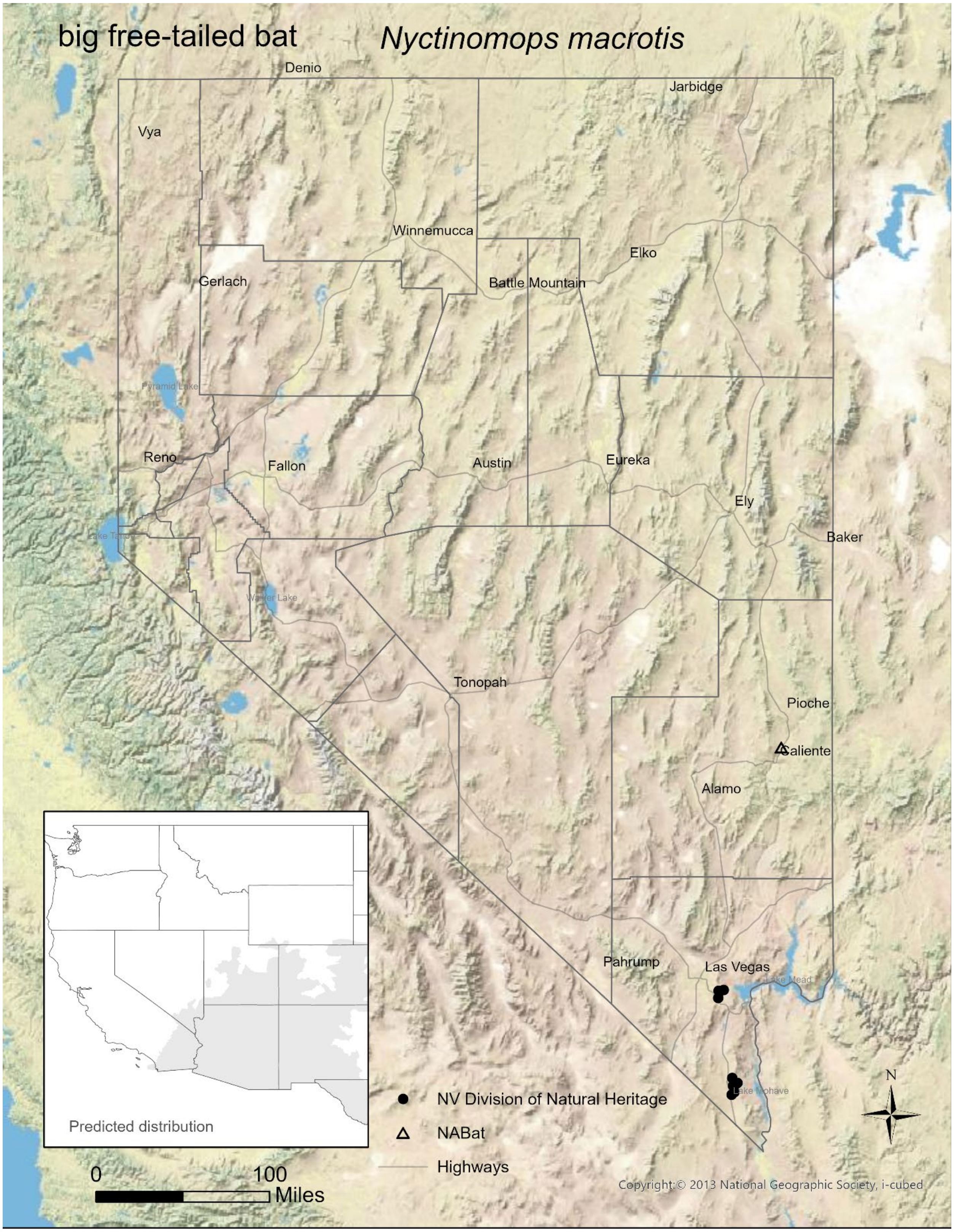
7.1.2. Allen's Big-eared Bat Distribution Map



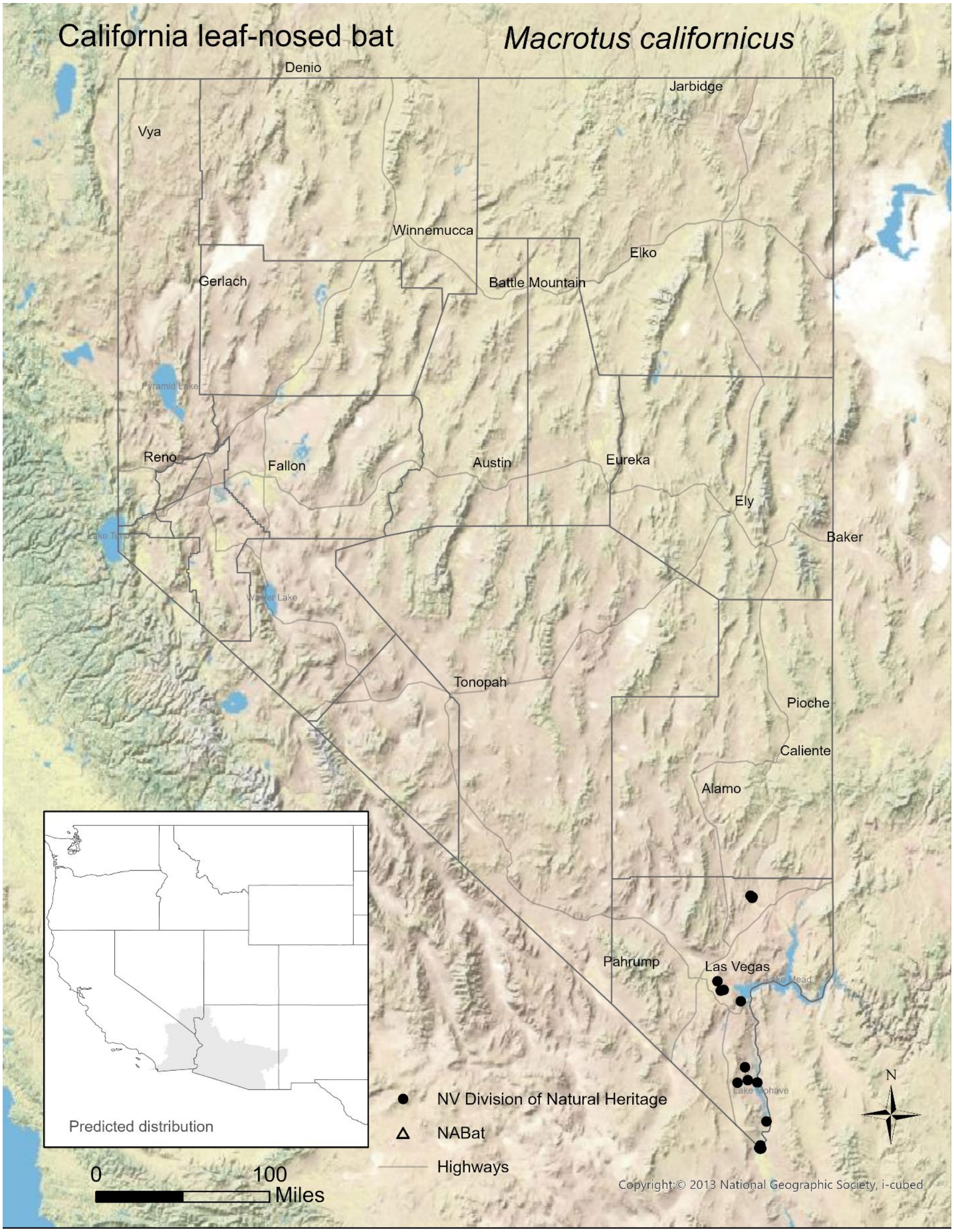
7.1.3. Big Brown Bat Distribution Map



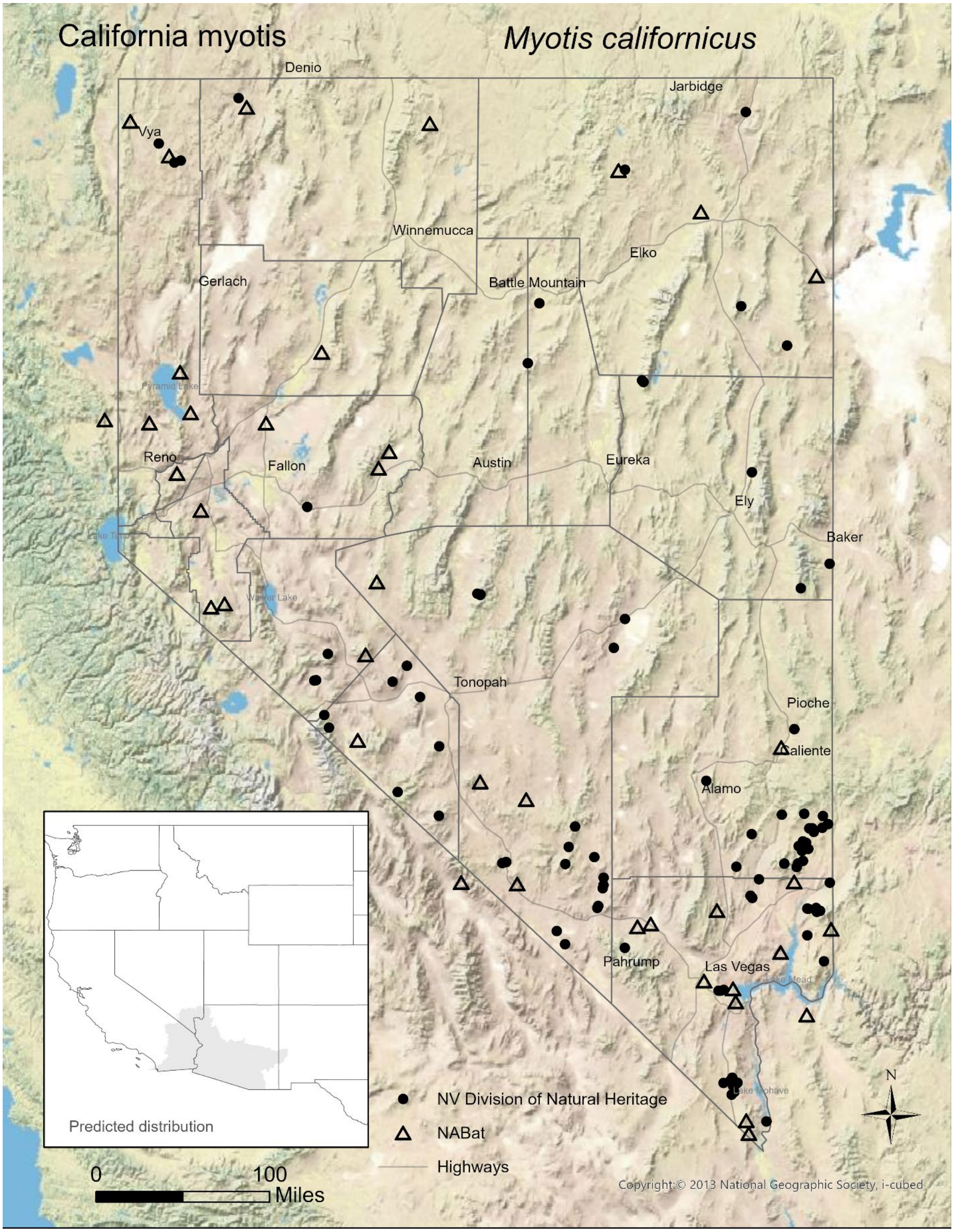
7.1.4. Big Free-tailed Bat Distribution Map



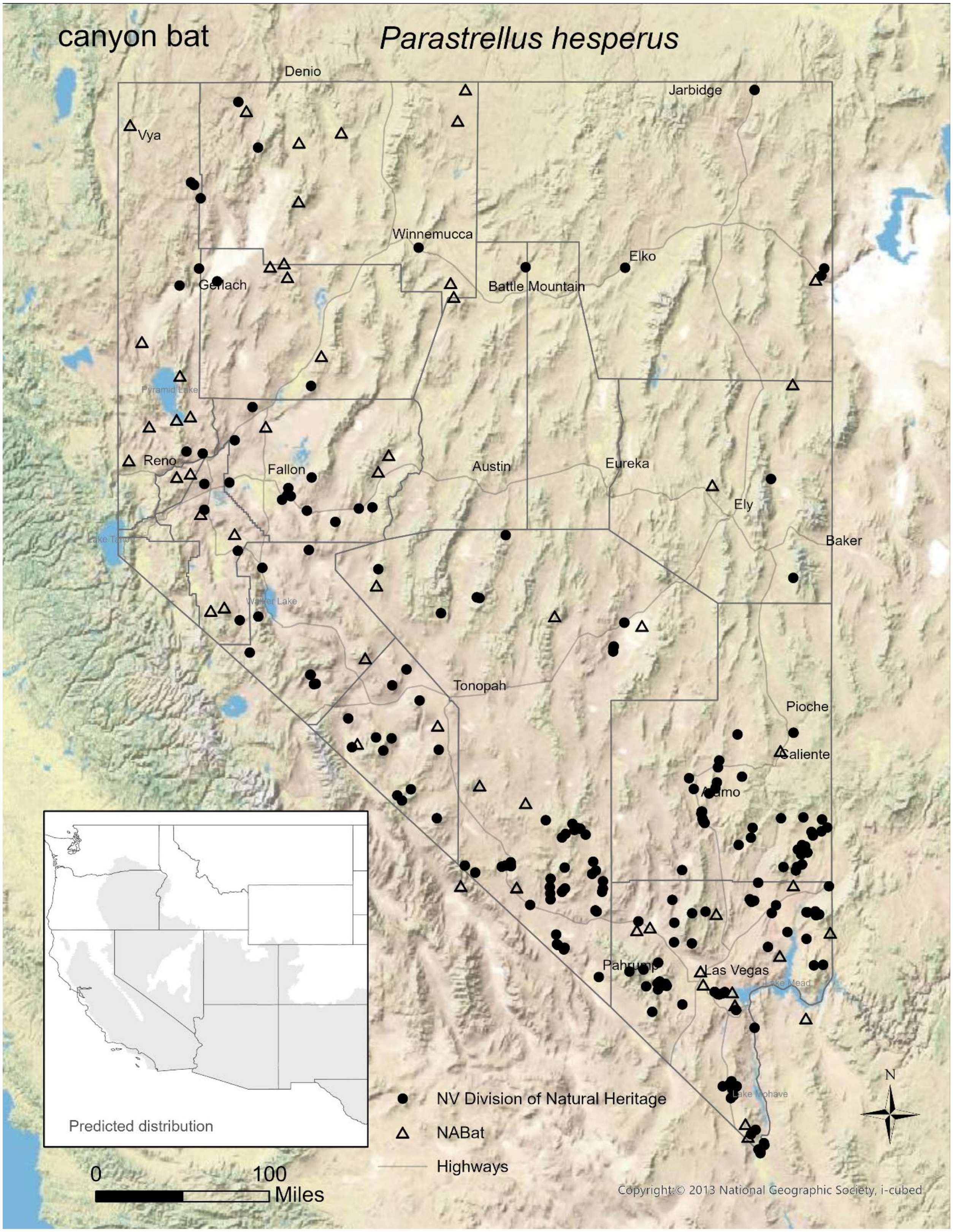
7.1.5. California Leaf-nosed Bat Distribution Map



7.1.6. California Myotis Distribution Map

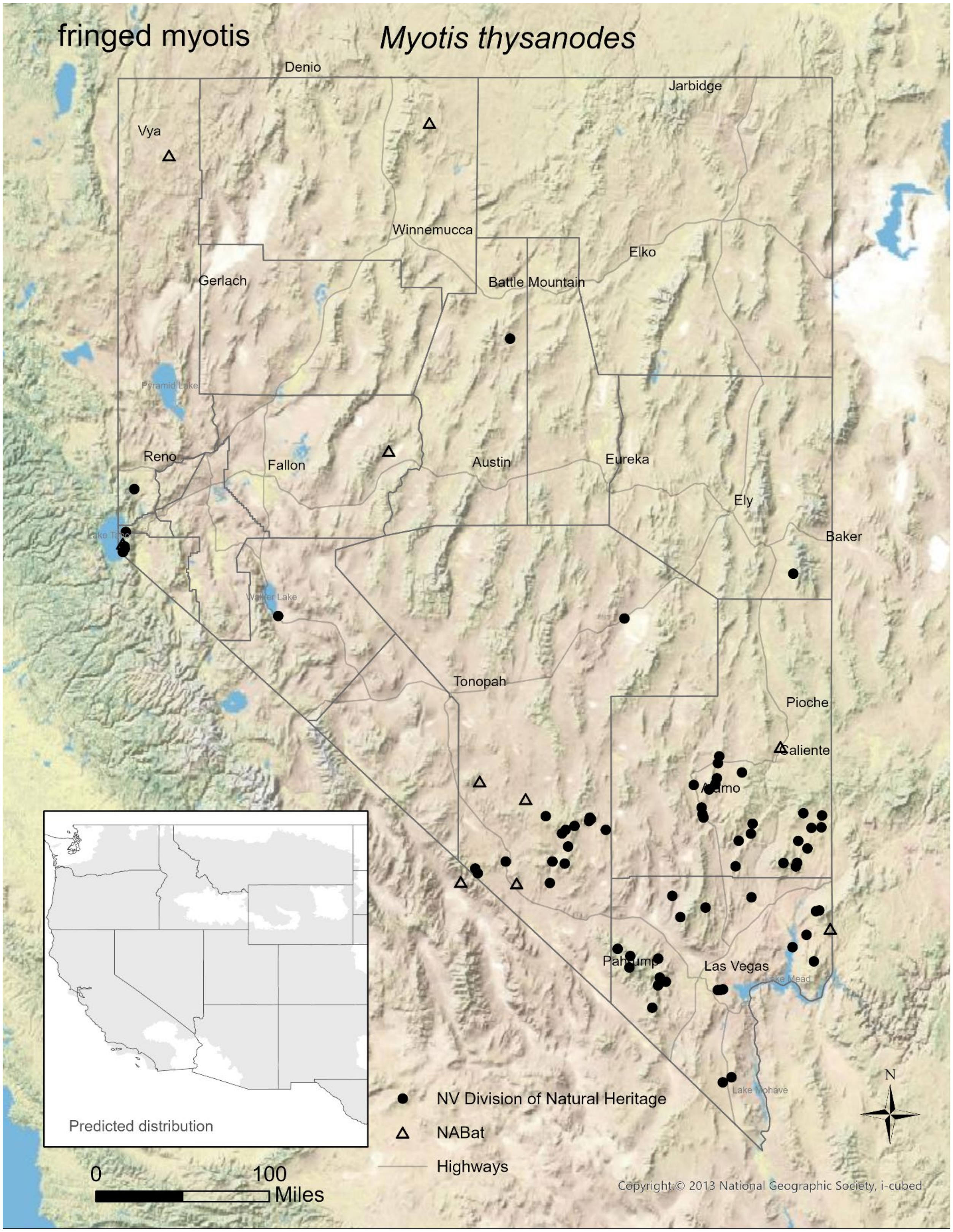


7.1.7. Canyon Bat Distribution Map

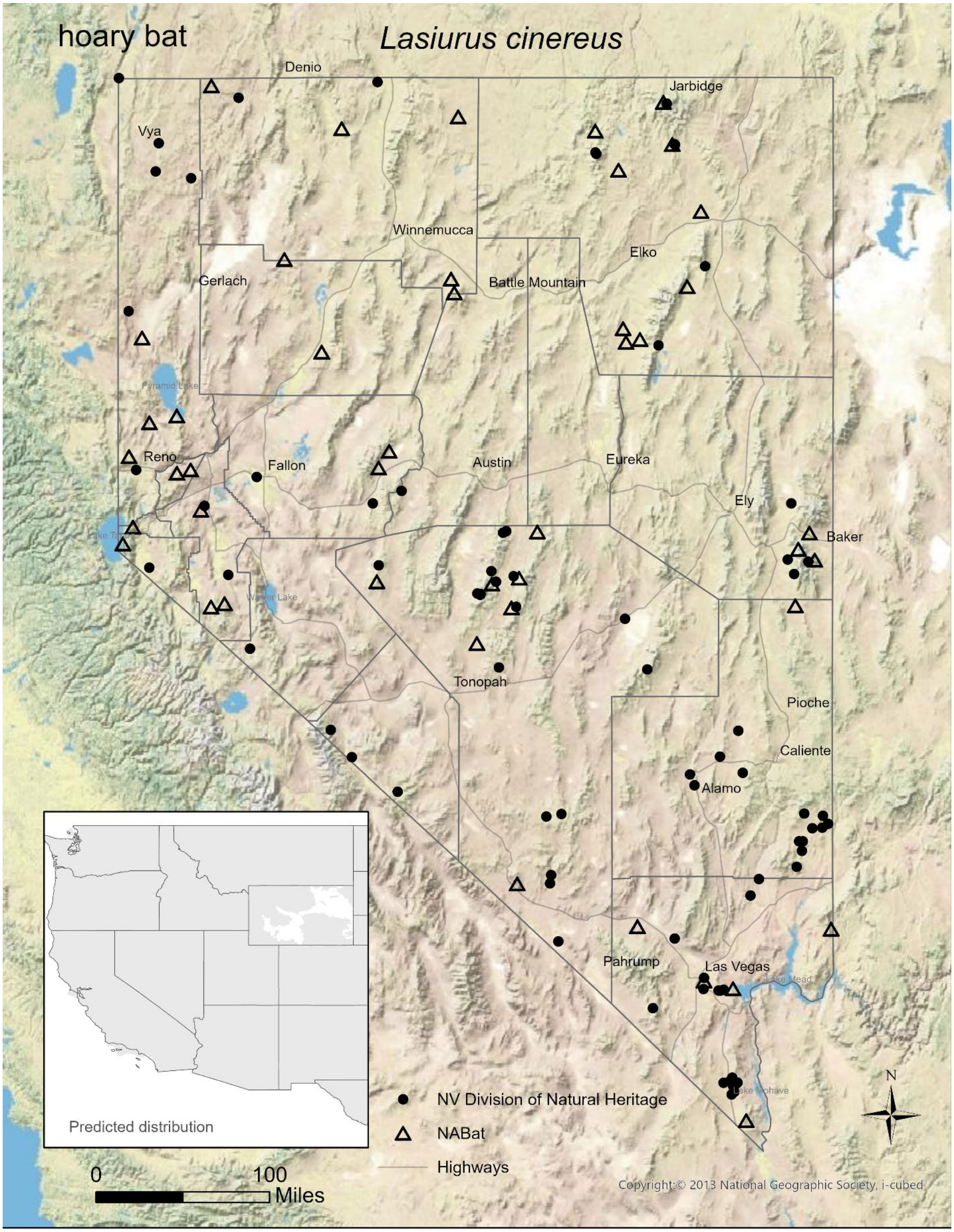


7.1.8. Cave Myotis Distribution Map

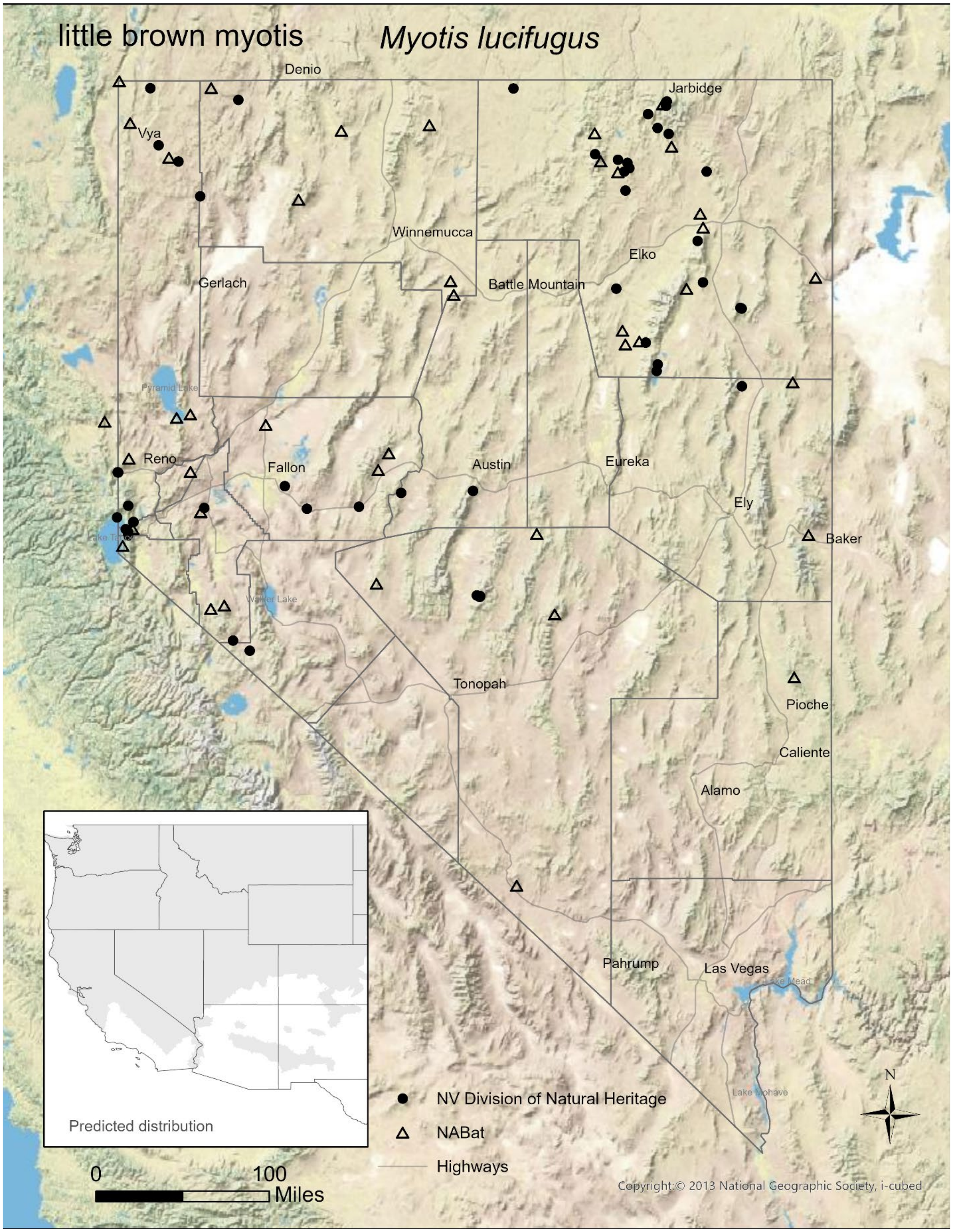
7.1.9. Fringed Myotis Distribution Map



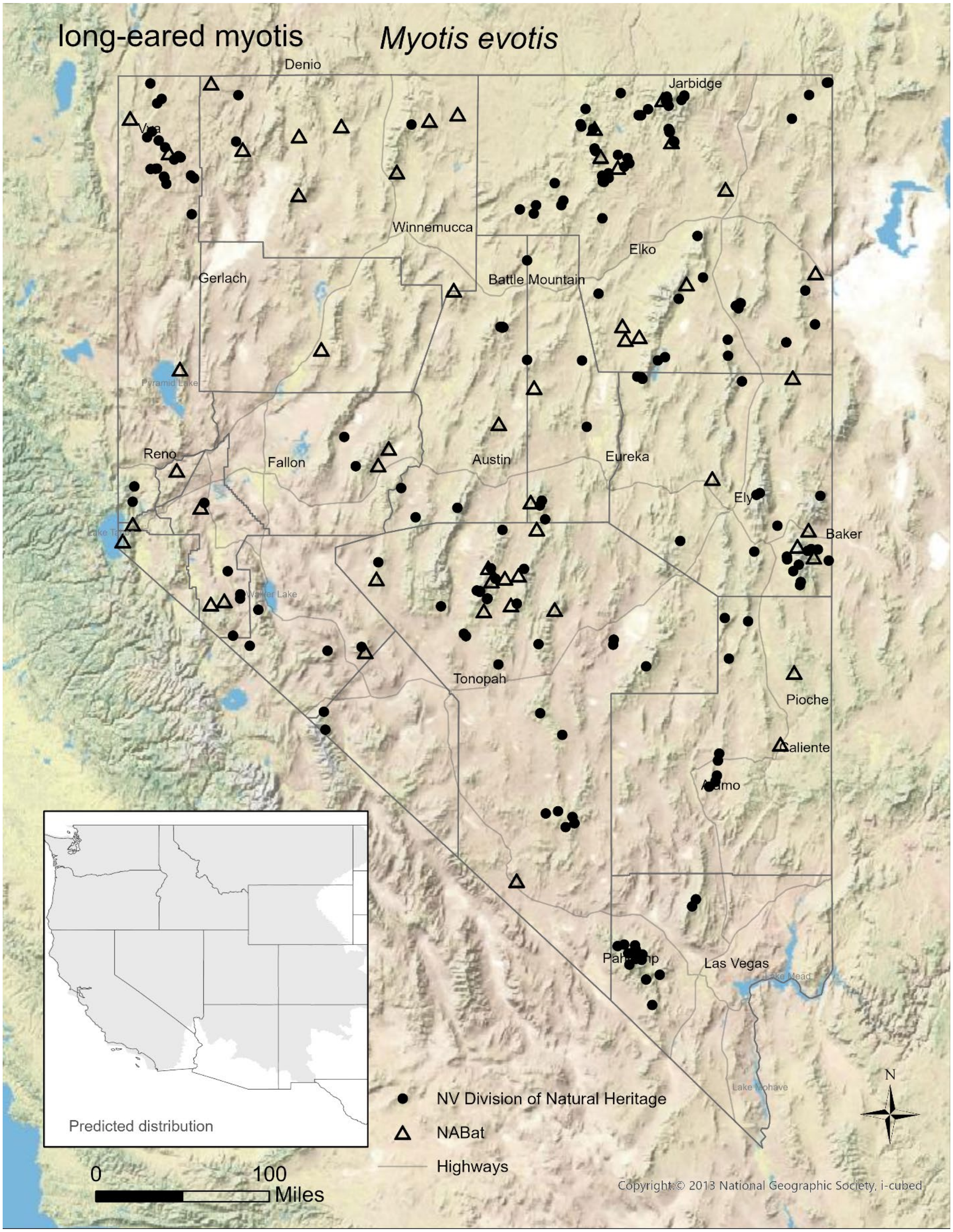
7.1.10. Hoary Bat Distribution Map



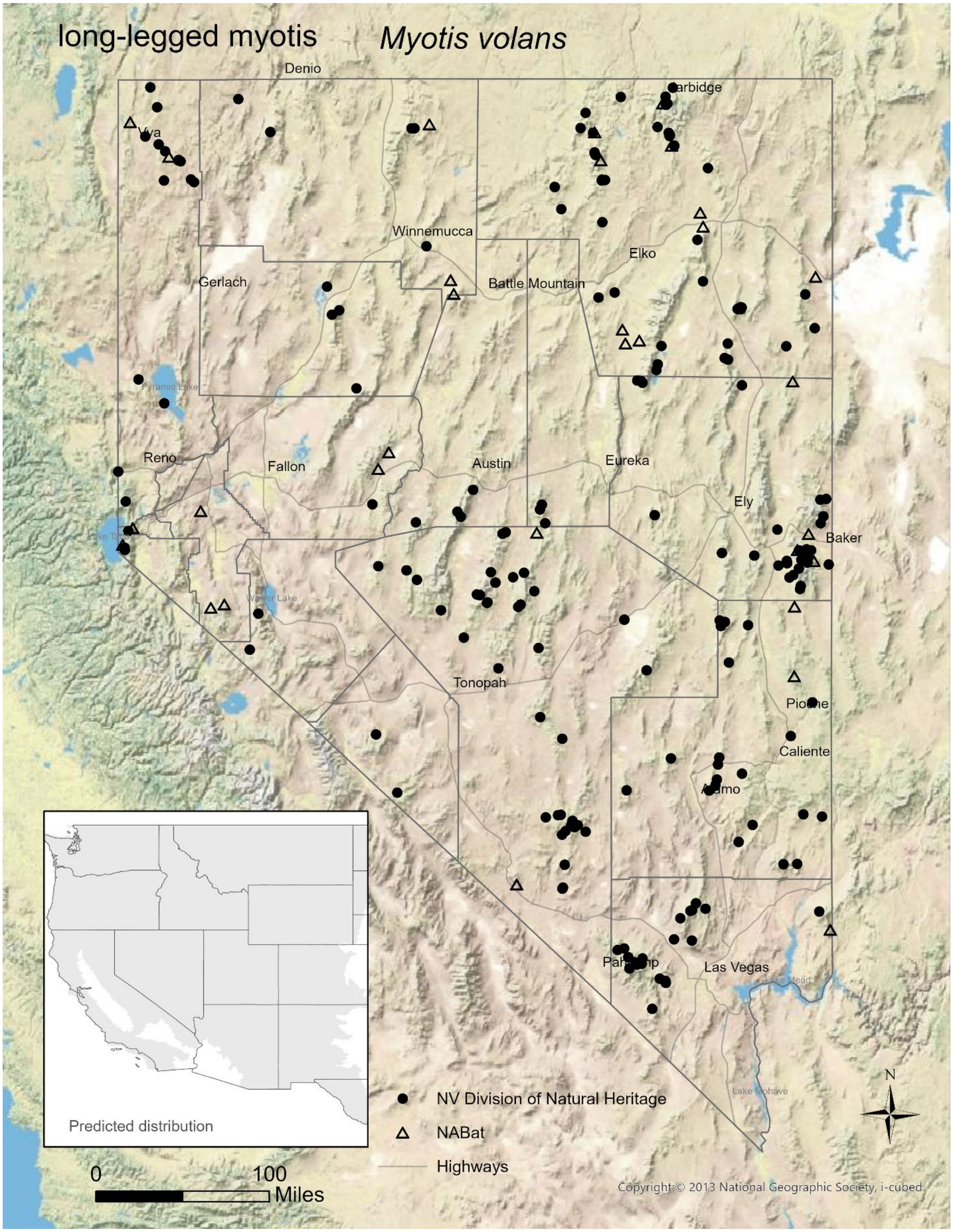
7.1.11. Little Brown Myotis Distribution Map



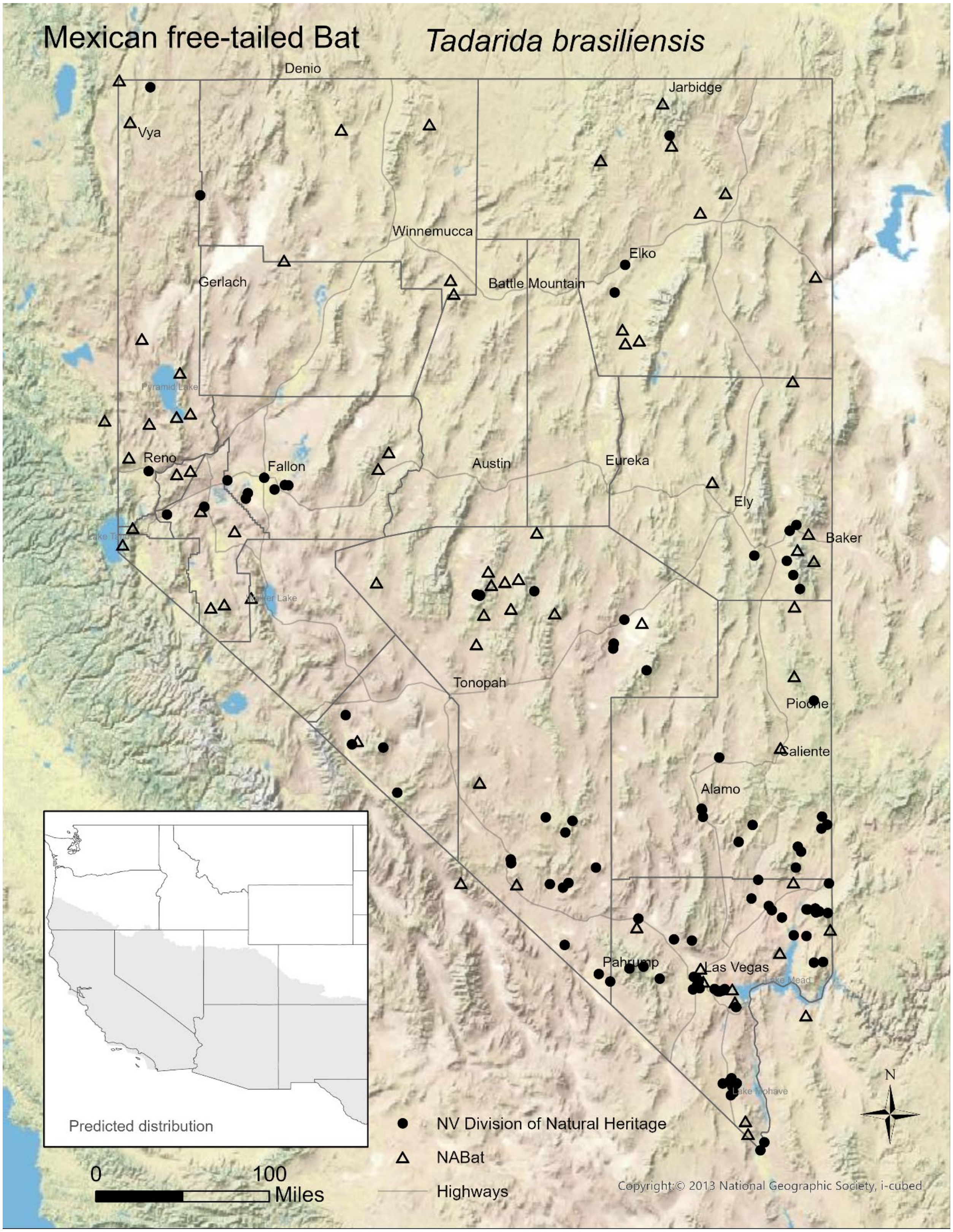
7.1.12. Long-eared Myotis Distribution Map



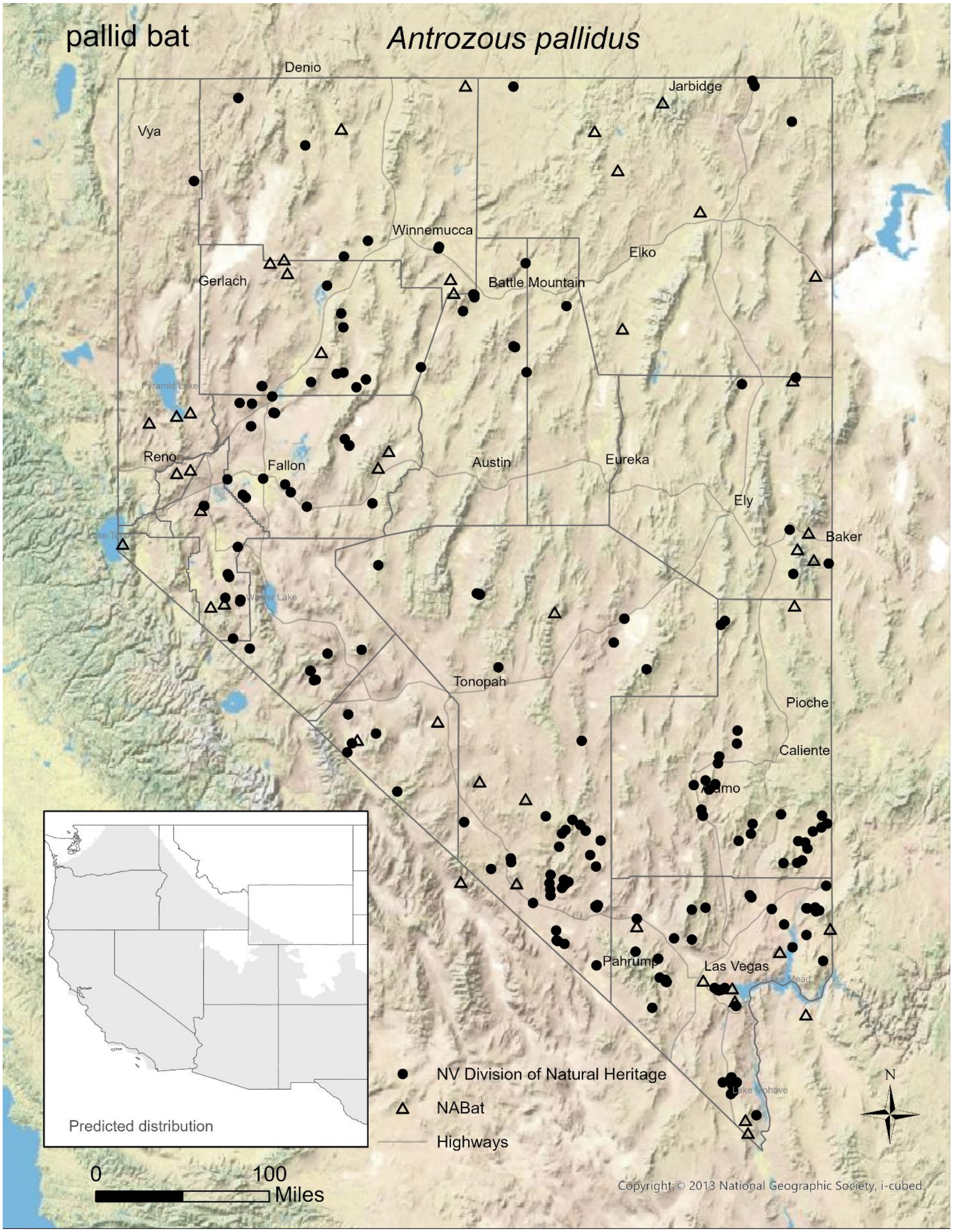
7.1.13. Long-legged Myotis Distribution Map



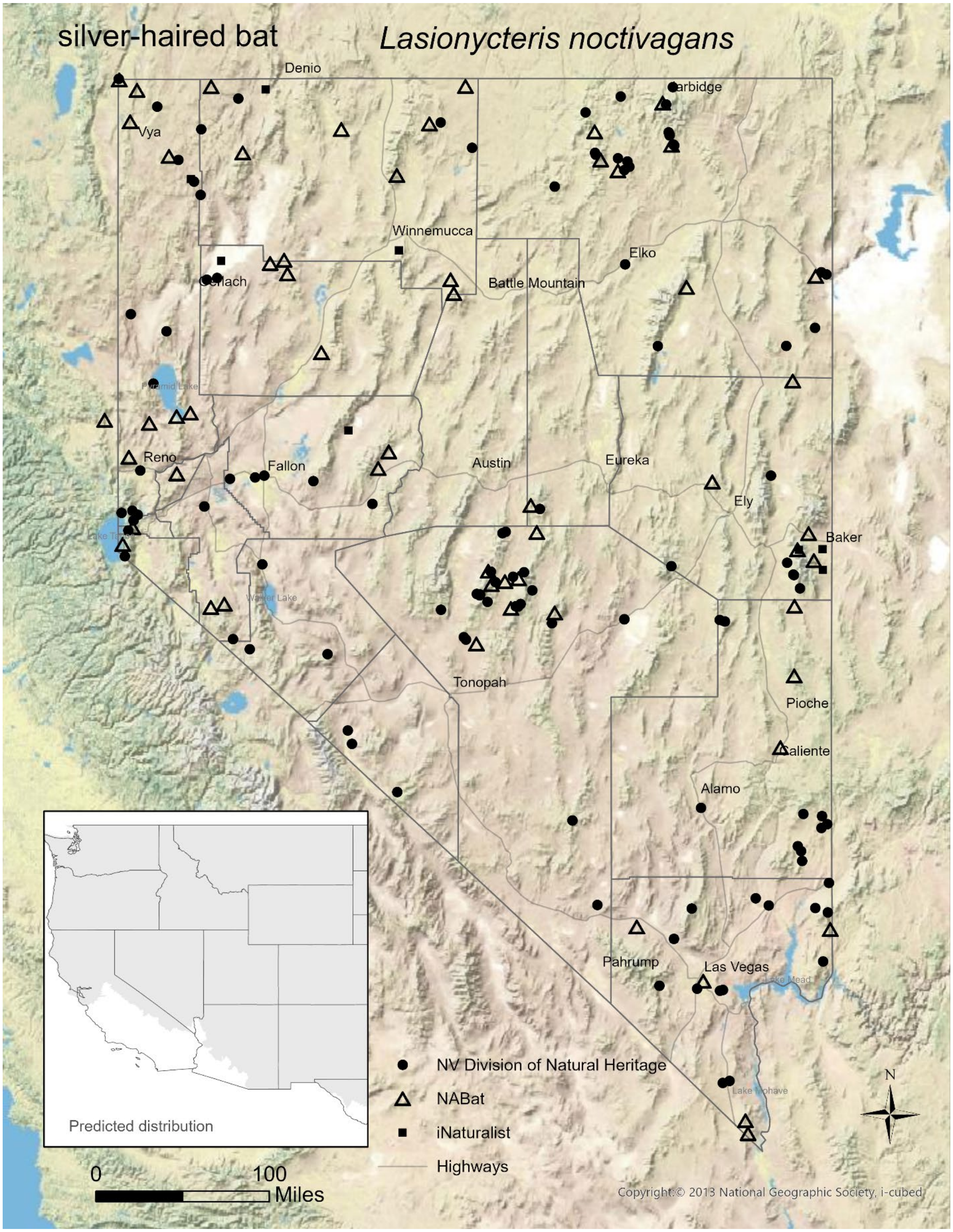
7.1.14. Mexican Free-tailed Bat Distribution Map



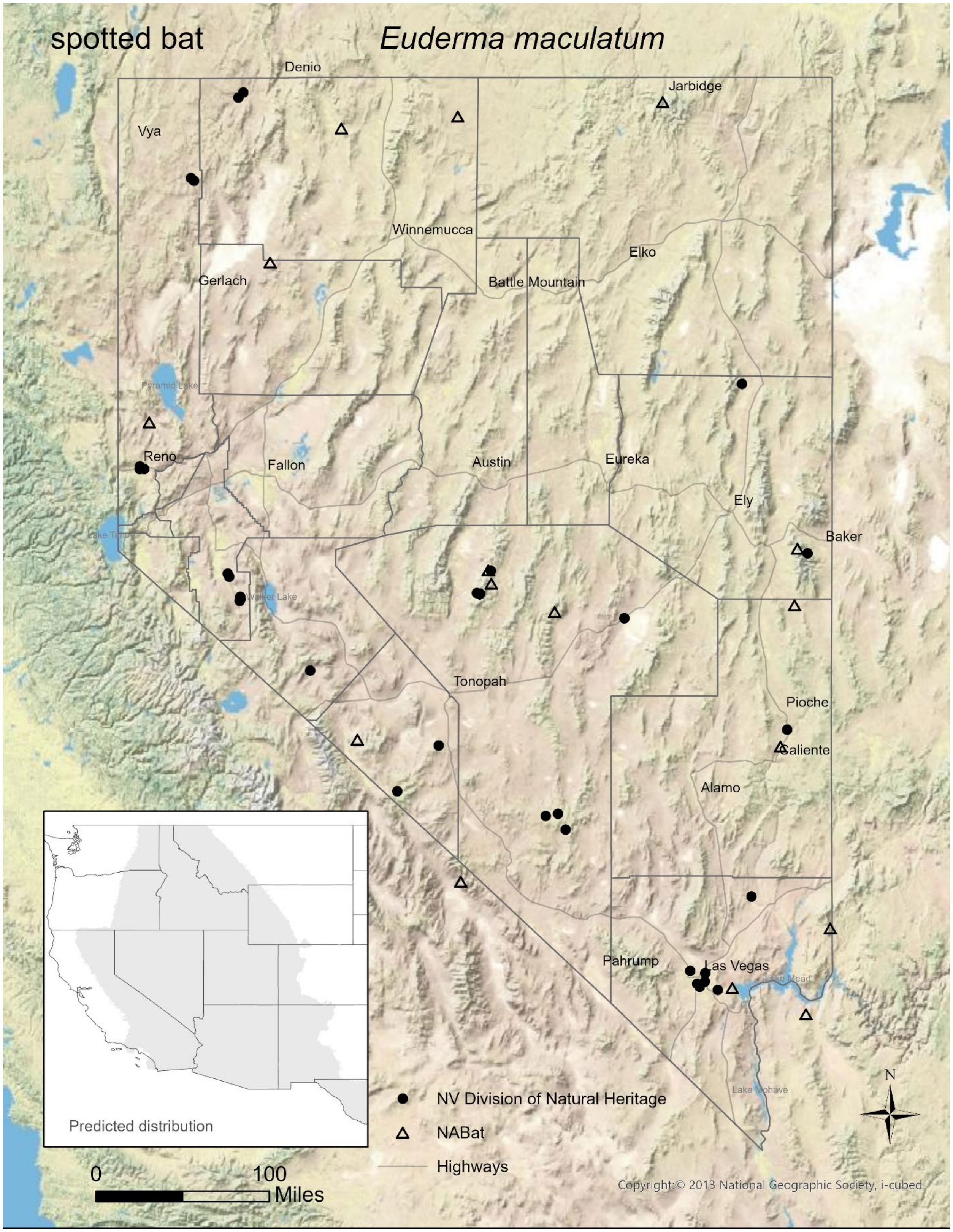
7.1.15. Pallid Bat Distribution Map



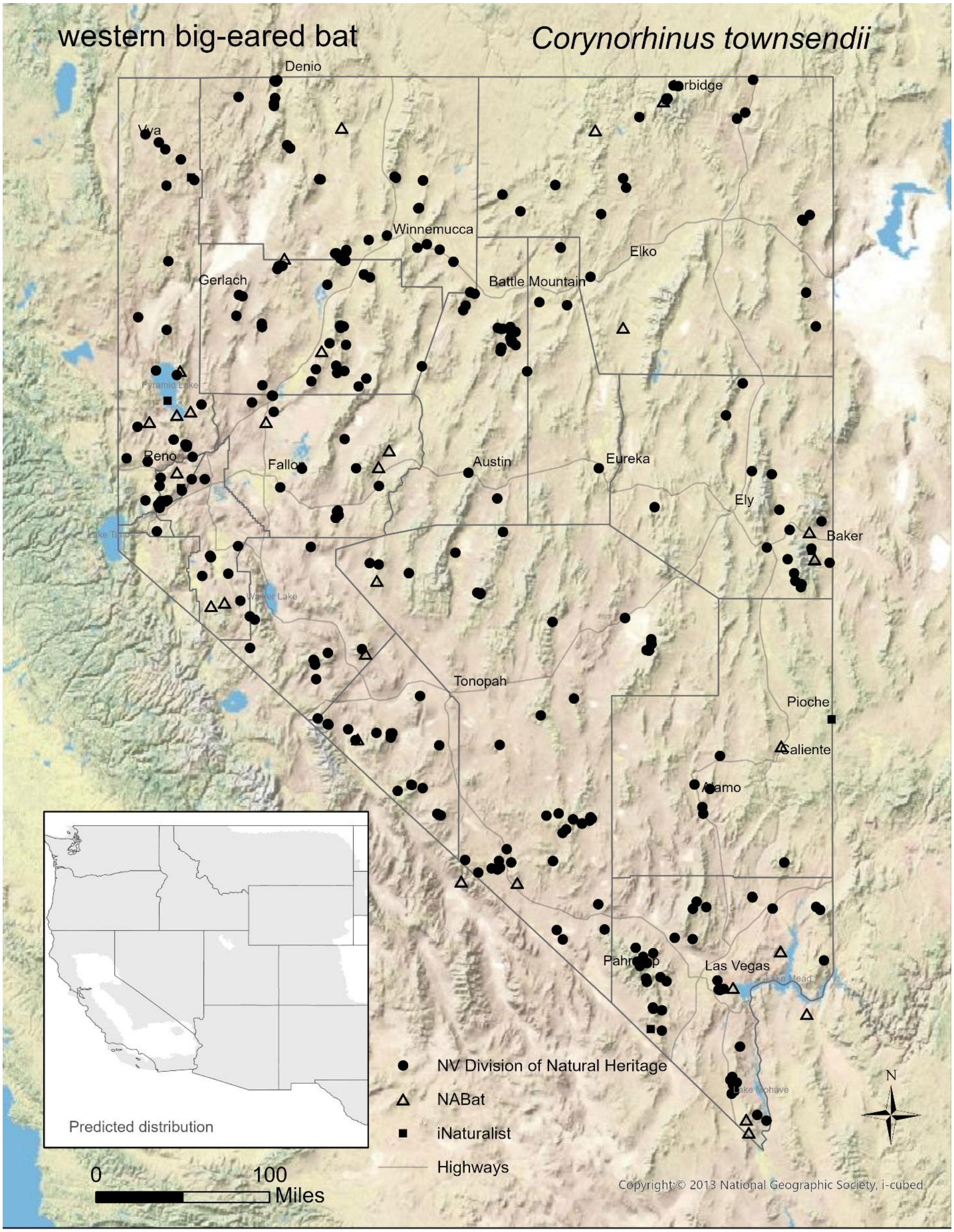
7.1.16. Silver-haired Bat Distribution Map



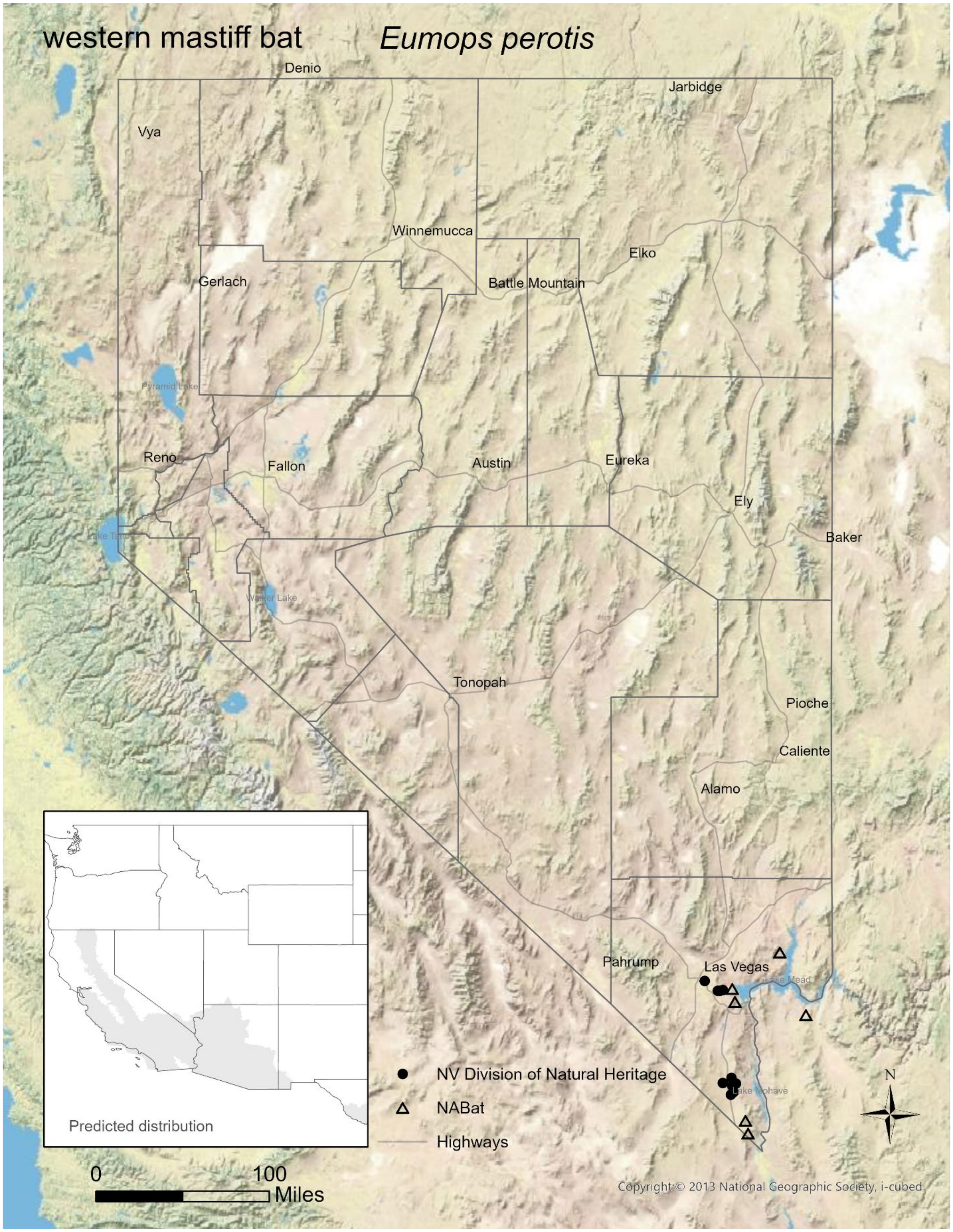
7.1.17. Spotted Bat Distribution Map



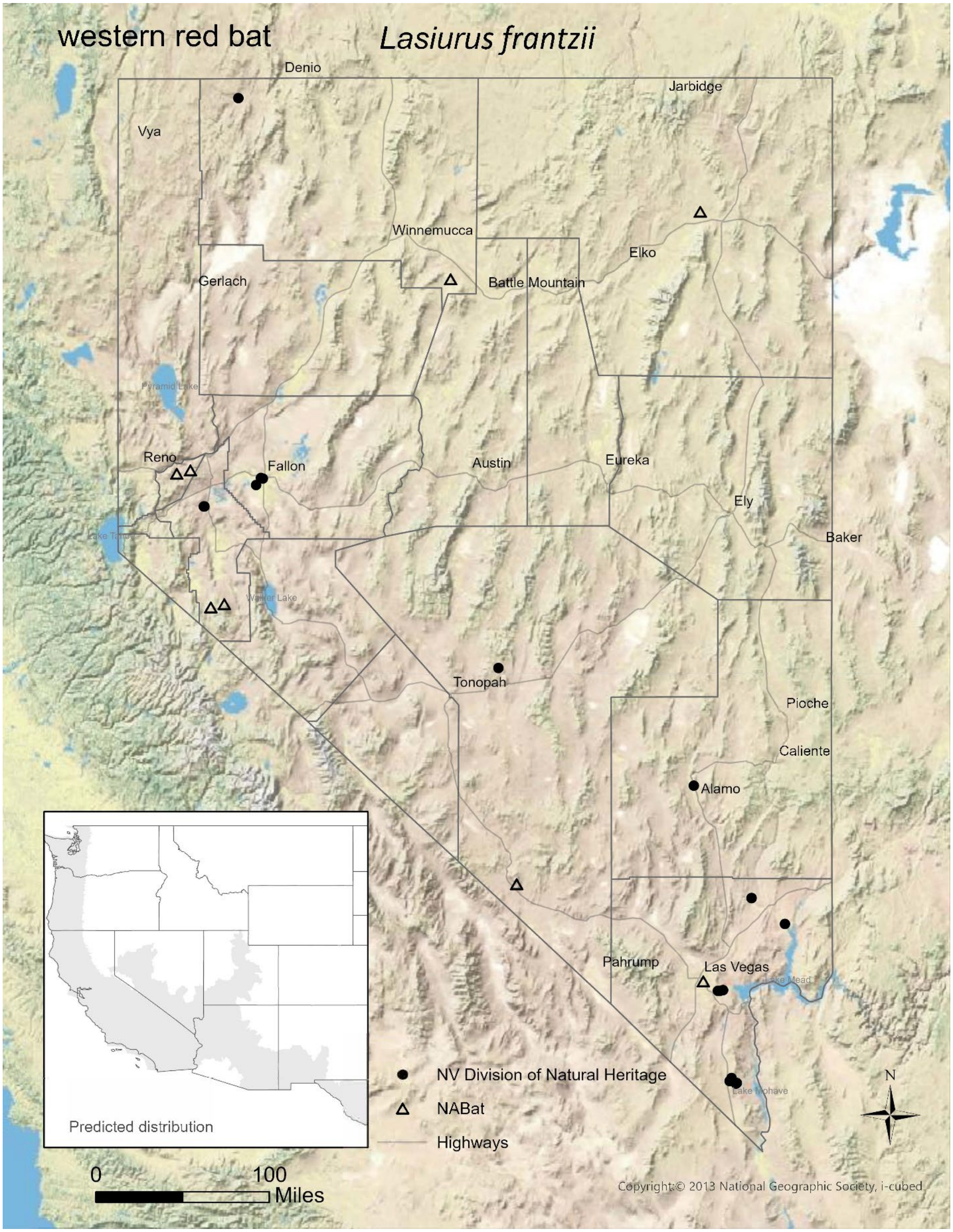
7.1.18. Western Big-eared Bat Distribution Map



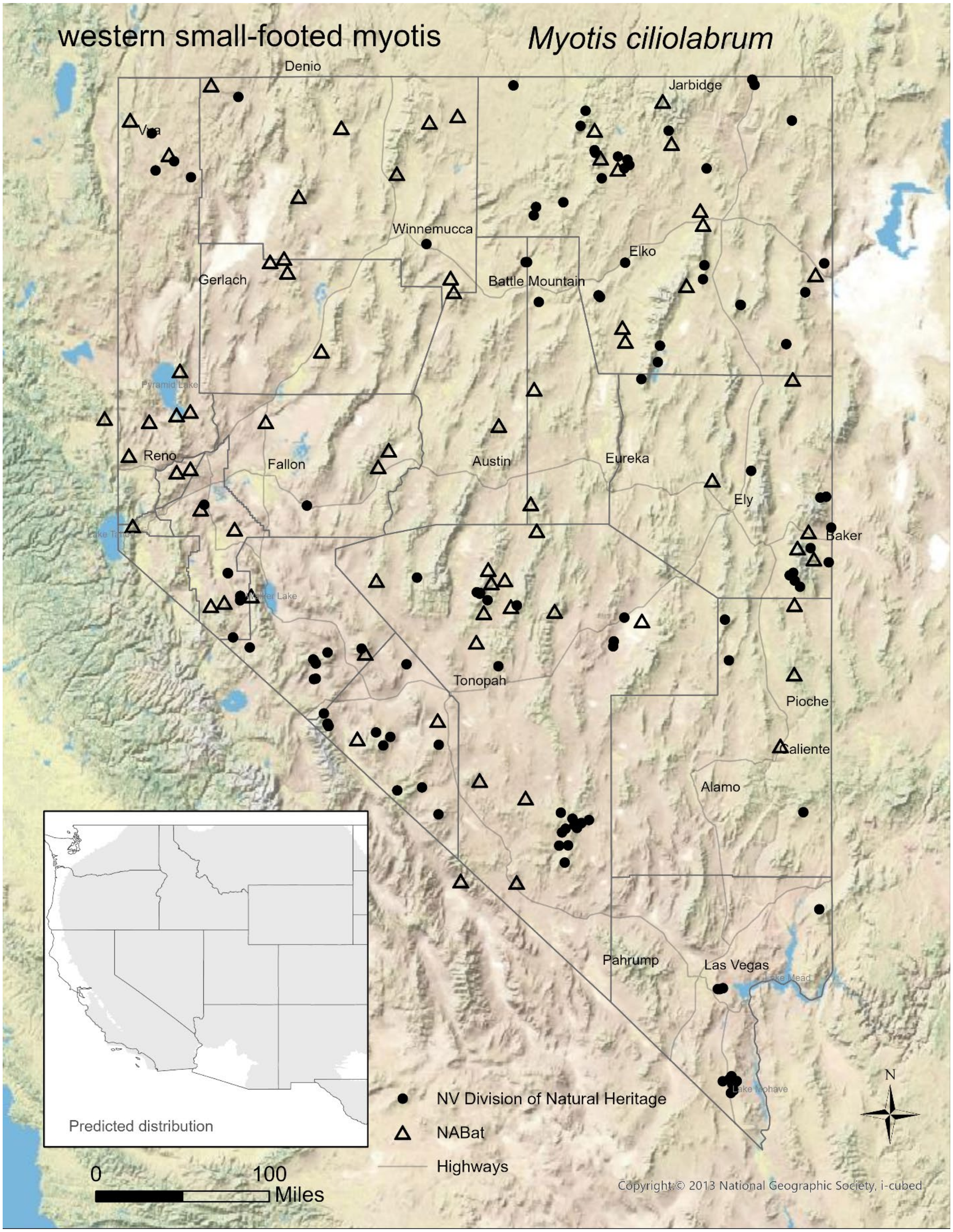
7.1.19. Western Mastiff Bat Distribution Map



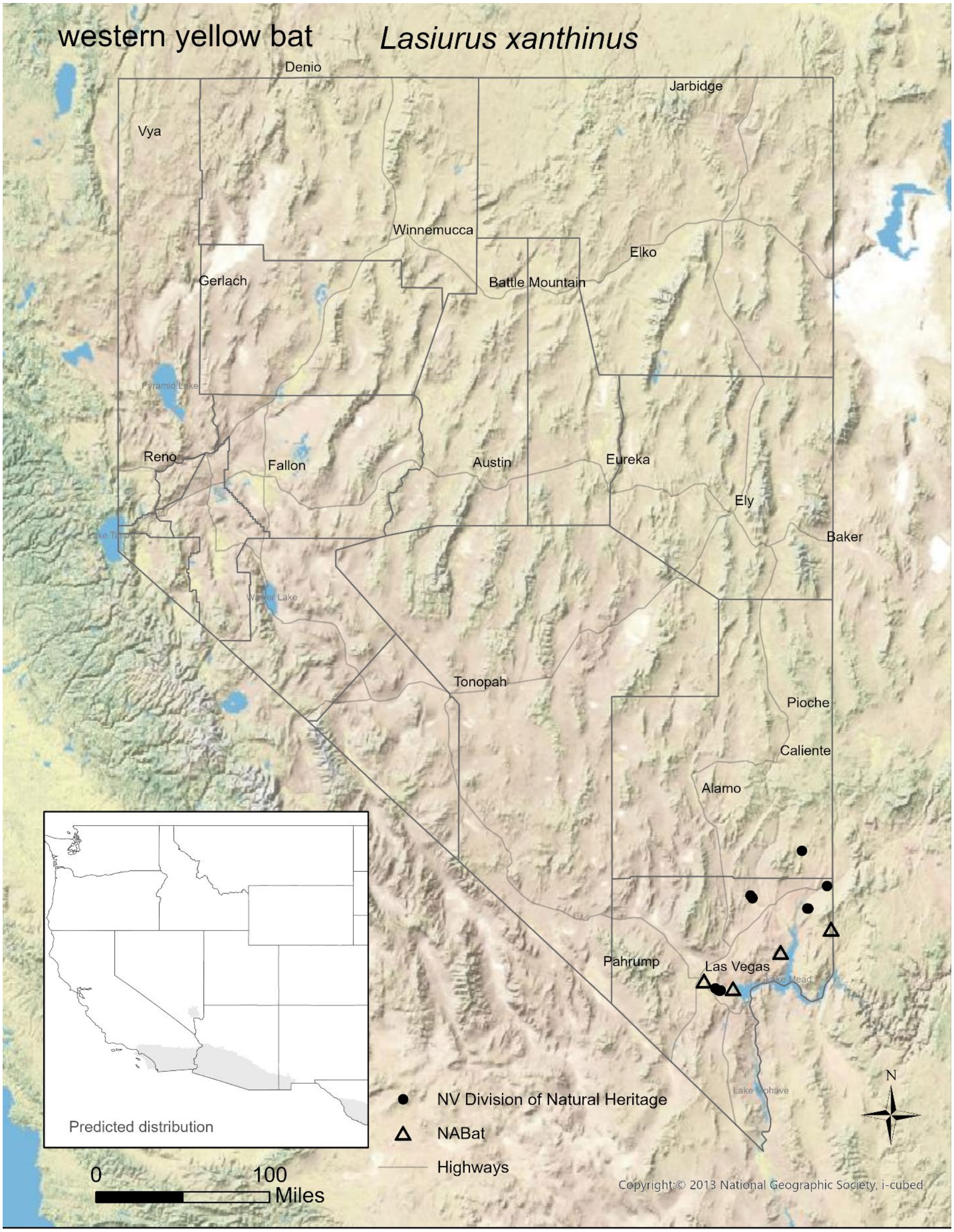
7.1.20. Western Red Bat Distribution Map



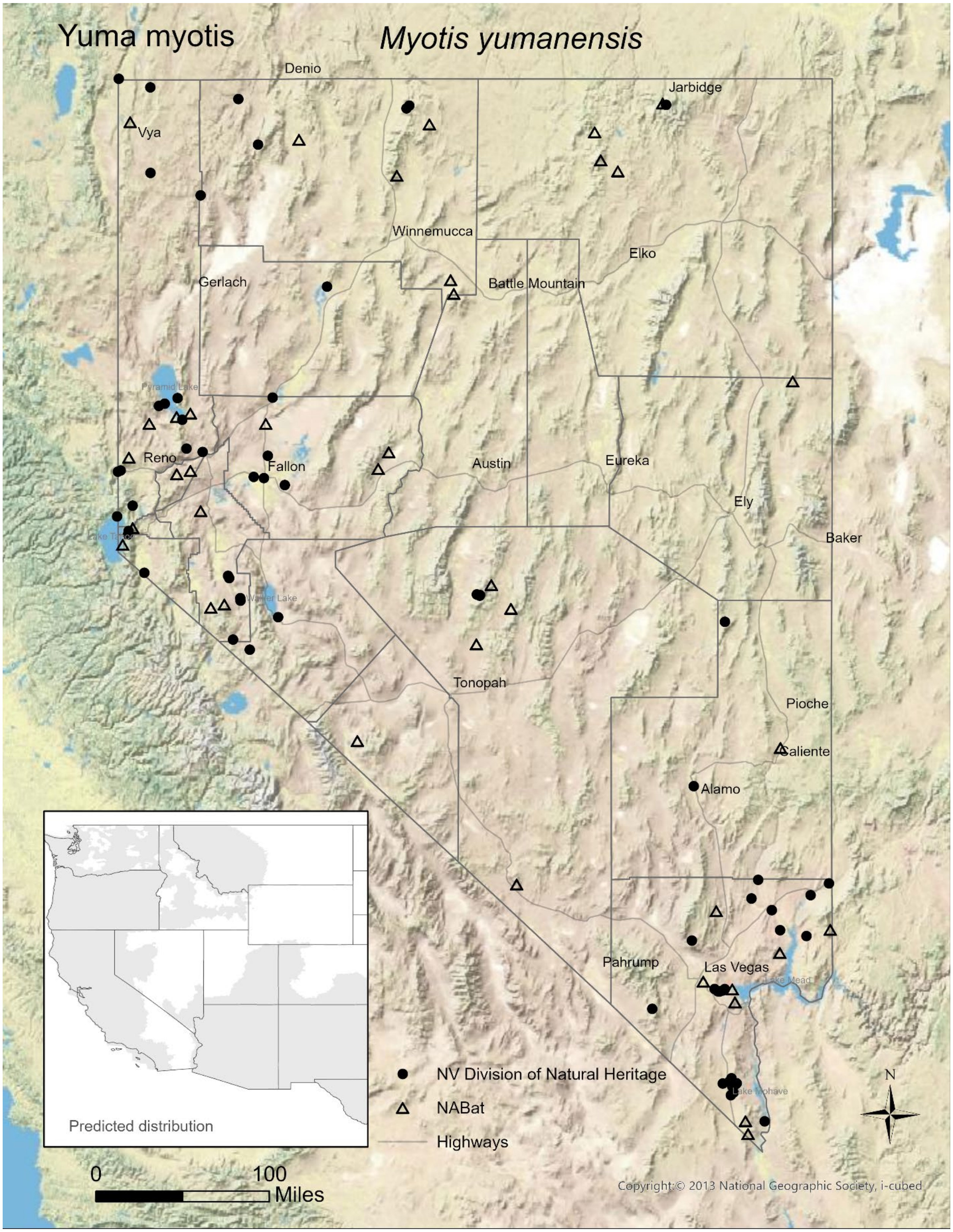
7.1.21. Western Small-footed Myotis Distribution Map



7.1.22. Western Yellow Bat Distribution Map



7.1.23. Yuma Myotis Distribution Map



7.2. Key To Conservation Status Codes

NatureServe (Heritage Program) Conservation Status Rank Definitions (G and S Rank)	
Abbreviation	**Definition - see http://www.natureserve.org/explorer/ranking.htm for more detailed information.**
G	Refers to the **global** population of a species.
S	Refers to the **subnational** (state) population of a species, subspecies, or variety.
1	**Critically Imperiled** – At very high risk of extirpation in the jurisdiction due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors.
2	**Imperiled** – At high risk of extirpation in the jurisdiction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
3	**Vulnerable** – At moderate risk of extirpation in the jurisdiction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
4	**Apparently Secure** – At fairly low risk of extirpation in the jurisdiction due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
5	**Secure** – At very low or no risk of extirpation in the jurisdiction due to a very extensive range, abundant populations or occurrences, with little to no concern from declines or threats.
S#S#	**Range Rank** – A numeric range rank (e.g., S2S3 or S1S3) is used to indicate uncertainty about the exact status of a taxon. Ranges cannot skip more than two ranks (e.g., SU is used rather than S1S4). A range rank could also be applied at the global scale as well (e.g., G2G3).
NA	Conservation status rank is **Not Applicable** because element is not a suitable target for conservation activities (often used for non-native species or hybrids).

U.S. Bureau of Land Management (BLM) Status	
Abbreviation	**BLM Status**
S	Sensitive Species – Species designated Sensitive by State Director of Nevada BLM.

U.S. Forest Service (USFS) Status	
Abbreviation	**USFS Status**
R4S	Region 4 (Humboldt-Toiyabe National Forest) Sensitive
R5S	Region 5 (Inyo National Forest or Lake Tahoe Basin Management Unit) Sensitive or Watch status

State of Nevada Protection and Designations (NAC 503)	
Abbreviation	**State Designation**
PM	Protected Mammal (NAC 503.030.1)

State Wildlife Action Plan (SWAP) Designation	
Abbreviation	**Nevada SWAP Designation**
SGCN	Species of Conservation Need

7.3. Nevada Bats Conservation Status Table

Scientific Name	Common Name	G-Rank	S-Rank	BLM	USFS	SWAP
Antrozous pallidus	pallid bat	G4	S3	S	R5S	SGCN
Corynorhinus townsendii	western big-eared bat	G4	S2	S	R4S, R5S	SGCN
Eptesicus fuscus	big brown bat	G5	S3S4			PM
Euderma maculatum	spotted bat	G4	S2	S	R4S	SGCN
Eumops perotis	western mastiff bat	G4	S1	S		SGCN
Idionycteris phyllotis	Allen's big-eared bat	G4	S1	S		SGCN
Lasionycteris noctivagans	silver-haired bat	G3	S3	S		SGCN
Lasiurus cinereus	hoary bat	G3	S2S3	S		SGCN
Lasiurus frantzii	western red bat	G4	S2	S		SGCN
Lasiurus xanthinus	western yellow bat	G4	S1			PM
Macrotus californicus	California leaf-nosed bat	G3	S2	S		SGCN
Myotis californicus	California myotis	G5	S3S4	S		PM
Myotis ciliolabrum	western small-footed myotis	G5	S3S4	S		SGCN
Myotis evotis	long-eared myotis	G5	S3	S		SGCN
Myotis lucifugus	little brown myotis	G3	S2S3	S		SGCN
Myotis thysanodes	fringed myotis	G4	S2	S	R5S	SGCN
Myotis velifer	cave myotis	G4	S1	S		SGCN
Myotis volans	long-legged myotis	G4	S3S4	S		SGCN
Myotis yumanensis	Yuma myotis	G5	S3	S		SGCN
Nyctinomops femorosaccus	pocketed free-tailed bat	G5	S1			PM
Nyctinomops macrotis	big free-tailed bat	G5	S1	S		SGCN
Parastrellus hesperus	canyon bat	G5	S3S4	S		SGCN
Tadarida brasiliensis	Mexican free-tailed bat	G5	S4	S		SGCN

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