

COLORADO BAT CONSERVATION PLAN



Prepared by
The Colorado Committee of the Western Bat Working Group

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INTRODUCTION

Eighteen of the 124 species of mammals inhabiting Colorado are bats. The unique life history characteristics of bats prevent many people from realizing that they comprise 15 percent of our native mammal fauna. Being fast fliers that are active at night, bats are mostly elusive to human senses except in the early evening hours when they can be seen foraging or when they are seen in their roosting habitat. In addition bats often roost in hard-to-reach, well-hidden places making human encounters with bats rare.

Most bats found in Colorado are relatively small, but wingspans can reach 436 mm for the big free-tailed bat (*Nyctinomops macrotis*). The smallest bat species is the western pipistrelle (*Pipistrellus hesperus*, 4-6 g), and the heaviest is the hoary bat (*Lasiurus cinereus*, up to 35 g). Bats are extraordinarily long-lived for their body size. For example, the little brown bat (*Myotis lucifugus*) is capable of living more than 30 years in the wild (Cross 1976). Populations replace themselves rather slowly; in almost all species, females typically give birth to a single young per year. Although juvenile survival is high in the roost, once the young bats fly, mortality can be extremely high (Humphrey and Cope 1976). Because bats tend to form large concentrated colonies, give birth to only one young per year, and have high juvenile mortality, species are especially prone to threats from human encroachment, loss of habitat, and disturbance to roosts. They also spend more than half their lives in their roosting environment and, as such, are highly sensitive to disturbance and loss of roosting habitat, especially during reproductive and hibernation seasons. Bats in Colorado utilize a variety of roosts including caves, crevices, trees, and human-made structures such as mines, tunnels, bridges, and buildings. The microclimate provided by these roosts varies greatly and so very few of these structures in a given area prove appropriate for species-specific needs (Armstrong et al. 1994, Fitzgerald et al. 1994).

For most species of Colorado bats, males and females segregate during the active summer months. Males form small bachelor colonies or roost singly, whereas females form larger colonies that range from a few individuals to as many as several hundred females and their young (Armstrong et al. 1994). Colorado bat species mostly hibernate locally, undergoing short seasonal migrations that may require moving to a higher elevation in order to find suitable underground chambers. Abandoned mine shafts are commonly used as hibernacula. Fall swarming involves high levels of bat activity throughout the night; with bats flying in and out of caves or mines. The reasons bats use caves or mines for swarming are not fully understood (Davis and Hitchcock 1965, Fenton 1969), but the activity has been documented in Colorado (Navo et al. 2002). The potential importance of swarming to the viability of a species is unknown but could be critical.

Throughout history, bats have been misunderstood and vilified. This negative outlook stems from the lack of knowledge of a mammal that in many ways tests our sense of reality. The more we learn about their true biology, however, the less scary and more astonishing bats become. Conservation efforts for bats lag far behind those for more charismatic animals. Technological advances such as the development of mist nets, sonar-scanning devices (bat detectors), radiotelemetry, and the use of satellites and global positioning systems have allowed biologists to better understand the diversity, behavior, and ecology of bats.

In Colorado, the efforts of many dedicated individuals (e.g., members of institutions such as the Bats/Inactive Mines Program, the CU Museum of Natural History, the Colorado Bat Society (CBS), and the Denver Museum of Nature and Science (DMNS)) have stimulated bat conservation efforts and public education forums, saving many bat colonies and slowly changing the fear and hatred of bats into fascination and appreciation. Education, along with public support for conservation efforts, is essential in conserving bat populations and their roosting habitats, and thus maintaining their ecological role as the most significant vertebrates preying on nocturnal insects in Colorado and throughout North America.

In an effort to establish needs and goals of bat conservation, the Colorado Committee of the Western Bat Working Group was established in 1998 (see Colorado's link on the Western Bat Working Groups website at <http://www.batworkinggroups.org>). Its mission is to provide guidance to private individuals, agencies, and other groups to facilitate the conservation and management of bats and their habitats in Colorado. Bat conservation needs to be proactive in order to prevent sensitive species from becoming endangered or threatened. The Colorado Bat Conservation Plan summarizes the current state of knowledge, begins to prioritize needs for various species, provides goals for species conservation, and lists management recommendations and research needs. This document will be disseminated to those who manage land in Colorado, those with an interest in bat conservation and research, and institutions responsible for managing natural resources in the state.

The Conservation Plan is structured as follows: first, we provide a list of bat species found in Colorado by ecoregion (Figure 1 and Table 1); and second, we provide a Conservation Strategy. The Conservation Strategy focuses on seven categories of issues that affect bat populations in the state: (1) mining; (2) cave and crevice management; (3) forest management; (4) rangeland management; (5) urban development; (6) research, inventory, and protocols; and (7) species status, population trends, and monitoring. After each category we list how it parallels the research and management goals of the North American Bat Conservation Partnership's (NABCP) Strategic Plan. The NABCP was created to support continent-wide bat conservation efforts in an organized way. It is an alliance of working groups (including the Western Bat Working Group), bat researchers, non-governmental organizations, and state and federal agencies from Mexico, Canada, and the US (<http://www.batcon.org/nabcp/newsite/index.html>). The Strategic Plan created by the NABCP provides the framework and direction for other local, state, and federal bat conservation plans.

Bats mark the presence of healthy, functioning ecological communities. We hope that the gaps in knowledge outlined in this document provide direction for future bat research projects and management programs in the state of Colorado.

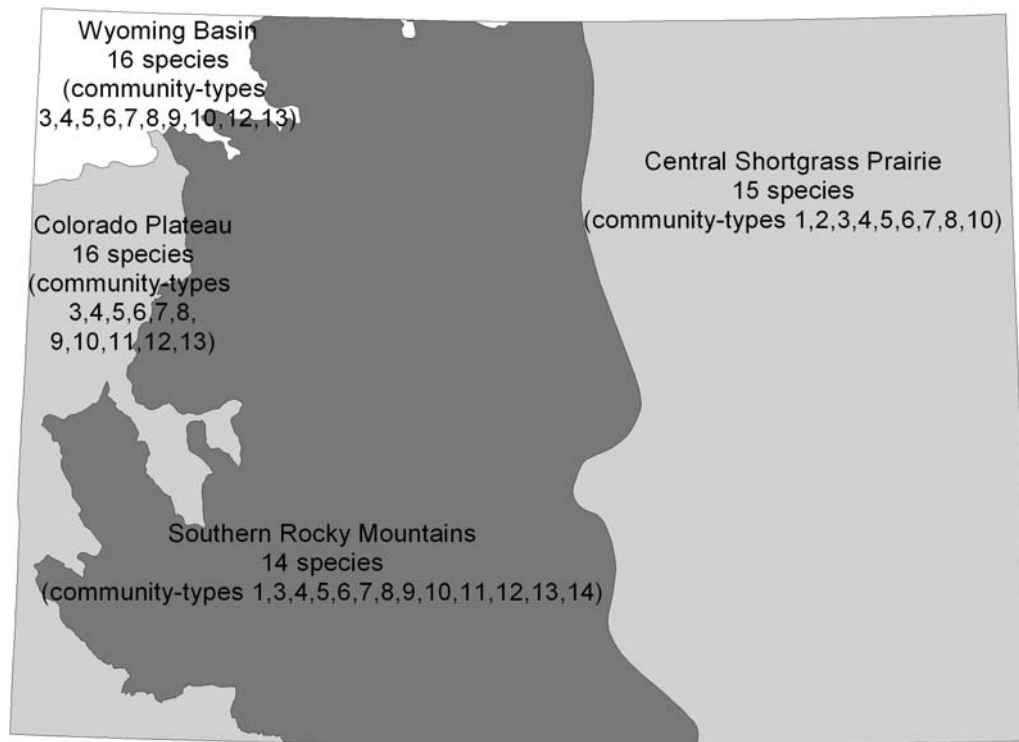


Figure 1. Ecological distribution of bats in Colorado in four ecoregions and 14 community-types (see Table 1), based on Armstrong (1972).

Table 1. List of 18 species of bats known to occur in Colorado and the community-types* in which they occur (see Figure 1), based on Armstrong (1972).

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|--|---|---|---|---|---|---|----|---|---|----|----|----|----|----|
| <i>Myotis californicus</i> (California Myotis) | | | | X | | X | X | | | | | | | |
| <i>M. ciliolabrum</i> (Western Small-footed Myotis) | X | X | | X | X | X | X | X | | | | | | |
| <i>M. evotis</i> (Long-eared Myotis) | | | | | X | | X | X | X | X | X | X | X | |
| <i>M. lucifugus</i> (Little Brown Bat) | | | X | X | | | X | X | X | X | | X | X | |
| <i>M. thysanodes</i> (Fringed Myotis) | | | | | | | X | X | | | | | | |
| <i>M. volans</i> (Long-legged Myotis) | | | | X | | | X | X | | X | | X | X | |
| <i>M. yumanensis</i> (Yuma Myotis) | | | X | | | X | X | | | | | | | |
| <i>Lasiurus borealis</i> (Red Bat) | | | X | | | | | | | | | | | |
| <i>L. cinereus</i> (Hoary Bat) | | | X | | | | X | X | X | X | X | | X | |
| <i>Lasionycteris noctivagans</i> (Silver-haired Bat) | | | X | | | | X | X | X | X | X | | X | |
| <i>Pipistrellus hesperus</i> (Western Pipistrelle) | | | | X | X | X | X | | | | | | | |
| <i>P. subflavus</i> (Eastern Pipistrelle) | | | X | | | | | | | | | | | |
| <i>Eptesicus fuscus</i> (Big Brown Bat) | | | X | X | | | X | X | X | X | X | | X | |
| <i>Euderma maculatum</i> (Spotted Bat) | | | | | X | X | X | | | | | | | |
| <i>Corynorhinus townsendii</i> (Townsend's Big-eared Bat) | | | | X | X | X | X | X | | | | | | |
| <i>Antrozous pallidus</i> (Pallid Bat) | | | | X | X | X | X | | | | | | | |
| <i>Tadarida brasiliensis</i> (Brazilian Free-tailed Bat) | | | | | X | X | | | | | | | | |
| <i>Nyctinomops macrotis</i> (Big Free-tailed Bat) | | | | | X | X | | | | | | | | |
| TOTALS | 1 | 1 | 7 | 8 | 8 | 9 | 14 | 9 | 5 | 6 | 4 | 3 | 6 | 0 |

*1 = Subhumid grassland; 2 = Plains wetland; 3 = Plains riparian woodland; 4 = Saxicoline brush; 5 = Sagebrush; 6 = Semidesert scrub; 7 = Pinyon-juniper woodland; 8 = Ponderosa pine woodland; 9 = Montane forest; 10 = Mountain meadow; 11 = Subalpine forest; 12 = Highland streambank; 13 = Aspen woodland; 14 = Alpine tundra/fellfield

CONSERVATION STRATEGY

The Conservation Strategy is designed to provide natural resource managers, researchers, and graduate students with information and direction in the conservation needs of Colorado bats. The Strategy provides an overview of the most important issue categories identified for each species, and for bats in general. The categories are those that either directly impact the species or the habitats they depend on for survival. Once a category was identified, we then selected key issues, goals for each issue, objectives for each goal, and management and research needs to accomplish each objective. A reference to appropriate goals in the North American Bat Conservation Plan is provided at the end of each threat introduction. The major categories we identified are:

- I. Mining
- II. Cave and Crevice Management Practices
- III. Forest Management Practices
- IV. Rangeland Management Practices
- V. Urban Development

A section on research, inventory, and protocols is also included to provide guidance for those work with bats or are provide permitting and project review/approval. A final section, "Species status, population trends, and monitoring" provides specific research, inventory, or monitoring projects to delineate the status of species in Colorado. The conservation strategy is not intended to be a benchmark for what types of projects should be supported in the state. Nor is it a justification for not funding or supporting other types of research not specifically mentioned. Rather, it should provide assistance to resource managers and researchers given the limited funding and growing conservation needs for many species.

I. MINING

Twenty-eight (62 percent) of the 45 bat species in the US use mines (Altenbach and Pierson 1995). Bats have become dependent upon abandoned mines for roosting habitat because recreational caving and deforestation have diminished natural bat habitat (Tuttle and Taylor 1994, Altenbach and Pierson 1995). Colorado has about 23,000 inactive mines and preliminary survey results indicate that 30 percent of abandoned mines show signs of bat roosting habitat, and 15 percent are characterized as important sites of bat activity (K. Navo per. comm.). The recent interest in abandoned mined lands (AML) reclamation has led many agencies to inventory mine locations. For instance the National Park Service (NPS) has identified 3200 mine sites in the national park system, with 10,000 individual mine openings (Burghardt 2003). Like cave roosts, mines are used as hibernacula, maternity roosts, bachelor colonies, temporary stopovers, or night roosts. Yet unlike caves, abandoned mines are being systematically closed for public safety. This activity can pose a threat to bats that use mines, and mine closure methods can be destructive to bat roosts if done at an improper time (Altenbach and Pierson 1995). However, gates that keep out humans but allow access by bats have been used extensively in the eastern US for over 20 years. To preserve critical habitat, bat gates must be designed to allow unrestricted ingress and egress, especially for maternity roosts. The bat gate closure must also

minimize changes to the microclimate of the roost (Richter et al. 1993, Tuttle 1977, White and Seginak 1987).

Since 1980 government agencies, conservation groups, and private individuals have safeguarded over 6120 abandoned mines in Colorado and many thousands more in the US. In 1990 the Colorado Division of Wildlife (CDOW) and the Colorado Division of Minerals and Geology (CDMG) began a cooperative effort -- the Bats/Inactive Mines Program -- to survey all abandoned mine openings for bat use prior to closure, and to install bat gates on those openings that provide critical habitat. The CDOW and CDMG have or will install 456 bat-compatible closures on inactive mines. Some mines have multiple openings and require more than one gate. While more research is needed on species-specific responses to particular cave/mine gate designs, initial results of ten years of post-gate evaluations indicate several designs are working well (Navo and Krabacher in press).

Mines are used as habitat by 13 Colorado bat species, some of which were formerly designated as Category 2 candidate species under the Endangered Species Act (ESA; US Fish and Wildlife Service 1994). The following bat species are known to commonly use mines as day roosts, maternity roosts, or hibernacula: California myotis (*Myotis californicus*), western small-footed myotis (*M. ciliolabrum*), long-eared myotis (*M. evotis*), little brown bat (*M. lucifugus*), fringed myotis (*M. thysanodes*), long-legged myotis (*M. volans*), pallid bat (*Antrozous pallidus*), big brown bat (*Eptesicus fuscus*), Yuma myotis (*M. yumanensis*), and Townsend's big-eared bat (*Corynorhinus townsendii*). In addition, a unique bachelor colony of 100,000 to 250,000 Brazilian free-tailed bats (*Tadarida brasiliensis*) inhabits the Orient Mine in the San Luis Valley during the summer. This is the largest known bat colony in Colorado.

Abandoned and active mines are particularly important to Townsend's big-eared bat, a former category 2 candidate under the ESA (US Fish and Wildlife Service 1994), a Sensitive Species for the US Forest Service (USFS), and a Special Status Species for the Bureau of Land Management (BLM). There are 12 known Townsend's big-eared bat maternity roosts in Colorado, seven of which are in abandoned mines. There are 257 hibernacula and/or transient roosts currently known, 239 of which are in abandoned mines. Most of these colonies are small in size and estimated to contain fewer than 30 individuals per mine. Identification and preservation of mines for bat habitat is critical to maintaining current populations of Townsend's big-eared bats and other sensitive bat species. Bat gates prevent unwanted human access to dangerous mines while preserving critical bat habitat.

Another factor that could impact mine-roosting bat species in Colorado is active mining operations. Renewed mining activity at previously inactive mines can disrupt or destroy habitats. Construction of associated facilities, road development, and deforestation can destroy drinking and foraging habitat, particularly at surface mines and ore processing sites. Cyanide leach ponds that do not restrict bat access are of particular concern as they may attract bats and birds. Surveys have shown that bats are among the most numerous mammals found dead of cyanide poisoning at these water sources (Clark 1991, Clark and Hothem 1991). Currently, there are no open cyanide ponds in Colorado and there are existing policies to ensure that there is no overall net loss of critical or important wildlife habitat consistent with CDOW and US Fish and Wildlife Service (USFWS) recommendation. Critical habitat is often excluded from a mining permit

area, or poor habitat is upgraded to compensate for the loss of habitat from mining operations. In cases where “remining” is occurring, current rules and regulations consider “pre-existing conditions and the degree to which the proposed plan would provide for net improvements in the protection of human health, property, or the environment (mineral rules and regulations of the Colorado mined land reclamation board for hard rock, metal and designated mining operations, 2 CCR 407-1, Rule 6.4.20 (18)). For cyanide ponds, active mine operations are required to net or otherwise restrict access by birds and bats to ponds that contain more than 40 ppm cyanide. Active mines are also regulated to prevent releases of acid mine drainage, from surface or groundwater, that do not meet water quality standards. In the permit application, mining companies are required to “describe measures to prevent wildlife from coming into contact with designated chemicals, toxic or acid forming chemicals, or areas with acid mine drainage (mineral rules and regulations of the Colorado mined land reclamation board for hard rock, metal and designated mining operations, 2 CCR 407-1, Rule 6.4.20 (18)).

Survey techniques and protocols are continually being revised to accommodate new research into bat dependence on mines. Since mines are inherently dangerous, it is imperative that this research be conducted in a safe manner. Oxygen-deficient air, toxic gases, unstable rock, and vertical drops in and around abandoned and inactive mines have claimed 18 lives and injured 23 in Colorado since 1955. For further discussion of potential hazards and the safety procedures to be followed at abandoned and inactive mine sites see Altenbach (1995), Burghardt (1996, 1997, 2002), Navo (2001) and Riddle (1995).

We address three categories of issues for mine-roosting bats in Colorado: inadequate knowledge of bat dependence on mines; active mining practices; and abandoned/inactive mines.

NABCP: I Research-Goal 1-A1; Goal 2-A3; / II Management-Goal 2-A1.

Increase Knowledge of Bat Dependence on Mines

To conserve bat populations it is essential to determine the importance of mines to bats. This includes determining bat dependency on mines, mine structure, configurations that provide ideal habitat, and population trends of species that utilize mines for roosts.

Goal: Identify and determine the importance of mines as roosting habitat.

Objective 1: Determine critical microclimate factors that limit bat populations inhabiting mines -- particularly for species of concern -- to help identify and protect roosting habitat.

Objective 2: Develop and evaluate new research techniques for identification and monitoring of bat species that inhabit mines, and for the evaluation of mines as roosting habitat.

Management Recommendations:

- Establish a monitoring program to document population numbers and trends for species that inhabit protected mines, particularly species of concern.

Research Needs:

- Develop non-intrusive monitoring techniques and equipment for use at abandoned mines.
- Delineate the microclimate requirements of mine-roosting bats.
- Develop techniques to monitor population trends of mine-roosting bats (see also Species Status, Population Trends, and Monitoring section).

Active Mining

Active mining operations have the potential to impact bat populations (Brown 1997). The Mining Rules governing the permitting and operation of active mines are promulgated by the multidisciplinary Mined Land Reclamation Board and administered by the CDMG and other regulatory agencies. The rules prevent harm or damage to wildlife species or habitat. However, as research on bats continues, new information should be disseminated to regulatory agencies and mining operations in order to develop reclamation techniques that preserve bat populations.

Goal: Preserve foraging and critical non-mine habitats, and minimize impacts to existing bat colonies in active mine areas.

Objective 1: Provide information and technical support to mine operators and regulatory personnel about sensitive bat species, bat conservation practices, and mechanisms to preserve habitat.

Objective 2: Provide information and technical support to mine operators and regulatory personnel to monitor the success of bat conservation measures.

Objective 3: Exclude bats from mines that are slated for re-mining. If possible, encourage the movement of colonies to other suitable habitat.

Objective 4: Work with mining companies to identify and implement new artificial bat habitats.

Management Recommendations:

- Continue to work with mining companies and regulatory agencies to implement techniques that minimize and mitigate mine-related impacts.

Research Needs:

- Continue studies of mine design and reclamation techniques that enhance bat habitat at the conclusion of mining operations. This should include the development of viable bat roosts.
- Determine the nature and extent of water quality problems and their effects on bat populations.
- Determine the impact of active mining operations on bat populations.

Closure of Abandoned/Inactive Mines

Closure of abandoned mines for public safety can eliminate important bat habitat.

Goal: Preserve critical habitat in abandoned mines. Preserve viable bat populations, especially species of concern.

Objective 1: Promote and implement safe protocols for surveying abandoned mines (e.g., Altenbach 1995, Navo 2001, and Western Bat Working Group 1998).

Objective 2: Evaluate all abandoned mine openings slated for closure to identify critical bat habitat. Continue programs and partnerships such as the Bats/Inactive Mine Program.

Objective 3: Develop an inventory of abandoned mines that are potential bat habitat by using the Abandoned Mine Reclamation Program database, as well as abandoned mine inventory data of the USFS, BLM, NPS, and other land managers.

Objective 4: Promote and implement protocols for installing bat-compatible closures (e.g., Burghardt 2003, Dalton and Dalton 1995, Navo and Krabacher 2002, Tuttle and Taylor 1998).

Objective 5: Exclude bats from mines that are slated for closure when gating is not feasible. If possible, move colonies to other suitable habitat (Brown 1997).

Objective 6: Continue to evaluate the success of bat gates by monitoring mines before and after gate installation to determine post-gate usage, colony numbers and trends, and effects on mine microclimate from gate designs (Navo and Krabacher in press).

Management Recommendations:

- Work with CDMG and federal agencies to install bat-compatible closures on mines that are important bat habitat, particularly for species of concern. Ensure that proper bat exclusion techniques are used prior to mine closures when not bat-compatible.

Research Needs:

- Determine the roosting habits of bats that use abandoned mines and identify the types of non-mine roosts that are used by these species. Documentation is especially important for Townsend's big-eared bat and other species of concern, and is necessary to help determine the importance of mines as available roosting habitat (also see Appendix A).
- Determine the success of bat gate designs used in Colorado, and research potential modifications to enhance their success for bat conservation and public safety (Ludlow and Gore 2000).
- Research the feasibility of relocating bat colonies from mines that cannot be gated.
- Determine short- and long-term impacts of radioactive exposure on bat populations inhabiting uranium mines, particularly species of concern, and the importance of these mines to bat populations.
- Research the relationships of mine clusters to local colonies and the impacts to these colonies of closing a portion of a cluster. This would include studies on the movements between nearby roosts by various species of bats.

II. CAVE AND CREVICE MANAGEMENT PRACTICES

Many species of bats in the US rely heavily on cave roosts during hibernation in winter, as nurseries in summer, and as bachelor roosts or migratory stopovers between seasons. For these reasons, caves can be critical resources for bats and have been classified as “essential” for at least 18 species in the continental US (McCracken 1989). Cave-dwelling bats are still threatened by recreational disturbance in and surrounding cave roosts, cave development for tourism and guano mining, improper cave gate design, and scientific research (i.e., excessive banding of bats and general disturbance by researchers during critical time periods; Mohr 1952, 1972, 1976, Rabinowitz and Tuttle 1980, Richter et al. 1993, Tuttle 1979, White and Seginak 1987). Direct disturbance to suitable cave roosts is a major threat and has resulted in the listing of several species under the ESA, the designation of several taxa as former Category 2 candidate species (US Fish and Wildlife Service 1994), and has resulted in population declines of more common taxa. Disturbances to caves can be unintentional (cavers moving through an area harboring a colony, shining lights or talking that arouses bats or causes females to abandon young) or intentional (vandals shooting into roosting clusters or emerging bats, hitting bats with clubs or rocks, immolating torpid bats with torches, or setting fires with timbers or old tires in caves). Commercialization of caves for tourism or the mining of guano has caused abandonment by bats. Natural disturbances such as flooding can also reduce population numbers (DeBlase et al. 1965). Swarming behavior in and around caves is an activity that is not well documented or researched in western North America (Navo et al. 2002, Schowalter 1980), but could be critical to various species using caves in Colorado.

Like other biota and cultural or geologic resources in caves and karst environments, bat populations are vulnerable and easily damaged by human activities. Over 700 caves are known in Colorado (Rich Wolfert, Colorado Grotto, per. comm., Parris 1973, Kolstad 1996). It is unknown how many of these or undiscovered caves are significant to bats. Exploring caves is increasingly popular and many well-known caves are being visited more frequently by greater numbers of people and during more seasons throughout the year (Fish 1999, National Speleological Society Members Manuals 1980-2000). Because many of the state's caves are situated at higher elevations, winter visits to caves have been rare. The popularity of winter recreation such as snowmobiling and skiing is contributing to increased cave visitation during winter (Rhinehart 1999), thus increasing the likelihood of disturbing hibernating bat populations. With increased interest in caving, more people are also trying to discover new caves and passages within known caves. Excavation, sometimes using drilling and explosives, is increasingly being used to augment exploration (Kolstad 1996, Medville 2000, Rhinehart 2000). Historically the primary mechanism for protecting Colorado cave resources has been secrecy or gates limiting access. Currently only 16 caves in Colorado are gated to regulate or limit human access (Rhinehart 1998). Of these, ten are privately owned. Only one has a gate intentionally designed to accommodate bat use, although bats are known to roost in 10 of the 16 caves. Townsend's big-eared bat has been found in seven of the gated caves, and although none of the gates have bat-compatible designs, all of the caves have fall/winter roosting where this species appears to tolerate restricted access points. It is unknown if the level of use has changed after gating at these caves.

The 1988 Federal Cave Resources Protection Act (16 USCS 4301 et seq., FCRPA) is a law that requires protection of caves on federal lands that have been designated as significant, and gives criteria for determining significance. A number of caves have been nominated as significant in accordance with this act. Three of these are gated (two have bat-friendly gates) or have resource management plans in place. Other laws and regulations that may provide additional protection for cave resources include: the 1897 Organic Administration Act (16 U.S.C. 551), the 1973 ESA (87 Stat. 884, as amended; 16 U.S.C. 1531), the 1906 Antiquities Act (34; 16 U.S.C. 431 et seq.), and the 1979 Archaeological Resources Protection Act (16 U.S.C. 470aa).

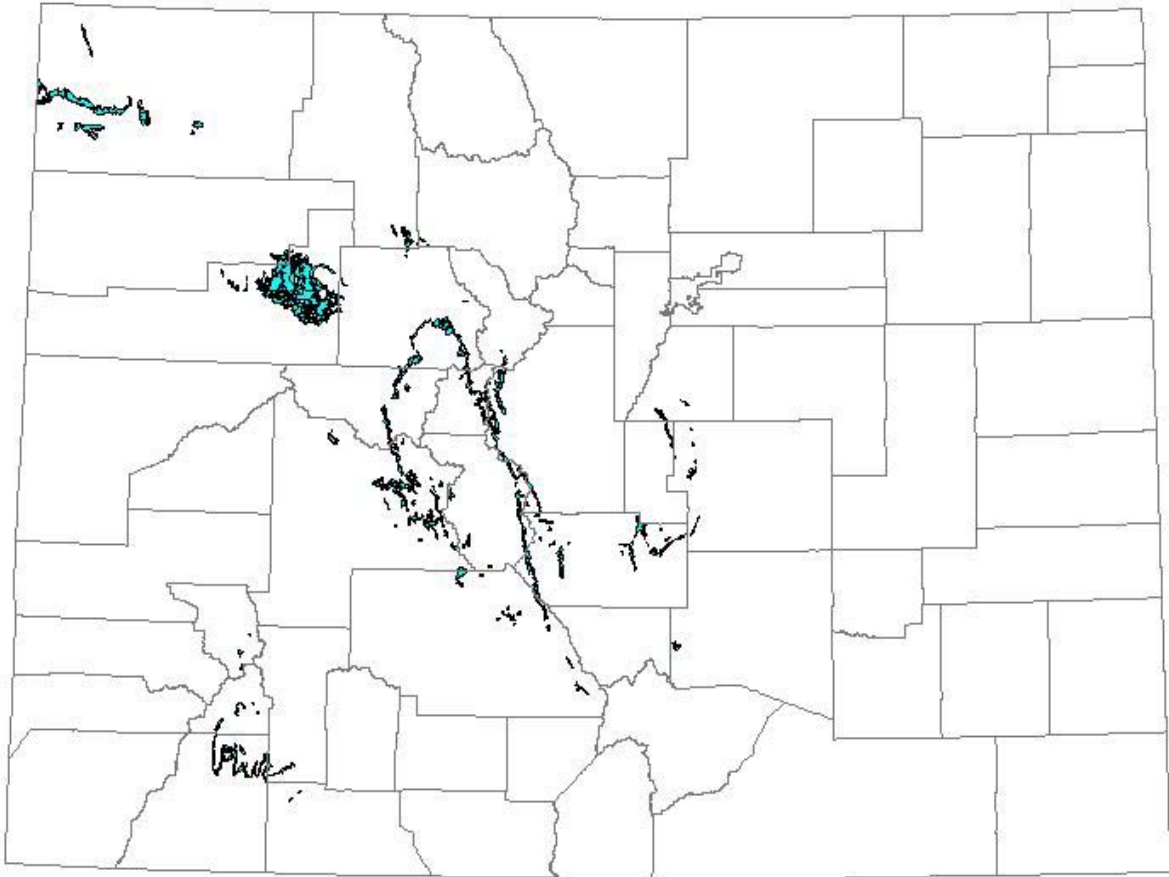


Figure 2. Karst and limestone areas in the state of Colorado.

Surface disturbing activities near caves can result in detrimental impacts to bat populations. Karst -- a type of topography that develops when soluble rocks are dissolved (Ford and Williams 1989) -- is especially vulnerable to surface disturbance that impacts bat populations roosting in caves, as well as the environmental components critical to reproduction. The environmental impacts from surface disturbance near caves, especially karst-related ecosystems, have only recently been recognized as important conservation issues. Not all caves used by bats occur in karst areas, but maintaining healthy karst ecosystems and processes can only be achieved by ensuring surface uses do not disrupt these processes (Aley 2000, Baichtal 1995, Kunaver 1987).

Karst areas in Colorado (Figure 2) occur primarily in carbonate rocks (Parris 1973, Kolstad 1996) but solutional caves are also found in gypsum, anhydrite, and quartzite (Davis 1999a, 1999b). Most of the caves in the state likely to be significant to bats occur in these karst areas. Caves are also scattered throughout the state in claystone, alluvial, and talus deposits, and are developed along faults and fissures in metamorphic and igneous rock (Davis 1998a,b, 1999a,b, Kolstad 1996, Parris 1973, Rhinehart 2000). Some of the caves occurring in non-carbonate rocks are extensive and are known to provide significant roost sites for bats (Davis 1998a). Some of these caves may also be sensitive to surface disturbances.

We address six categories of issues for cave- and karst-inhabiting bats: inadequate knowledge of bat dependence on caves and karst ecosystems; surface and subsurface land management practices; mismanagement of cave resources; recreational impacts; human disturbance; and climbing activities.

NABCP: I Research-Goal 1-A1; Goal 2-A3; Goal 3-A1; Goal 4-A3 / II Education-Goal 3-A1; / III Management-Goal 1-A1; Goal 2-A1.

Inadequate Knowledge of Bat Dependence on Caves and Karst Habitat

Current knowledge of bat resources in Colorado's caves is insufficient to provide adequate protective conservation and management actions.

Goal: Gain a more comprehensive knowledge of bat roosting in Colorado caves including identifying, protecting and restoring ecosystems and habitats critical to the viability of cave associated bat populations.

Objective 1: Identify caves that currently support or historically supported bat populations.

Objective 2: Identify the ecosystem components and associated habitats that contribute to viability of cave bat populations.

Objective 3: Standardize protocols for both external and internal surveys of caves to minimize bat impacts and to reduce impacts to other sensitive cave features.

Management Recommendations:

- Inventory and evaluate caves for bat use, including maternity, hibernation, migration, and swarming use.
- Implement the standards presented in the Species Conservation Assessment and Conservation Strategy for the Townsend's big-eared bat (Pierson et al. 1999) -- Inventory, Monitoring, and Research Protocols, and the guidelines in Appendices A and C.

Surface and Subsurface Land Management Practices

Goal: Encourage surface and subsurface land management practices that protect bat populations and their cave environments.

Objective 1: Develop and implement surface and subsurface land management practices that protect cave and karst ecosystem components crucial to bat habitat.

Objective 2: Promote surface land management policies that preserve the integrity of karst-dependent ecosystems and groundwater.

Management Recommendations:

- Avoid filling cave entrances, sinkholes, and open karst depressions with slash debris.
- Minimize topsoil erosion and the removal of vegetation in karst areas.

- Avoid use of persistent pesticides and herbicides in karst areas.
- Protect springs and established wetlands in areas that support historically occupied caves. (Resources for these recommendations include Aley 2000, Baichtal 1995, Daoxin 2000, Harding and Ford 1993, Kunaver 1987, USFS 1990 & 1994.)

Research Needs:

- Identify hydrological components including in-feeder streams, sinkholes, open fissures, and springs within karst areas. This may involve dye trace studies.
- Delineate catchments and recharge zones in karst areas to determine extent of land vulnerable to impact.

Objective 3: Promote surface land management policies and guidelines that minimize degradation of subsurface air quality and microclimates.

Management Recommendations:

- Preserve natural airflow in and out of occupied cave entrances and passages. Actions that may adversely alter the cave microclimate include back-filling of cave entrances, modifying sinkholes, placing entrance gates or other structures that modify airflow patterns, and unregulated digging in cave passages.
- Minimize the use of prescribed burning in karst areas and near caves (Pierson et al. 1999). A number of cave management plans created by federal agencies prohibit burning near cave entrances (Deschutes National Forest, 1994; Lincoln National Forest, 1995; Gifford-Pinchot National Forest, 1991; Hoosier National Forest, 1991). Fire management was identified as an important consideration in management on karst landscapes by the Australian Speleological Federation in their submission to the Minister for Environment Concerning Mount Etna Caves Management Plan (<http://www.wasg.iinet.net.au/mtetna.html>). Fire can impact caves and karst features by exposure to smoke and ash, it can degrade cave entrances by increasing erosion, and it can cause leaching of carbon deposits into caves. The Australian Speleological Federation recommended modifying prescribed fires around sensitive cave sites or by avoiding fire altogether.

Objective 4: Encourage management agencies to use guidelines that integrate the needs of bats with key ecological features provided by caves.

Management Recommendations:

- Identify nearby foraging, drinking and other roost sites critical to the cave-obligate or -affiliate bat species. Protecting these features for bats roosting in nearby caves will reduce energy expenditures.
- Implement zones of "no-impact" or "limited impact" from surface management activities around all caves with significant bat roosts.
- Require surveys for bat roosts when proposing timber sales and other surface management activities such as prescribed burning and road building when they are near significant caves or karst features. Provide guidelines for such surveys.
- Apply seasonal restrictions to avoid disruption of maternity, swarming, hibernation, or other critical life-cycle activities when timber sales or road building are proposed near known roost

sites. These buffer zones should reflect the species composition and sensitivity of roost sites. For Townsend's big-eared bat, restrict timber harvest activities and road building within a 0.25-mile radius buffer around caves with year-round bat use. In addition, these activities should be restricted seasonally to avoid disturbance to Townsend's maternity roosts (April 1 to October 1) and hibernacula (November 1 to April 1). These critical time periods of hibernation and maternity activity may vary regionally and should be determined by a qualified biologist (Pierson et al. 1999).

- Maintain a buffer zone of two miles for pesticide spraying around all Townsend's big-eared bat roost sites. Allow spot applications of herbicides to be considered as a weed management tool.
- Maintain or improve riparian and wetland habitats near Townsend's big-eared bat roosts in 10-mile radius to achieve healthy and diverse structure. No prescribed burning or vegetative alteration in shrub-steppe or pinyon/juniper habitats should be conducted within a 1.5-mile radius of Townsend's big-eared bat roosts (Pierson et al. 1999). See Appendix A for other considerations concerning buffer zones.

Research Needs:

- Examine the relationships between external characteristics of surface features associated with caves, particularly in karst areas, that may relate to the microclimate in the roost. These features include entrance elevation and configuration, local environmental characteristics, vegetation cover surrounding entrances, and water sources. Monitor the effectiveness of these restrictions to see if they aid bat populations.

Managing Recreation Impacts

Historically, the management of recreational use in caves that harbor bat colonies has not promoted bat viability and use. Cave visitation at inappropriate times can disturb bat colonies resulting in roost abandonment and the direct or indirect mortality of nonvolant or hibernating bats.

Goal: Develop and implement sound cave resource management practices that best benefit roosting bats, as well as other cave resources. Recruit cooperative support from the caving, research, and management communities.

Objective 1: Prioritize protection of caves that contain bat species of concern, especially where these species demonstrate high roost fidelity or narrow habitat requirements.

Objective 2: Involve recreational cavers in the process of developing cave management guidelines.

Objective 3: Install bat-compatible closures at caves when necessary to protect sensitive bat populations.

Objective 4: Enforce existing laws and regulations pertaining to wildlife and cave resources.

Objective 5: Protect potentially suitable cave roost sites, even if not currently used by bats.

Management Recommendations:

- Consult with agencies, owners, and cave groups to identify caves where bats are currently roosting or have historically roosted.
- Develop cave management guidelines that provide for recreational use when consistent with protecting bats and other cave resource values.
- The FCRPA provides a basis for developing management guidelines. Other laws and regulations that may provide additional protection for cave resources include: the 1897 Organic Administration Act (16 U.S.C. 551), the 1973 ESA (87 Stat. 884, as amended; 16 U.S.C. 1531), the 1906 Antiquities Act (34; 16 U.S.C. 431 et seq.), and the 1979 Archaeological Resources Protection Act (16 U.S.C. 470aa).
- Implement protective strategies for all significant cave roost sites. The American Society of Mammalogists recommends guidelines to help protect bat roosts (Sheffield et al. 1992). These guidelines were adopted in the Strategy for the Townsend's big-eared bat (Pierson et al. 1999).
- Regulate human use in caves with sensitive bat resources by developing cooperative agreements, memoranda of understanding, and cave entry permits for both recreation and research, if appropriate.
- For Townsend's big-eared bat, implement seasonal or diurnal use restrictions at caves during critical bat use periods. Close caves to recreational use from November 1 to April 1 to protect hibernacula and from April 1 to October 1 to protect nursery caves. The critical time periods of hibernation and maternity activity may vary regionally and should be determined by a qualified biologist (Pierson et al. 1999).
- When bat compatible closures are required, design structures that minimize changes to the cave microclimate and entrance configuration, and that provide secure access control. Recruit recreational cave user's support to construct and install these closures. Plans for such closures have been developed for many caves (Bat Conservation International (BCI), USFWS, and CDOW to name a few).
- Protect caves historically occupied by sensitive bat species.

Research Needs:

- Develop and improve remote survey techniques including infrared photography, acoustic survey techniques, electronic entry and exit counting, and species identification.
- Identify factors, both external and internal to the cave, to evaluate potential for future use by bats. These factors may include cave microclimate, elevation, and proximity to forage and water.
- Determine if the presence of cave pools is important to bats choosing hibernacula.
- Develop techniques for DNA analysis of bat remains for indicating historic use in caves when skulls are not present to identify species.
- Develop techniques for analysis of bat guano that may document species using a cave and their prey selection.
- Develop an indicator test for distinguishing roost stains from other naturally occurring stains on cave ceilings and walls.
- Study the relationship between cave water quality and the trace mineral needs of bat species. Monitor water chemistry, especially calcium and sulfate concentration, as well as

microorganisms, pollutants and contaminants. Investigate the possible relationship between the presence of water resources inside caves and bat roost site preference.

- Model cave environments to determine optimal roost conditions and factors important for bats. This may include monitoring temperature, humidity, airflow patterns, cave passage geometry and complexity, presence of cave water, and entrance location and cover.
- Measure the distance and location of drinking and foraging sites from established bat cave roosts. Determine if and why bats are using multiple caves.

Disturbance and Recreational Impacts to Cave Roosts

Goal: Minimize or prevent impacts by recreational cave users, researchers, and the general public in caves where significant or sensitive populations of bats are present.

Objective 1: Provide information to cavers and other public users about "bat friendly" caving techniques.

Objective 2: Coordinate with owners of private caves to establish protective measures for caves supporting critical bat populations.

Objective 3: Establish seasonal protection measures for caves that support critical populations of bats, including the construction of bat compatible closures.

Objective 4: Standardize protocol for both external and internal surveys to minimize stress to bats and impacts to other sensitive cave features.

Management Recommendations:

- Encourage agencies and private cave owners to ask cave visitors to practice "bat-friendly" caving techniques.
- Offer support or assistance to cave managers (particularly for show caves) by providing educational programs or materials relating to bat conservation.
- Offer bat management and conservation technical support to private cave owners.

Research Needs:

- Evaluate the impact of entrance signs and other education efforts on caving practices.
- Investigate alternative caving and research techniques that reduce impacts to bats.
- Research the human-use trends in individual caves that are past, current or potential bat habitats to determine appropriate management strategies. Supporting information may be obtained from entry registers, caving publications and personal accounts, and through surveillance devices.
- Study factors affecting roost fidelity in high-use recreational and commercial caves. Determine the strategies bats are adopting to cope with high human activity levels. Investigate ways to minimize disturbance of bats at commercial caves during tours.

Recreational Climbing

Recreational climbing is increasing in popularity in Colorado. The cracks and crevices in rock faces that provide attractive sites for climbers also provide sites for bat roosting. Fourteen of our 18 species will roost in crevices and can be disturbed by recreational climbing. High climbing activity may displace roosting bats, and increase threats to species of concern.

Goal: Minimize impacts of recreational climbing on crevice-roosting bats through education and cooperation.

Objective 1: Work with the local climbing communities to educate members about the importance of crevices to bats and the potential for disturbance by recreational climbing during critical time periods.

Objective 2: Identify localities where recreational climbing activities are high and/or increasing, and may impact bats. Work with management agencies to minimize negative impacts.

Objective 3: Identify sites with significant bat roosts in cliffs or crevices where significant climbing activities occur.

Research Needs:

- Obtain information on the location of critical areas for crevice-roosting bats.
- Research the extent of impacts to crevice-roosting bats resulting from recreational climbing.

III. FOREST MANAGEMENT PRACTICES

At least 10 species of Colorado bats use forest ecosystems for roosting and foraging habitat, including the western small-footed myotis (*Myotis ciliolabrum*), long-eared myotis (*M. evotis*), fringed myotis (*M. thysanodes*), long-legged myotis (*M. volans*), little brown bat (*M. lucifugus*), Townsend's big-eared bat (*Corynorhinus townsendii*), red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), big brown bat (*Eptesicus fuscus*) and silver-haired bat (*Lasionycteris noctivagans*). Certain management activities such as the removal of large snags and wildlife trees have the potential to adversely affect the viability of these bat populations.

Forest bats roost in both live and dead trees, often roosting under loose exfoliating bark, in cavities, or vertical cracks. In aspen mixed forest stands in Alberta, Canada, bats preferred roost trees that were tall, dying, or newly dead with heart rot and low leaf cover (Crampton and Barclay 1996). Vonhof (1995) and Campbell et al. (1996) observed a similar pattern in British Columbia and northeastern Washington, respectively. In a northern Arizona study, Rabe et al. (1998) found that ponderosa pine snags used by bats were larger in diameter and were more likely to have exfoliating bark than random snags.

Vonhof (1995) found bat roost trees in mixed coniferous forest in southern British Columbia to be situated within forest stands, not in the open. He concluded that although leaving small numbers of trees within clearcuts has been shown to provide habitat for some cavity-nesting birds, this practice might not provide suitable bat roost habitat. Retaining isolated trees in an open clearcut,

for example, may not provide the range or the number of alternate trees necessary to meet the roosting needs of forest-dwelling bats.

Studies have shown that forest bats typically switch roosts often during the maternity season, suggesting they may require multiple tree roosts. Bats may switch roosts to avoid disturbance or predation (Kunz 1982), to acquaint young with possible future roost sites (O'Shea and Vaughan 1977), to respond to shifts in prey availability, or to respond to changing roost conditions (Lewis 1995). The use of multiple snags by maternity colonies and the ephemeral nature of bark on roost snags suggest that bats may require higher snag densities than birds, particularly snags in early decay stages and with loose bark (Rabe et al. 1998). Cavities excavated in snags by birds may be available for many years, but bat roosts under loose bark may be relatively short-lived.

Old growth forests contain a greater abundance of large snags in a variety of decay classes than second growth stands (Cline et al. 1980). Thomas and West (1991) found that bats used old growth Douglas-fir forests in the Pacific Northwest primarily for roosting rather than foraging. Their study showed that forestry practices that remove old growth and thus reduce the overall age structure of forests without retaining snags and damaged trees would significantly affect bat populations.

When foraging, bats often move along forest edges more than within the forest interior (Black 1974, Crampton and Barclay 1996, de Jong 1994, Kunz and Martin 1982). This may facilitate orientation, but may also maximize contact with insect prey. When comparing bat foraging activity among forests, clearcuts, and water bodies, activity was found to be higher around water bodies (Lunde and Harestad 1986). "Clutter" is defined as vegetation that has the potential to impede bat echolocation and flight. Some bats are capable of maneuvering close to vegetation and thus are able to forage in highly "cluttered" habitats. Brigham et al. (1992) and Saunders and Barclay (1992) reported that such "clutter-tolerant" bats were not confined to using cluttered areas for foraging, but routinely exploit open habitats as well.

Because there is evidence that bats use old growth forests primarily for roosting rather than feeding (Thomas and West 1991), forests should be managed on a landscape level to include a sufficient amount of old stands, open water bodies, and foraging habitat (Grindal and Brigham 1998, Jung et al. 1999, Krusic et al. 1996). More research is needed to ascertain how different forest management practices affect long-term survival and population status of forest bats.

We address two categories of issues for forest bats in Colorado: loss of tree roosts in forest ecosystems; and degradation of foraging habitat.

NABCP: I Research-Goal 2- A3; Goal 3- A1, A2, A4, A5; Goal 4- A1 / III Management-Goal 1- A1; Goal 2- A1, A2, A7.

Loss of Tree Roosts in Forest Ecosystems

Goal: Manage forest vegetation types for viable populations of forest bats by maintaining quality roosting habitat.

Objective 1: Increase the awareness, protection and development of roosting habitat for forest bats.

Management Recommendations:

- Protect an adequate density of large diameter and/or tall snags and wildlife trees within forest stands. In addition, trees with the following characteristics should be favored for retention: loose bark, dead or broken tops, lightning strikes, natural cavities, or woodpecker cavities.
- Provide snags in clumped or clustered patterns across the landscape, to address frequent roost switching that occurs with many forest-dwelling bats.
- In mature aspen stands, protect snags, live cavity trees and trees with evidence of heart rot within intact habitat patches. Avoid leaving these trees isolated within clearcut blocks (Vonhof 1995).
- Create tree-roosting habitat in desirable areas that currently lack sufficient habitat. Topping live trees with a chainsaw or with explosives are two currently accepted methods of creating snags (Bull et al. 1981).
- Develop future bat roosting habitat by identifying large-diameter live wildlife trees for retention during harvest activities. These trees should be protected during subsequent harvest entries as well.
- Develop firewood guidelines to ensure the protection of adequate snag and wildlife tree densities.
- Provide land managers with up-to-date information on bat roost ecology and management recommendations for incorporation into agency plans.
- Restore fire to forest stands to meet management objectives. Periodic low intensity burning in some forest systems could help maintain a more open understory and reduce clutter that impedes bat flight. Incorporate snag and wildlife tree protection measures within burn plans.
- Provide county extension agents and the Colorado State Forest Service with information to assist private landowners with the protection and development of roost trees. Make private landowners aware of the value of snags and live cavity trees. Roost trees should not be removed as private lands are cleared for development.

Research Needs:

- Conduct studies to determine roosting requirements for each of the forest bat species. Roosting ecology, roost site characteristics, roost density and distribution requirements, and the role of overstory and understory “clutter” around roost sites should be examined.
- Determine what size of habitat patch is necessary to meet bat roosting needs within the aspen forest type.
- Better define the different types of roost sites used by forest bats (i.e., day versus night roosts, winter tree roosts, maternity roosts versus roosts used by solitary individuals).
- Develop snag recruitment models of snag stage that are specific to each forest type.
- Obtain more information on the effects of various timber harvest systems (e.g., group selection, clearcut, salvage, and individual tree selection) on existing and potential bat roosting habitat.
- Obtain more information on the effects of forest thinning as a silvicultural practice on bat populations.

Degradation of Foraging Habitat For Bats

Goal: Manage forest vegetation types for viable bat populations by maintaining quality foraging habitat.

Objective 1: Design forest management practices using guidelines that ensure protection and development of foraging habitat.

Management Recommendations:

- Provide land managers with up-to-date information on bat foraging ecology and management recommendations for incorporation into agency plans.

Research Needs:

- Obtain data on bat foraging habitat requirements specific to Colorado forests. What role do forest stands play in providing bat foraging habitat? What bat species forage in forest stands?
- Obtain more information on the effects of various timber harvest practices (e.g., group selection, clearcut, salvage, and individual tree selection) on existing and potential bat foraging habitat.

IV. RANGELAND MANAGEMENT PRACTICES

Bats use riparian areas and rangelands for foraging, and in many places, these areas are an important source of drinking water. Moths, the preferred prey of many bats, especially Townsend's big-eared bats, reproduce on shrubs, trees, and flowering plants, but not on grasses. Vegetation structure is a critical component in the life cycles of insect prey, especially for moths. The impacts to vegetation structure from over-grazing and vegetative conversion through fire, mechanical, and chemical manipulation is unknown, but potentially significant to some populations of bats. Chemical control of insects on Colorado rangelands is not widespread, but would also threaten the prey-base of bats, as well as pose a risk of direct poisoning. Finally, available drinking water for bats may be limiting in the arid regions of Colorado.

We address the following four categories of issues resulting from rangeland management practices in Colorado: loss of riparian habitat; loss of vegetative structure in pinyon-juniper and sagebrush rangelands; impacts from pesticide spraying; and lack of adequate drinking water sources.

NABCP: I Research-Goal 1-A2, A3; Goal 3-A3; Goal 4- A1 / II Management-Goal 1-A1; Goal 2-A1, A4. NABCP: I Research-Goal 4/Priority Action 2. NABCP: I Research/Goal 1/Priority Action 2; III Management/Goal 2/Priority Action 4.

Loss of Riparian Habitat

Riparian habitats are an important resource due to the high diversity of insects and access to a water source. Riparian areas near maternity roosts also may provide important flyways for

foraging females and volant young. Riparian vegetation structure may be a critical component in the life cycles of the preferred prey (moths) of Townsend's big-eared bat. The loss and/or degradation of these habitats, especially in xeric settings, may affect populations associated with these sites.

Goal: Preserve and restore riparian habitats near colonies of bats through the promotion of sound grazing management practices and riparian buffers.

Objective 1: Identify important roosting colonies on public lands and implement management practices to maintain or improve riparian habitats for foraging and flyways.

Objective 2: Determine the importance of cottonwood riparian ecosystems for foraging, roosting and migration.

Management Recommendations:

- Implement recommendations regarding maintaining or improving riparian and wetland habitat within 10 miles of Townsend's big-eared bat roosts (Pierson et al. 1999).

Research Needs:

- Investigate the importance of riparian habitats through studies of the bat activity levels in these areas, and through radio tracking of bats.
- Investigate the use and importance of riparian habitats to insect prey.
- Research the potential impacts of exotic riparian species such as salt-cedar (*Tamarix ramosissima*) and Russian-olive (*Elaeagnus angustifolia*) on insect communities and subsequent effects on foraging.

Loss of Vegetative Structure in Pinyon-Juniper and Sagebrush Rangelands

The conversion of pinyon-juniper and sagebrush by fire, mechanical manipulation, chemical pest control, and grazing can lead to a loss of vegetative structure that may impact foraging habitats. In the West, fire, mechanical manipulation, and chemical control have converted large acres of native shrub-steppe habitats into monotypic exotic grasslands. The conversion of sagebrush to exotic grasslands in Colorado is of special concern. The pinyon-juniper/sagebrush habitat comprises only 7 percent of the Colorado landscape (Armstrong et al. 1994) yet provides the highest bat species diversity of all habitat types in the state. While the impacts to bats from loss or changes in the insect prey base are unknown, it may be an important factor affecting bat populations.

Goal: Prevent large-scale declines of insect prey or changes in insect species associated with conversion to rangelands near known roosts of Townsend's big-eared bats and other species of concern.

Objective 1: Promote awareness of the importance of shrublands and pinyon-juniper habitats in the food web of bats with management agencies and landowners. Encourage smaller scale vegetation and/or seral stage conversion projects.

Objective 2: Provide information and recommendations to management agencies during major planning efforts to incorporate the need for diversity of vegetative structure in rangelands and shrub-steppe habitats.

Management Recommendations:

- Implement the standards regarding vegetation conversions in the Strategy for the Townsend's big-eared bat (Pierson et al. 1999): "No prescribed burning or vegetative alteration in shrub-steppe or pinyon-juniper habitats will be conducted within a 1.5 mile radius of *C. townsendii* roost sites. Within the 0.5 mile radius of *C. townsendii* roost sites, no more than half of the forested habitat can be subjected to prescribed burning per decade, and only at a time when the roost is not occupied."

Research Needs:

- Obtain data on the importance of vegetation structure to insect prey.
- Obtain data on scales and patterns of rangeland vegetation conversions that support viable bat populations.

Impacts from Pesticide Spraying

The use of insecticides on rangelands and agricultural lands may cause direct poisoning of bats through the consumption of affected insects. Bats are especially at risk of poisoning from large-scale use of insecticides because of their diet, high metabolic rates, high food intake, and high rates of fat mobilization during migration, hibernation, and lactation (Clark et al. 1988). Additionally, the potential impacts to bats from loss or change in the insect prey-base are unknown. Known colonies of bats should be protected from pesticide spraying projects.

Goal: Prevent large-scale use of insecticides on rangelands and promote awareness of potential harm to bats on agricultural lands through educational efforts, input into land use planning efforts, and interaction with farming communities.

Management Recommendations:

- Implement the standards regarding pesticide spraying in the Strategy for the Townsend's big-eared bat (Pierson et al. 1999).
- Identify all bat roosts within potential spray areas through surveys or literature review.
- Intensify target insect sampling to decrease spray block size.
- In determining buffer zone (no spray), consider the application method and potential for spray drift.
- Consider utilizing a 2-mile radius buffer zone around all bat roost sites until further research has been conducted on specific buffer zones for specific pesticides.
- Within a 10-mile radius of known Townsend's big-eared roost sites, strip spray 0.25 mile strips (Pierson et al. 1999).
- Utilize species-specific control measures when available (e.g., Nosema, a specific pesticide, or other specific biological control) (Pierson et al., 1999).
- Work with the Colorado Bat Society (CBS), universities, the USFWS, other land management agencies, farmland organizations, and the CDOW to promote studies to obtain information on the impacts of pesticide use.

Research Needs:

- Study the impacts to bats of pesticide use in Colorado to control rangeland insect pests.
- Study the impact on bats of pesticide use on agricultural lands.
- Study the value of bats as consumers of insects to agricultural lands.
- Research alternative pest control options that are safer to bats and other wildlife species.

Conservation of Drinking Water Sources

In the arid regions of the Colorado rangelands, availability and access to open water for drinking may be limiting to populations of bats. Additionally, water chemistry may be important to nursery colonies.

Goal: Promote availability of open water for bats in arid rangelands through management actions and recommendations. Identify key drinking sites for bat colonies.

Objective 1: Promote awareness to land management agencies of bats need for open water, and consideration of bat accessibility to existing and planned water developments for other wildlife and livestock.

Objective 2: Develop and promote designs for water guzzlers that allow easy access by bats.

Objective 3: Encourage land management agencies to consider maintaining access to water in abandoned mines in arid areas without other open water resources.

Research Needs:

- Develop and test designs for wildlife guzzlers that allow easy use by bats.
- Determine drinking water chemistry requirements of maternity colonies and identify and conserve water sources near these roosts, especially for Townsend's big-eared bat and other species of concern.

V. URBAN DEVELOPMENT

Threats to bats as a result of urban development may include loss of foraging habitat and alteration of existing habitats. Conversely, urban development may increase the number of potential roosts for some Colorado bats (i.e., building-roosters such as the big brown bat (*Eptesicus fuscus*) and the little brown bat (*Myotis lucifugus*)), but there has been little research on the selective value of human-made roosts versus natural roosts. Although urban habitats may provide a wealth of new roosting opportunities for these species, food supplies in urban areas may be lower than in more rural habitats (Geggie and Fenton 1985). Urban development may also contaminate existing water sources and riparian areas, adversely affecting bat foraging patterns. Vaughan et al. (1996) found that bat activity was reduced downstream from sewage outputs in southwestern England.

The loss of roost sites due to development also may be an issue affecting bat conservation. While the increase of structures may provide roosting habitat that favors certain species, it is unknown whether these structures and the associated increases in certain bat populations negatively impact other species of bats.

We address three categories of issues concerning urban development in Colorado: loss of wetland habitat; loss of anthropogenic roosting structures; and disturbance to bat roosts in urban settings.

NABCP: I Research-Goal 2- A3; Goal 3-A1, A3, A5; Goal 5- A1 / II Education- Goal 1-A2, A5; Goal 3-A1, A2, A3; / III Management-Goal 2-A1, A6.

Loss of Wetland Habitat

Wetlands provide foraging and drinking habitat for bats. The loss of wetlands in urban settings may affect bat populations associated with these areas.

Goal: Preserve and improve wetland habitat through land use planning.

Objective 1: Provide information to land managers and county planners about the importance of these habitats to bats and other wildlife, and promote the conservation of wetlands.

Management Recommendations:

- Work with current wetland conservation programs, such as the CDOW's Wetlands Initiative Program, Ducks Unlimited's Marsh Program, etc.

Research Needs:

- Expand current knowledge of the use of wetlands by bats, especially in urban settings. Document the benefits of insect control by bats.

Loss of Human-made Roosting Structures

The loss of structures for roosting habitat may impact populations through the modification and/or replacement of bridges, and the eviction and/or killing of bats roosting in houses and other buildings. Old and abandoned buildings may be particularly important roosts for bats. This applies to old cabins and other structures that could be used by bats on public lands and in rural areas. Conversely, urban sprawl may increase roosting opportunities for some bat species.

Goal: Prevent the decline of bat species associated with bridges and houses in urban and rural settings in Colorado.

Management Recommendations:

- Work with Colorado Department of Transportation (CDOT) to staff more aware of the relationship of bats and bridges, and to conserve roosts when opportunities develop. Provide information to CDOT regarding bridge designs and modifications that are compatible with bats.

- Provide information to state, federal, and county pest control agencies, and to private companies regarding best management practices on excluding bats from houses, and encourage non-lethal techniques.
- Promote the use of bat houses in urban settings as a preferred alternative for dealing with nuisance bat problems.
- Work with the Colorado Historical Society and others to promote the preservation of important bat roosts in historical buildings.

Research Needs:

- Obtain data on the use and importance of bridges. Complete basic bridge surveys.
- Collect data on bat house designs and placement for successful use by bats.
- Research the roosting potential provided in new developments to determine if loss of historical roosts in old buildings and bridges is offset by new development. Determine if the increase of species that favor roosting in urban settings is impacting other species.

Disturbance of Bat Roosts

Disturbance of bat roosts in urban settings may negatively affect bat populations. Bats roosting in urban buildings may also cause negative images of bats to the general public.

Goal: Promote awareness of the beneficial effects of bats in houses and urban situations. Promote proper techniques and solutions for dealing with nuisance bats with the public and pest control companies.

Objective 1: Promote awareness of the implications of bats to human health in Colorado. Work with the Colorado Department of Health and Environment, CBS, the public school system, and others to reduce public fear of bats, and educate on the proper approach to bat/human interactions.

Objective 2: Provide information to pest control agencies and companies regarding best management practices on excluding bats from houses, and promote non-lethal techniques.

Objective 3: Promote the use of bat houses in urban settings for nuisance bat problems.

Objective 4: Identify companies or individuals that can conduct ecologically responsible exclusions of unwanted bat roosts in buildings.

Objective 5: Promote awareness of urban insecticide spraying programs and the potential impacts to bat populations.

Management Recommendations:

- Work with the CBS to promote bat house use in nuisance bat situations.
- Work with the CBS and the CDOW to promote awareness and training of pest and animal control agencies and companies regarding proper techniques and perspectives on nuisance bat issues.

- Work with the CBS and BCI to promote information exchange regarding bat house designs and placement.

Research Needs:

- Develop studies to evaluate the impacts to bat populations from urban pest spraying programs.
- Study the success of different designs of bat houses specifically in Colorado, and refine these designs to be optimal.

VI. RESEARCH, INVENTORY AND PROTOCOLS

Our knowledge of bats is less comprehensive than that of other mammals. This is due in part to the difficulties in the observation and identification of bats. Bats are nocturnal, generally silent to the human ear and very mobile. In our efforts to learn more about bats, the development of research techniques continues to rely heavily on the development of new technologies. Some techniques have adversely impacted individuals or significant portions of bat populations. Both field and lab techniques disturb bats and every attempt should be made to develop research techniques that maximize the collection of sound data while minimizing impacts.

We address four categories of issues potentially affecting bats from scientific activities: lack of protocols for research inventory and monitoring at roosts; and concerns about marking, trapping, and telemetry.

NABCP: I Research-Goal 6-A3 / II Management-Goal 1-A3.

Research Protocols

Goal: Follow established protocols for research, inventory, and monitoring at roosts.

Objective 1: Monitoring of maternity roosts should be conducted by external evening exit counts. The use of night vision equipment is recommended for more accurate counts. Remote techniques should be encouraged. The counts should be conducted in spring or early summer, one to two weeks prior to parturition of the species. This “window” should be determined for the colony through prior study. Future roost counts should be conducted as close to the same dates as possible. See Navo (2001) for protocols recommended for maternity and other roosts.

Because of the great sensitivity of maternity roosts to disturbance, they should not be entered unless absolutely necessary. Under no conditions should animals be removed from or disturbed in a nursery cluster. Any netting of bats at these roosts should be conducted outside the roost and away from the roost entrance. The use of harp traps should be conducted at the roost entrance.

Objective 2: Because of the impacts of disturbance to hibernating bats, monitoring of bats at hibernating sites should be kept to a minimum. Hibernacula should not be entered more than

once every two to three years unless absolutely necessary. Surveys should be conducted with great caution and as quickly and quietly as possible (Navo 2001).

Objective 3: Banding of bats should only be conducted by experienced bat biologists, preferably using lipped bands. Band numbers and banding locations should be documented and provided to the CDOW for future reference. Because of past problems associated with banding of some species, banding studies should show good justification and clear and obtainable objectives in permit applications. Widespread and indiscriminate banding of bats should be discouraged. Banding of a large percentage of any one colony is discouraged and should not be permitted on Townsend's big-eared bats unless accompanied by clear scientific objectives.

Marking

The marking of individuals is used to study general population dynamics and movement patterns. All marking techniques, however, have the potential to affect the mortality of the bats under study. The use of metallic and plastic bands has been borrowed from techniques developed for birds and has been employed since the 1940s. More recent marking techniques include the use of necklaces (made of either beaded keychains or plastic ratchet loops) and of Passive Integrated Transponder (PIT) tags. Additionally, light marking of individuals to study real-time movement patterns has employed Light Emitting Diodes (LED), reflective tape, and chemiluminescent and Betalight markers.

The use of all these marking techniques requires the capture and handling of individuals. Metallic bands, PIT tags and necklaces can affect mobility and even cause direct injury if inappropriately applied, and bats must be recaptured either in hand or by a PIT reader placed at roost entrances to determine identity. Plastic bands and light tagging/marking techniques help minimize the need for recapture, but still may affect mobility and the ability of predators to depredate bats. However, in order to mark bats, they must be at least initially handled, which can alter time and energy budgets, cause roost-site abandonment, and can stress animals to the point of causing death.

Goal: Minimize impacts to bats used in research by modifying or refining current techniques where necessary and creating less invasive ones.

Objective 1: Work with bat researchers to target less-sensitive populations of bats for study.

Objective 2: Develop less invasive marking techniques in collaboration with universities and researchers around the globe.

Objective 3: Develop protocol guidelines to minimize adverse effects from marking bats.

Research needs:

- Develop less intrusive marking techniques.
- Investigate feasibility of analytical methods that minimize the need to mark individuals.

Trapping

Trapping is fundamental to many inventories and research studies. Species identification is difficult for *Myotis* without handling, and in order to mark individuals bats must be captured. Trapping methods have improved substantially over the years, but all methods can affect bats adversely. Bats can be captured directly from roost sites, during emergence from roosts, and while foraging away from roosts. Of these, the least disturbing is probably capturing away from roost sites while foraging or drinking. Bats will often switch roosts (often to lesser-quality sites) in response to having been trapped at the primary roost. More significantly, capture during hibernation or lactation disrupts critical energy budgets required for these particular stages. Timing will generally be determined by the research needs and it is important to understand the expected responses of bats from differences in the timing of disturbances. Hand capture, hand nets, bucket traps, bag and funnel traps, mist nets and harp traps all pose threats of direct injury to the bat at the time of capture. Trapping poses threats that will vary depending on season and method used, but all methods share the common threat of stress from the capture itself.

Goal: Minimize stress to bats by ensuring that all collection-permit applicants have received thorough training on the capture and handling of bats.

Objective 1: Develop trapping protocols that allow for a minimum of disruption to bats. Work with the CDOW to employ minimum training standards required by all bat collection-permit applicants. Engage CBS and the Colorado Bat Working Group to host bat trapping workshops that educate prospective researchers.

Objective 2: Encourage the development of trapping techniques that minimize stress on bats, and encourage the use of harp traps at caves or mines instead of mist nets.

Objective 3: Encourage the use of remote techniques and methods instead of captures where feasible.

Research needs:

- Examine the feasibility of using alternate survey methods for inventory where bats do not need to be marked (e.g., bat detectors such as the AnaBat II system) or identified to species.
- Encourage the development of less intrusive methods for capture.

Telemetry

Recent developments in radio-transmitter technologies have allowed researchers to learn more about movement patterns and roosting behavior in bats. Keeping transmitter to body weight ratios below 5 percent (Stebbings 1982, 1986) is thought to minimize adverse effects to bat movements and survival. There is little data available, however, on the actual impacts on long-term survival of transmitters applied to bats. Additionally, many studies now violate this “5 percent rule.” However, the limited number of attachment methods poses the potential threat of direct injury.

Research needs:

- Design a research study to test the “5 percent rule” for bat radio transmitter size.

VII. SPECIES STATUS, POPULATION TRENDS, AND MONITORING

Too little is currently known about most species of bats in Colorado to provide evaluations of their status and population viability. While some work over the last five to ten years has helped elucidate general distributions and protected some colonies across the state, there remain many questions and information gaps. Monitoring of bats presents many challenges to resource managers and researchers (see “Workshop on Monitoring Trends in United States Bat Populations: Problems and Prospects” at <http://www.mesc.usgs.gov/BPD/ireport.htm>), yet estimating trends in bat populations is vital to preserving the biological diversity of Colorado. Understanding changes in populations is especially important for those species formerly considered Category 2 candidates under the ESA (US Fish and Wildlife Service 1994), and to prevent the future need for listing as state or federal threatened or endangered species. The following list of management projects, data gaps, and research needs is intended to help guide and focus the limited resources available for bat conservation. These projects will provide valuable information to determine species status, and will help develop the tools required to monitor population trends and implement future conservation actions. They are not in a specific order of priority.

NABCP: I Research-Goal 1-A1, A2, A3; Goal 2-A1, A2, A3, A4; Goal 3-A1, A2, A3, A4, A5; Goal 6-A1, A2; Goal 7-A2; III Management-Goal 2-A1, A2, A5; Goal 4-A2.

- Inventory caves to identify and protect important bat colonies, especially in areas with high densities of significant cave and karst formation (such as on the White River National Forest).
- Identify and evaluate all caves that supported historical populations of bats species of special concern to determine current status of these populations, and identify currently unoccupied but potentially suitable roosts for protection.
- Continue to survey, identify, and protect important bat roosts in abandoned mines on public and private lands in cooperation with active state and federal AML closure programs.
- Determine the importance of caves to hibernating populations.
- Fully define the roosting habitat of maternity and hibernating colonies of Townsend’s big-eared bat.
- Search for and document maternity roosts for all bat species formerly designated Category 2 candidates under the ESA (US Fish and Wildlife Service 1994).
- Delineate the microhabitat parameters of Townsend’s big-eared bat roosts.
- Determine types of seasonal roosts used by Townsend’s big-eared bat, and the importance of each type to long-term conservation of the species.

- Evaluate the amount of roost switching by maternity colonies of Townsend’s big-eared bat, and determine the distances moved, frequency of switching, and factors that trigger such movements.
- Evaluate the seasonal movements of Townsend’s big-eared bat colonies between summer nurseries and winter hibernacula, and define population units for conservation.
- Provide long-term conservation of the Orient Mine, the largest bat roost in Colorado.
- Evaluate potential impacts from radiation to bats roosting in uranium mines.
- Determine the types of seasonal roosts utilized by all species of concern, and the importance of each type of roost to long-term survival of each species.
- Establish the use and importance of man-made structures used as roosts by species of concern.
- Complete a genetic analysis of the subspecies of fringed myotis (*Myotis thysanodes*) in Colorado.
- Delineate the distributional range of *Myotis occultus* -- a possible new distinct species in Colorado.
- Determine the extent and importance of “swarming” by bats at caves and mines.
- Determine the winter status of spotted bats (*Euderma maculatum*) in the state.
- Establish monitoring programs for selected colonies of former Category 2 candidates under the ESA (US Fish and Wildlife Service 1994).
- Determine the winter hibernation status of all species of bats in the state.
- Develop new techniques and equipment to allow less intrusive monitoring of bat colonies.
- Verify the roosting requirements of tree roosting bats, as reported from research elsewhere, in Colorado’s forests.
- Determine migratory patterns and important flyways of migratory bat species in Colorado. If identified, protect, maintain, and restore if necessary, and monitor important migratory corridors and flyways.
- Determine the summer status of both species of free-tailed bats (*Tadarida brasiliensis* and *Nyctinomops macrotis*) in Colorado.

- Establish an acoustic bat call library for Colorado, which is essential to document local distribution and foraging behavior of bats.
- Provide a comprehensive evaluation of the success of bat gates in Colorado.
- Encourage and initiate interstate and international communication and coordination for conservation of our migratory bats, especially the Brazilian free-tailed bat (*Tadarida brasiliensis*). Explore the potential of bat conservation partnership with bird conservation efforts (Partners In Flight).
- Evaluate the potential of using artificial roosts in areas where the loss of natural roosts has been documented, and may be limiting population recovery.

LIST OF POTENTIAL PARTNERS

- American Cave Conservation Association
- Bat Conservation International
- Cave Research Foundation
- Colorado Bat Society
- Colorado Cave Survey (National Speleological Society affiliate)
- Colorado Division of Wildlife
- Colorado Natural Areas Program
- Colorado Natural Heritage Program
- Colorado State Department of Public Health and Environment
- County and city parks departments
- County health departments
- Denver Museum of Nature and Science
- Federal Agencies (USFS, BLM, NPS, USFWS, etc...)
- Greater Outdoors Colorado Organization
- Individual cavers/spelunkers

- Landowner incentive programs
- Local grottos (National Speleological Society affiliates)
- National Speleological Society
- National Show Caves Association
- National Cave Management workshops
- Private biologists and speleological consultants
- Private landowners (e.g., ranches and show caves)
- State parks
- University researchers

SPECIES RANKINGS

The Western Bat Working Group (WBWG) held a workshop in Reno, Nevada, February 9-13, 1998. The purpose of this workshop was to develop a regional priority matrix intended to provide states, provinces, federal land management agencies, and interested organizations and individuals a better understanding of the overall status of a given bat species throughout its western North American range (Western Bat Working Group 1998). The Colorado committee of the WBWG decided to go through a similar ranking exercise specific to the state of Colorado and the four ecoregions identified earlier in this document (Wyoming Basin, Colorado Plateau, Southern Rocky Mountains, and Central Shortgrass Prairie). This ranking exercise was designed to be a quantitative way of prioritizing conservation and research efforts for bats in Colorado.

We identified three criteria for ranking: management, research, and knowledge gaps (Table 2). Each of these criteria was given a value from 0 to 3. A score of zero was chosen when a particular criterion was not applicable to a given species. We then examined how each species was associated with 8 categories: (1) mining; (2) cave and crevice management practices; (3) forest management practices; (4) rangeland management practices; (5) urban development; (6) summer roost status; (7) winter roost status; and, (8) status in Colorado. The first five of these categories are the threats or issues described previously in the Conservation Strategy. Summer and winter roost status were categories describing a species roosting habitat during these different seasons. If a species was known or believed to be a summer resident and reproductive in Colorado, we assigned the rank of 0. If a species was known to be reproductive in the summer and the roosting habitat is abundant and not under any urgent threats, we assigned a rank of 1. If the species status in the summer is unknown, or unverified for the state, we assigned a rank of 2. Finally, if a species was a known summer resident, but the roosting habitat is unknown or not well documented for the state, or the roosting habitat is believed to be under urgent threat, we assigned a 3.

Similarly, for the winter roost status category, we assigned a 0 if the species is known or believed to be a winter resident in Colorado. A 1 was assigned if the species is known to be a winter resident and roosting habitat is abundant and not under any urgent threats. A 2 was assigned if the winter status is unknown or poorly documented for the state. Finally, a 3 was assigned if the winter status is unknown or poorly documented, and roosting habitat is not well known, and/or roosting habitat is under urgent threat. Summer and winter roost status categories were only assigned a rank as a function of the research criterion. A final rank for status in Colorado was given for each species and is based on the various state and federal lists (CDOW, USFS, BLM, and USFWS).

We also examined the distributional range of each species in the state of Colorado by the four ecoregions. We assigned three categories to describe a species range: “ubiquitous,” “peripheral,” and “habitat requirement.” If a species occurred throughout an ecoregion, the “ubiquitous” category received the value of 1, while the “peripheral” category received a 0. Conversely, if the distribution of a species was on the edge of an ecoregion, the “peripheral” category was given a 1, while the “ubiquitous” category, a 0. If a species was not known to occur within an ecoregion, both categories received a 0. For the “habitat requirement” category, we evaluated whether a

species had a specific habitat requirement within that ecoregion, and if it did it was given a value of 1, 2, or 3. If no specific habitat requirement was known, it was assigned a 0.

Finally, we assigned weights to each of the above criteria. Weights were arbitrarily chosen and ranged from 1 to 5, but not all values between 1 and 5 were used. Management was given a weight of 5, research a weight of 3, and knowledge gaps a weight of 2. We decided that issues or threats most directly affected by management should be weighed more heavily. Generally, management issues can be implemented in the short-term, while research and knowledge building are long-term activities. The following weights were given to the categories of a species' range: ubiquitous was given a weight of 2, peripheral 1, and habitat requirement 5. The habitat requirement category was considered most important when evaluating a species' range. Second in importance was whether the distribution of a species was ubiquitous or peripheral. Species that are habitat specialists can require more targeted management and conservation efforts than habitat generalists. More value was given to the ubiquitous than the peripheral category.

We assigned the following weights to the five threat categories: mining, and cave and crevice management were both given a weight of 1.5; both forest and rangeland management were assigned a 1.25, and urban development was assigned a 1. We recognized that cave management, changes in mining practices, and management activities associated with abandoned mines could affect a larger number of species than forest, range management, and urban development. Mines and caves are small features in large landscapes that support relatively dense concentrations of bats during critical times in their life histories, and Colorado has an active mine closure program so both mines and caves were assigned a weight of 1.5. Both forest and range management practices also can affect bat populations seriously, but the impacts are more dispersed and therefore were not considered as urgent. Forest and range threat weights were 1.25. Finally, urban development has the potential to affect bat populations, but some of the impacts associated with urban development can be beneficial to some species (e.g., big brown bat, *Eptesicus fuscus*). Urban development was assigned a weight of 1.

To more clearly explain this ranking exercise we provide a specific example of the process with Townsend's big-eared bat (*Corynorhinus townsendii*) (see Appendix C for ranks and summary scores for each species). For the mining category or threat, we rated this species a 3 for management, research, and knowledge gaps. Townsend's big-eared bat has a high association with mines and mining practices; management implications are real and could be urgent at some locations. In addition, research needs identified for this species with regards to mines are numerous. Summer and winter roost status were both rated 0 except for in the research criterion where we gave both summer and winter status a 3 (we believe more research is needed). We then weighted and summed these values for mining in the following way: (weight for management * rank for management issue and mining) + (weight for research * rank for research issue and mining) + (weight for knowledge gaps * rank for knowledge gaps and mining) = (5 * 3) + (3 * 3) + (2 * 3) = 30.

This exercise was repeated for cave and crevice management, forest management, rangeland, and urban development in a similar manner. A final rank for "Status" was given for each species and reflects the status of the species in the state of Colorado (this value was not weighted). These

values were then summed for an overall species “Category Score” (see Table 3). We then examined the distributional range of Townsend’s big-eared bat in Colorado. For central shortgrass prairie we gave a rank of 0 for ubiquitous (this species is not common in the shortgrass prairie), a 1 for peripheral, and a 3 for habitat requirement (this species would only be found in this ecoregion if there was suitable roosting habitat available, such as mines or caves). We then weighted and summed these values for range in the following way: (weight for ubiquitous * rank for ubiquitous in shortgrass prairie) + (weight for peripheral * rank for peripheral in shortgrass prairie) + (weight for habitat requirement * rank for habitat requirement in the shortgrass prairie ecoregion) = (2 * 0) + (1 * 1) + (5 * 3) = 16. This exercise was repeated for the other three ecoregions and these values were then summed for an overall “Range Score” (Table 3).

Once the values for each category of threat and range were weighted and summed for each species, we added the two together to get an overall Conservation Priority Score (Table 3). These ranks are meant to be a guide to focus conservation efforts toward species that are: 1) relatively specialized in terms of habitat and therefore more sensitive/susceptible to environmental change; 2) under the most urgent threats and research needs; and 3) that offer reasonable opportunity for effective conservation to occur within the geographic bounds of Colorado. Therefore, species with more generalized habitat requirements and species that occur peripherally in Colorado appear with lower ranks at the bottom of the list. This ranking is not intended to designate which species are most endangered or imperiled, but rather which species are most in need of management actions, research, and attention by managers. A red (black), yellow (light gray), and green (dark gray) color code was also assigned mimicking the colors used by the WBWG’s regional priority matrix. We assigned two species a code of red: Townsend’s big-eared bat (*Corynorhinus townsendii*) and the fringed myotis (*Myotis thysanodes*).

Table 2. Rating criteria for species rankings exercise.

| Criteria | 0 | 1 | 2 | 3 |
|-----------------|---|---|--|--|
| Management | Species not believed to be associated with this threat | Species associated with threat as it applies to all bats in general, or only minor association | Species known to have some association with threat, and some management implications are possible | Species has high association with threat, management implications real and could be urgent |
| Research | No research required for this species related to these threats | Research needs for these threats few, or believed to be low priority; covered by other species | Research needs identified for this species/threat, but not believed urgent for management and conservation | Research needs identified for this species/threat numerous, believed urgent for management and conservation |
| Knowledge Gaps | No significant knowledge gaps exist for this species related to these threats; good information available | Information available, mostly outside of Colorado, or data give no indication of significant needs related to this threat | Little data are available related to threat, or current data from Colorado seem to conflict with data from other areas | No data available for this species/threat, but believed to have high potential for importance, or good data available that strongly suggests relevance of these threats to the conservation of the species |

Table 3. Results from ranking exercise for the bats of Colorado (in descending order by conservation priority score). The red, yellow, and green designations mimic the color codes from the regional priority matrix developed by the Western Bat Working Group (1998).

| SPECIES | | CATEGORY SCORE | RANGE SCORE | CONSERVATION PRIORITY SCORE |
|-----------------------------------|---|----------------|-------------|-----------------------------|
| <i>Corynorhinus townsendii</i> | ● | 126 | 67 | 193 |
| <i>Myotis thysanodes</i> | ● | 108 | 55 | 163 |
| <i>M. volans</i> | ● | 71 | 47 | 118 |
| <i>M. lucifugus</i> | ● | 78 | 33 | 111 |
| <i>M. evotis</i> | ● | 80 | 31 | 111 |
| <i>Euderma maculatum</i> | ● | 67 | 40 | 107 |
| <i>M. ciliolabrum</i> | ● | 66 | 38 | 104 |
| <i>Eptesicus fuscus</i> | ● | 78 | 28 | 101 |
| <i>M. yumanensis</i> | ● | 67 | 29 | 96 |
| <i>Lasiurus cinereus</i> | ● | 47 | 48 | 95 |
| <i>Tadarida brasiliensis mex.</i> | ● | 71 | 24 | 95 |
| <i>Lasionycteris noctivagans</i> | ● | 30 | 48 | 78 |
| <i>Nyctinomops macrotis</i> | ● | 49 | 29 | 78 |
| <i>Antrozous pallidus</i> | ● | 53 | 23 | 76 |
| <i>M. californicus</i> | ● | 51 | 18 | 69 |
| <i>Pipistrellus hesperus</i> | ● | 45 | 23 | 68 |
| <i>Lasiurus borealis</i> | ● | 35 | 7 | 42 |
| <i>Pipistrellus subflavus</i> | ● | 11 | 6 | 17 |

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APPENDIX A

CONSIDERATIONS FOR BAT ROOST PROTECTION

The preservation and conservation of bat roosts is the most important issue in bat conservation; destruction of bat roost sites, especially caves, has been one of the most important factors in the decline of bat populations in the US and around the world (Humphrey 1975, McCracken 1989, Mohr 1972). Sheffield et al. (1992) provides several useful guidelines for the protection of bat roosts. A few of these guidelines include:

- avoid revealing exact locations of bat roosts to the general public
- limit access to critical bat roosts to state or federal researchers with valid permits
- disturbance within a roost should be minimized
- research should be discontinued while bats are hibernating
- collections of specimens should be minimal and should occur outside the roost instead of inside
- education efforts should be increased

There are several additional ways to protect bat roosts. These include various bat-friendly closures (bat-compatible gates, cages or cupolas, gated culverts, cable nets, half-gates, perimeter fences, and seasonal closures), buffer zones, climbing regulations, and cave registers or permit requirements. We discuss several of the most commonly implemented alternatives below.

Bat-compatible Gates

Gates have been used extensively in the eastern US for more than 20 years to protect critical cave roosts. However, if these gates are not bat-compatible, or if they modify the microclimate of the roost, they may actually pose a threat to bats (Richter et al. 1993, Tuttle 1977, White and Seginak 1987). Bat gate installation involves a number of important considerations:

- Learn the special needs of the bats using the mine or cave to be gated. Factors such as species of bat, colony size, season of use, roost type, cave/mine configuration, and other factors will determine what type of gate to install. Gate types can include angle iron full gates, culvert gates, ladder gates, cupolas, half-gates, and slot gate designs. Knowledgeable specialists from the CDOW, Colorado Committee of the Western Bat Working Group, CBS, BCI, or other local bat specialists with experience on the subject can be consulted to determine optimum gate design for a specific closure (also see Ludlow and Gore 2000, Pierson et al. 1999, and Sheffield et al. 1992).
- Provide an adequate flyway for bats emerging from the roost while also allowing for effective exclusion of human intruders. Current bat gate designs call for 5³/₄-inch spacing between horizontal bars and a minimum of 2 feet between upright posts. Some designs call for 4-inch spacing between horizontal bars in the lower 3 feet of the gate to absolutely

preclude children and small adults. This spacing is advisable with gates near human dwellings and high potential visitation. Materials and gate designs are factors in spacing.

- Minimize restriction and alteration of the overall mine or cave opening and surface interface in order to limit alteration of the microclimate within the roost, e.g., temperature, humidity, and airflow. This microclimate is critical to the quality of habitat provided by the roost (Richter et al. 1993, Tuttle 1977).
- Determine seasons of bat use and plan gate installation at a time when the bats are not present, or at a time that will cause minimal disturbance to the resident bats.
- Design the closure for maximum security and resistance to vandalism, considering such parameters as the mine's geology, proximity to populated areas, and degree of visitation.
- Prioritize roosts for closure when necessary, considering human health and safety, preservation of sensitive species, and cost.
- Procure funding and landowner consent for bat gates on private lands.
- Conduct public outreach programs to agencies, industry, and private landowners to promote bat-compatible closures where they are warranted.
- A monitoring program should be part of any gating program.

Specific designs for bat-compatible gates can be found in Pierson et al. (1999), Tuttle and Taylor (1994), and through the American Cave Conservation Association -- P.O. Box 409, Horse Cave, KY, 42749, 502-786-1466.

Buffer Zones

Buffer zones may be useful in protecting bat roosts. Policies were developed to protect caves on federal lands in 1994 by the Deschutes National Forest and the Oregon and Washington BLM. Included in the recommendations were a number of policies to protect bat habitat. On lands administered by the BLM, "no new surface disturbing activities would be authorized within a 350-foot radius of a cave opening or any known cave passages which may adversely impact any significant or potentially significant cave resource value." On the national forest, trees are not to be harvested within a 150 to 200-foot radius of cave entrances and infeeder drainages where slopes are less than 30 degrees. On slopes steeper than 30 degrees next to cave entrances, ground-disturbing activities are prohibited. Clear-cutting is not allowed within 250 feet of caves with significant bat populations. Forested corridors between cave entrances and nearest foraging areas are to be maintained at a 150 to 200-foot radius. If the nearby foraging area is a stream, then trees are not to be harvested 75 to 100 feet on either side. Hoosier National Forest uses a similar 150 to 200-foot radius buffer around cave entrances and infeeder drainages.

On the Tongass National Forest in Alaska, surface disturbing activities are restricted to a minimum of 100 feet from the edge of any karst feature (sinkhole, collapsed channel, stream infeeder or cave) if associated groundwater contributes to a significant cave, stream or domestic water supply. No surface disturbing activity will occur over land directly overlying any known significant cave or waters contributing to the cave (US Forest Service 1996).

Pierson et al. (1999) provides for more generous buffers than the above agencies. They suggest a buffer zone of 2 miles around all *C. townsendii* roost sites for pesticide spraying. They also

recommend no prescribed burning or vegetative alteration in shrub-steppe or pinyon/juniper habitats within a 1.5-mile radius of *C. townsendii* roost sites. For forested habitat, no more than half can be subjected to prescribed burning per decade within a 0.5-mile radius of the roost site and only when bats are not present. For timber harvesting they suggest maintaining a buffer zone of 500 feet (horizontal radius) around all roost entrances.

Seasonal Closures

Another useful protective measure for bat roosts is seasonal closures. Seasonal closures can be used during critical time periods such as maternity or hibernation periods. A general guide for seasonal closures suggested by Pierson et al. (1999) and Navo (2001) is to close caves used for hibernacula to recreational visitor use from November 1 to April 1 and close maternity caves from April 1 to October 1. These critical time periods of hibernation and maternity activity may vary regionally and need to be determined by a qualified biologist. There will also be site-specific flexibility to seasonal closures. Seasonal closures can also be imposed on climbing activities or any other recreational activity in and around roost sites.

APPENDIX B

SPECIES ACCOUNTS

The following species accounts were written by various members of the Western Bat Working Group in preparation for the WBWG workshop in Reno, Nevada, February 9-18, 1998. The accounts are ordered by Conservation Priority Score from the Colorado Committee's ranking exercise (Table 3). Two additional species, Allen's lappet-eared bat (*Idionycteris phyllotis*) and the cave myotis (*Myotis velifer*) are included. These two species have not been documented to occur in Colorado, but have been documented in adjacent states, and are of special conservation concern.

Townsend's big-eared bat (*Corynorhinus townsendii*)

Prepared by: R. Sherwin

- I. **DISTRIBUTION:** Townsend's big-eared bat (*Corynorhinus townsendii*), a member of the Family Vespertilionidae, occurs throughout the West, and is distributed from the southern portion of British Columbia south along the Pacific coast to central Mexico and east into the Great Plains, with isolated populations occurring in the south and southeastern US. It has been reported in a wide variety of habitat types ranging from sea level to 3300 m. Habitat associations include: coniferous forests, mixed mesophytic forests, deserts, native prairies, riparian communities, active agricultural areas, and coastal habitat types.
- II. **STATUS:** Global Rank - G4. State Ranks: AZ - S3; CA - S3S4; CO - S3; ID - S2; MT - S2S3; NM - S3; NV - S?; OR - S4; SD - S2S3; TX - S4; UT - S4; WA - S1; WY - S3; BC - S2S3. USFWS former category 2 (C2) candidate. It is listed as a Species of Special Concern by the Department of Fish and Game in California, and is considered a Species of Special Concern due to declining populations and limited distribution in Utah.
- III. **IDENTIFYING CHARACTERISTICS AND LIFE HISTORY:** Townsend's big-eared bat can be distinguished from all other vespertilionids by the presence of prominent, bilateral nose lumps. Distribution is strongly correlated with the availability of caves and cave-like roosting habitat, with population centers occurring in areas dominated by exposed, cavity forming rock and/or historic mining districts. Its habit of roosting on open surfaces makes it readily detectable, and it is often the species most frequently observed (commonly in low numbers) in caves and abandoned mines throughout its range. It has also been reported to utilize buildings, bridges, rock crevices and hollow trees as roost sites. Summer maternity colonies range in size from a few dozen to several hundred individuals. Maternity colonies form between March and June (based on local climactic factors), with a single pup born between May and July. Males remain solitary during the maternity period. Winter hibernating colonies are composed of mixed-sexed groups that can range in size from a

single individual to colonies of several hundred animals (or in some areas, particularly in the eastern US, several thousand). Mating generally takes place between October and February in both migratory sites and hibernacula. Foraging associations include edge habitats along streams, adjacent to and within a variety of wooded habitats. It often travels large distances while foraging, including movements of over 10 miles during a single evening. It is a moth specialist with over 90% of its diet composed of members of the Order Lepidoptera. Seasonal movement patterns are not well understood, although there is some indication of local migration, perhaps along an altitudinal gradient.

IV. THREATS: The primary threat to Townsend's big-eared bat is almost certainly disturbance or destruction of roost sites (e.g., recreational caving, mine reclamation, renewed mining in historic districts). Surveys conducted in Oregon and California indicate that historic roost sites have been negatively impacted in recent years with most reported colonies exhibiting moderate to sizable reduction in numbers. Additional surveys in Utah indicate that several historic maternity sites have been abandoned, although it is not known if these colonies have relocated. This species is very sensitive to disturbance and has been documented to abandon roost sites after human visitation. In California and at a number of sites in the East, depressed populations have recovered with the protection (i.e., gating) of roosts. In large portions of its western range, dependence upon abandoned mines puts this species at risk if mine reclamation and renewed mining projects do not mitigate for roost loss, or do not conduct adequate biological surveys prior to mine closure. Both roosting and foraging habitat may be impacted by timber harvest practices. Pesticide spraying in forested and agricultural areas may affect the prey base.

V. GAPS IN KNOWLEDGE: Identification and protection of significant roost sites is still needed in most areas. Significant populations need to be monitored over time. More information is needed on foraging requirements, seasonal movement patterns, and population genetics (i.e., the degree of relatedness within and between different maternity roosts).

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Kunz, T. H., and R. A. Martin. 1982. *Plecotus townsendii*. Mammalian Species 175:1-6.

Pierson, E.D. and W.E. Rainey. 1996. The distribution, status and management of Townsend's big-eared bat (*Corynorhinus townsendii*) in California. California Department of Fish and Game, Bird and Mammal Conservation Program Rep. 96-7. 49 pp.

Fringed Myotis (*Myotis thysanodes*)

Prepared by: P. Bradley and M. Ports

- I. **DISTRIBUTION:** The fringed myotis (*Myotis thysanodes*), a member of the Family Vespertilionidae, ranges through much of western North America from southern British Columbia, south to Chiapas, Mexico and from Santa Cruz Island in California, east to the Black Hills of South Dakota (Geographic Range = 16°-52°N to 92°-124°E; Altitudinal Range = sea level to 2850 m). Four subspecies ranges (*M. t. aztecus*, *M. t. pahasapensis*, *M. t. thysanodes*, and *M. t. vespertinus*) are delineated. Two unconfirmed *M. thysanodes* records exist for Jackson Co., Montana, 300 km NE of the confirmed range boundary (M. Beer, per. comm.). This species has been found in hot desert scrubland, grassland, xeric woodland, sage-grass steppe, mesic old-growth forest, and multi-aged subalpine coniferous and mixed-deciduous forest. Xeric woodlands (oak and pinyon-juniper) appear to be the most commonly used.
- II. **STATUS:** Global Rank - G5. State Ranks: AZ - S3; CA - S4; CO - S3S4; ID - S3; MT - S3; NM - S5; NV - S?; OR - S3; SD - S2; TX - S3; UT - S3; WA - S3?; WY - S3?; BC - S2S3. Globally, *M. thysanodes* is ranked as “demonstrably secure, widespread and abundant; although it may be quite rare in parts of its range, especially at the periphery” (The Nature Conservancy 1997). This contradicts, to a degree, with most state and provincial rankings. Specifically, *M. thysanodes* is ranked as “rare or possibly rare” in 8 of 13 States (AZ, ID, NV, OR, TX, UT, WA, WY), “watchlisted” in Colorado, proposed as a Species of Special Concern in California, and “threatened or endangered” in British Columbia. In addition, subspecies rankings of “imperiled globally because of extreme rarity” are assigned to *M. t. pahasapensis* (NE, SD, WY) and *M. t. vespertinus* (CA, OR, WA) (The Nature Conservancy 1997). As the aforementioned jurisdictions make up the majority of the range of *M. thysanodes* north of the Mexico-US border, the species may in fact be uncommon or rare through the bulk of its range, not merely “at the periphery.” Also, *M. thysanodes* is a former category 2 candidate species.
- III. **IDENTIFYING CHARACTERISTICS AND LIFE HISTORY:** The fringed myotis is a rather large *Myotis* with long ears and hair that is often reddish-brown. It can be distinguished from all other species by a conspicuous fringe of hair along the posterior edge of its interfemoral membrane. It is a colonial-roosting species with colonies ranging from 10 to 2000 individuals. Large colonies are exceedingly rare. Where available, caves, buildings, underground mines, rock crevices in cliff faces and bridges are used for maternity and night roosts, while hibernation has only been documented in buildings and underground mines.

Tree roosting has also been documented in large conifer snags in Oregon, in ponderosa pine snags in New Mexico, and in hollow redwood and giant sequoia trees in California. Maternity roosts have been found in sites that are generally cooler and wetter than is typical for most other vespertilionids. Copulation occurs in the fall following break-up of the maternity colony. Ovulation, fertilization, and implantation occur from April to May. Gestation averages 55 days. One young per female is born from May to July, pink, with eyes open, at 22% of adult weight. Young are capable of flight at 16 days and fully volant at 20 days. Limited information is available on diet. In one study, the dominant prey item was beetles, and in another moths. Other taxa that have been found in the diet are phalangids (harvestmen), gryllids (crickets), tipulids (crane flies), araneids (spiders), and hemipterans (bugs). The presence of non-flying taxa in the diet of the Oregon animals suggests a foraging style that relies at least partially on gleaning. Relatively long commuting distances (13 km one-way, 930 m elevation gain) have been documented for post-lactating females between roost sites and foraging areas. Extensive migrations are unlikely.

IV. THREATS: 1. Behavioral ecology: a. easily disturbed by human presence; b. especially vulnerable to disturbance due to roosting habits (colonial, location choice). 2. Population ecology: a. low fecundity; b. high juvenile mortality; c. long generational turnover. 3. Abandoned mine closures. 4. Recreational caving and mine exploration. 5. Renewed mining at historic sites. 6. Toxic material impoundments. 7. Pesticide spraying. 8. Vegetative conversion. 9. Livestock grazing. 10. Timber harvest 11. Building and bridge conversion. And 12. Lack of information regarding distribution and ecology.

V. GAPS IN KNOWLEDGE: 1. Hibernation roosts and winter behavior in general. 2. Migration behavior. 3. Seasonal abundance differences within and between geographic, altitudinal and habitat boundaries. 4. Preferred roost microclimates. 5. Adult male life history. 6. Generational turnover, longevity.

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Long-legged myotis (*Myotis volans*)

Prepared by: M. A. Bogan, E. W. Valdez, and K. W. Navo

- I. **DISTRIBUTION**: The long-legged myotis (*Myotis volans*), a member of the Family Vespertilionidae, ranges across western North America from southeastern Alaska, British Columbia and Alberta to Baja California and central Mexico. It occurs throughout the western US from the Pacific coast to the Great Plains and central Texas.
- II. **STATUS**: Global Rank - G5. State Ranks: AZ - S3; CA - S5; CO - S5; ID - S3; MT - S4; NM - S5; NV - S?; OR - S3; TX - S4; UT - S3S4; WA - S3; WY - S4; AL - S2; BC - S4S5. Former category 2 candidate species. Take regulated by permit in various states. Proposed as a Species of Special Concern in California.
- III. **IDENTIFYING CHARACTERISTICS AND LIFE HISTORY**: The long-legged myotis is recognized by its short rounded ears, small hind feet, long tibia, distinctly keeled calcar, and long, dense fur on the underside of the wing membrane that extends from the body to a line joining the elbow and the knees. Although some variation in color exists, it is typically dark brown. It is a bat primarily of coniferous forests, but also occurs seasonally in riparian and desert habitats. It is a relatively poor urine concentrator. This species uses abandoned buildings, cracks in the ground, cliff crevices, exfoliating tree bark, and hollows within snags as summer day roosts; caves and mine tunnels as hibernacula. It is active throughout the night, but peak activity is 3 to 4 hours after sunset. It is a rapid, direct flier, often traveling some distance while foraging, and feeds in and around the forest canopy, primarily on moths and other soft-bodied insects. Individuals copulate in autumn, with females storing the sperm over the winter, ovulating in the spring, and giving birth from May through August. Individuals have lived a maximum of 21 years.
- IV. **THREATS**: May be affected by closure of abandoned mines without adequate surveys and certain forest-management practices. Residues of DDT and its metabolites have been found in this species in Oregon.

V. GAPS IN KNOWLEDGE: No information known on population trends and use and acceptance of bat gates. More information is needed on roosting and foraging requirements.

VI. SELECTED LITERATURE:

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Little brown bat (*Myotis lucifugus*)

Prepared by: W. E. Rainey

I. DISTRIBUTION: The little brown bat (*Myotis lucifugus*) is among the most widespread and common bats in mesic, typically forested areas of temperate North America. Overall distribution extends from near the treeline in Canada and Alaska to the southern tier of the US. There is a distributional gap extending south from the largely treeless Great Plains through Texas. In the western US, this species is typically absent from hot, arid lowlands, but extends south (at increasing elevation) along forested mountain ranges into southern California, Nevada, Utah, and Colorado.

II. STATUS: Global Rank - G5. State Ranks: AZ - S3; CA - S4; CO - S5?; ID - S5; MT - S5; NM - S5; NV - S?; OR - S4; TX - SA; UT - S4; WA - S?; WY - S5; AL - S5; BC - S4S5.

III. IDENTIFYING CHARACTERISTICS AND LIFE HISTORY: The little brown bat is a medium size *Myotis* that lacks a calcar and has moderate length pointed ears with a blunt tragus. Pelage color is highly variable, but fur is typically longer, darker, and more glossy than similar co-occurring species. In the Northwest, external morphology and skull characters are insufficient to reliably assign a small percentage of individuals to *M. lucifugus* or the similar *M. yumanensis*, but intermediate individuals in southwest British Columbia were identifiable to species on biochemical characters. A few individuals in southern

Colorado and northern New Mexico are intermediate in skull characters between *M. lucifugus* and *M. occultus* (which are sometimes synonymized). Body size (and time to maturity) increases with latitude. Among woodland/forest bats, little brown bats are an ecological generalist exploiting a wide variety of natural and man-made roost sites and a taxonomically wide spectrum of flying insect prey including emerging adults of aquatic species. Summer maternity colony sites (consisting largely of reproductive females and dependent young) include tree cavities, caves, and human-occupied structures. Fidelity to physically stable day and night roost sites is strong and individuals return for many years. Active season roosting by males and non-reproductive females is little studied, but male aggregations are known. Daily foraging movements are likely in the 1 to 10 km range; seasonal aggregation at mass hibernation sites may involve larger distances. Hibernation sites (typically caves and abandoned mines) and seasonality have been studied in eastern and mid-continent populations, but are poorly known in the West.

- I. THREATS: The primary threats are common themes for forest bats -- alterations in snag density and recruitment from timber harvest (and its attendant liability issues), agricultural or residential habitat conversion or riparian forest alteration for flood control. This species often occupies structures and is vulnerable to pest control operations. Highly aggregated hibernation in abandoned mines in eastern and central North America suggests closure of mines without adequate survey could have major population impact. Populations in montane forest islands, especially near the southern range limit, are at greater risk because population sizes and available habitat are small and development pressures (e.g., forest recreation) can be high.
- V. GAPS IN KNOWLEDGE: Lack of knowledge of hibernation sites (and the degree of population aggregation at these sites) is a key point of vulnerability for this species. Inadequate systematic resolution may affect management decisions (e.g., the status of *M. occultus*). Isolated populations in montane forest islands may be sufficiently differentiated to deserve taxonomic recognition. The status of these should be carefully evaluated as their habitats and population sizes may be small and subject to strong development pressure.

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Long-eared myotis (*Myotis evotis*)

Prepared by: M. A. Bogan, E. W. Valdez, and K. W. Navo

- I. **DISTRIBUTION**: The long-eared myotis (*Myotis evotis*), a member of the Family Vespertilionidae, ranges across western North America from southwestern Canada (British Columbia, Alberta and Saskatchewan) to Baja California and eastward in the US to the western Great Plains.
- II. **STATUS**: Global Rank - G5. State Ranks: AZ - S3; CA - S3S4; CO - S4; ID - S4; MT - S4; NM - S4; NV - S?; OR - S3; SD - S1; TX - SX; UT - S3S4; WA - S3; WY - S4; AL - S2; BC - S4S5. Former category 2 candidate species. Some federal agencies list the species as being of concern; take is usually regulated by state permit.
- III. **IDENTIFYING CHARACTERISTICS AND LIFE HISTORY**: The long-eared myotis has pale brownish to straw-colored pelage. It is distinguished from the southwestern myotis (*M. auriculus*) and the fringed myotis (*M. thysanodes*) by having long (19 to 25 mm), glossy black ears and no distinct fringe of hairs along the edge of the uropatagium. The long-eared myotis eats moths and small beetles, as well as flies, lacewings, wasps, and true bugs. In areas where *M. evotis* and *M. auriculus* are sympatric, *M. evotis* tends to eat more beetles. This species is a slow flier and is often described as a hovering gleaner that feeds by eating prey off foliage, tree trunks, rocks, and from the ground. It generally leaves its roost for foraging after dark, but individuals have been caught as early as 0.5 hours after sunset. *M. evotis* occurs in semiarid shrublands, sage, chaparral, and agricultural areas, but is usually associated with coniferous forests. Individuals roost under exfoliating tree bark and in hollow trees, caves, mines, cliff crevices, sinkholes, and rocky outcrops on the ground. They also sometimes roost in buildings and under bridges. During the summer females form small maternity colonies, whereas males and non-reproductive females roost alone or in small groups nearby. Females give birth to one young in late spring to early summer. Individuals have lived up to 22 years. Presumably, most individuals hibernate during the winter.
- IV. **THREATS**: May be affected by closure of abandoned mines without surveys, recreational caving, some forest-management practices, and other activities (such as highway

construction, water impoundments, blasting of cliffs for avalanche control) that impact cliff faces or rock outcrops.

- V. GAPS IN KNOWLEDGE: Little or no information known on population trends, winter roosting requirements, winter range, importance of snags as summer roosts, and use and acceptance of bat gates. More information is also needed on foraging requirements.

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Spotted bat (*Euderma maculatum*)

Prepared by: B. Luce

- I. DISTRIBUTION: The spotted bat (*Euderma maculatum*), a member of the Family Vespertilionidae, ranges from southern British Columbia to Durango, Mexico. In the US it is known from all the states (except Washington) west of and including Montana, Wyoming, Colorado, New Mexico and Texas. While its distribution is fairly broad, it is extremely patchy and highly associated with prominent rock features. It has been found from extremely arid low desert habitats to high elevation forests.
- II. STATUS: Global Rank - G4. State Ranks: AZ - S1S2; CA - S2S3; CO - S2; ID - S1; MT - S1; NM - S3; NV - S1; OR - S1; TX - S2; UT - S2; WA - S?; WY - S1; BC - S3. Former category 2 candidate species. It is considered a Species of Special Concern in Arizona, California, and Utah.

III. IDENTIFYING CHARACTERISTICS AND LIFE HISTORY: The spotted bat can be distinguished from all other North American bats by its distinctive coloration (black fur with three large white dorsal spots). The dependency on rock-faced cliff roosting habitat limits the spotted bat to very small geographic areas with specific geologic features. Although known to roost on cliff faces and thought to be non-colonial, specific roost characteristics are not known. The spotted bat feeds primarily on flying moths. Foraging has been observed in forest openings, pinyon-juniper woodlands, large riverine/riparian habitats, riparian habitat associated with small to mid-sized streams in narrow canyons, wetlands, meadows, and old agricultural fields. The spotted bat generally leaves the roost around dark, and may fly continuously most of the night. Spotted bats are high-flying bats that emit a low frequency, generally audible echolocation call. The wintering habits of the spotted bat in the northern part of its range are not well understood. Specimens taken in September and October may indicate post-breeding wandering but could be elevational movement towards winter range. Parturition probably occurs prior to mid-June. Postpartum females have been captured from June to late August.

IV. THREATS: Historically the spotted bat has endured little impact from human disturbance due to the remoteness of its roosts, but impoundment of reservoirs and a recent increase in recreational rock climbing may impact the species in local situations. Large-scale pesticide programs for control of Mormon crickets and grasshoppers could impact the spotted bat by reducing availability of prey. Loss of foraging habitat (conversion of desert wash vegetation and/or grazing of meadows) may also impact the species.

V. GAPS IN KNOWLEDGE: More information is needed on life history and distribution.

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Western small-footed myotis (*Myotis ciliolabrum*)

Prepared by: M. A. Bogan, E. W. Valdez, and K. W. Navo

- I. **DISTRIBUTION**: The western small-footed myotis (*Myotis ciliolabrum*), a member of the Family Vespertilionidae, ranges across the western half of North America from British Columbia, Alberta, and Saskatchewan, throughout most of the US west of the 100th Meridian, and into central Mexico.
- II. **STATUS**: Global Rank - G5. State Ranks: AZ - S3; CA - S?; CO - S4; ID - S4; MT - S4; NM - S5; NV - S3; OR - S3; TX - S3; UT - S3S4; WA - S3; WY - S4; AL - S2; BC - S2S3. Former category 2 candidate species. USFS and BLM list as special status; generally regulated by state permit procedures.
- III. **IDENTIFYING CHARACTERISTICS AND LIFE HISTORY**: The western small-footed myotis is a small bat with a keeled calcar, small foot, black ears and a black mask across the eyes and nose. Pelage varies from brown to pale yellow. *Myotis ciliolabrum* differs from *M. californicus*, which is sympatric and similar in appearance, by having a longer, broader, and flatter skull with a gradual slope from cranium to rostrum; overall it is a more robust bat. However, these two species are often difficult to distinguish in the field. The western small-footed myotis occurs in deserts, chaparral, riparian zones, and western coniferous forest; it is most common in pinyon-juniper forest. Individuals are known to roost singly or in small groups in cliff and rock crevices, buildings, concrete overpasses, caves, and mines. They forage early in the evening, feeding on various small insects. Copulation takes place in the fall, with sperm being stored in females until spring when ovulation occurs. Females produce one young per year in late spring or early summer. Individuals have been known to live up to 12 years. Older literature refers to this species as *M. subulatus* and *M. leibii*.
- IV. **THREATS**: May be affected by closure of abandoned mines without adequate surveys and by recreational caving. Contaminant poisoning is a possibility.
- V. **GAPS IN KNOWLEDGE**: No information known on population trends, and use and acceptance of bat gates. More information is needed on roosting and foraging requirements.
- VI. **SELECTED LITERATURE**:

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Big brown bat (*Eptesicus fuscus*)

Prepared by: M. Perkins

- I. **DISTRIBUTION**: The big brown bat (*Eptesicus fuscus*), a member of the Family Vespertilionidae, has an extremely broad distribution reaching from Alaska and northern Alberta to northern South America. It occurs in all western states and provinces associated with the Western Bat Working Group. Two subspecies are recognized in the western US: *E. f. bernardinus* and *E. f. pallidus*. Big brown bats occur in a wide variety of habitats from desert scrub and moist coastal forests to high elevation conifer forests, and is one of the few species that persists in relatively urbanized environments.
- II. **STATUS**: Global Rank - G5. State Ranks: AZ - S4; CA - S5; CO - S5; ID - S5; MT - S4; NM - S5; NV - S?; OR - S4; TX - S5; UT - S4; WA - S?; WY - S5; AL - S4S5; BC - S4S5. Not listed by any state or province. Perceived as relatively common in many localities. It is the second most common bat found in urban areas in Washington and Oregon.
- III. **IDENTIFYING CHARACTERISTICS AND LIFE HISTORY**: Big brown bats are a medium- to large-sized North American vespertilionid. It can be distinguished from all other large vespertilionids by the combination of relatively dark color, a keeled calcar, and a blunt tragus. The tip of its tail usually extends 3 mm beyond the uropatagium. Big brown bats are a colonial species with the size of maternity colonies varying from about a dozen to several hundred. This species is well known for its propensity to roost in structures including buildings, mines, and bridges, but it has also been found in caves, crevices in cliff faces, and a hole in a giant saguaro. More recently, extensive tree roosting (particularly in large diameter snags) has been documented in forested, preferably uncluttered, landscapes. Bridges are commonly used as night roosts by males and pre-parturition and post-lactating females. In the West, big brown bats are known to hibernate in relatively small numbers per site in caves, buildings and mines. They forage within a few kilometers of the roost, generally pursuing prey in tree canopies, over meadows, or along watercourses. It feeds primarily on heavy-bodied insects and is an important predator on certain agricultural pests (e.g., *Diabrotica*, the spotted cucumber beetle). Although primarily beetle (coleopteran) specialists,

their diet also includes hemipterans, dipterans, lepidopterans, trichopteran and hymenopteran. This species mates in the fall and winter, but ovulation does not occur until the spring. Each female produces one young (the eastern subspecies produce twins) in early summer, after a gestation of about 60 days. The young are volant in three to four weeks. Big brown bats appear to be a relatively sedentary species and are not known to migrate large distances (although males may migrate elevationally in the Cascade Mountains). Females roost separately from males in the spring and summer, and roost with males at hibernating sites. This species hibernates for most of the winter in the northern portion of its range, but is active on warm nights in the winter in the Southwest.

IV. THREATS: Potential threats to this species include roost disturbance and destruction, particularly eradication of building-dwelling colonies by pest control operations, and removal of important roost trees during timber harvest. Grazing practices and loss of riparian areas could affect foraging habitat. Mine closures and renewed mining in historic districts could also impact this species.

V. GAPS IN KNOWLEDGE: More information is needed on roosting requirements, particularly in forested landscapes. The effects of timber harvest need to be investigated. Studies are needed to further investigate the role of this species in controlling insect pests. Information is generally lacking on seasonal movements and hibernation sites.

VI. SELECTED LITERATURE:

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Hoary bat (*Lasiurus cinereus*)

Prepared by: B. C. Bolster

- I. **DISTRIBUTION**: The hoary bat (*Lasiurus cinereus*), a member of the Family Vespertilionidae, is the most widespread of all North American bats. This species range is from near the limit of trees in Canada, southward at least to Guatemala, and from Brazil to Argentina and Chile in South America. Hoary bats are also found in Hawaii and the Galapagos Islands. Hoary bats are uncommon throughout most of the eastern US and in the northern Rocky Mountains, but are more common in the prairie states and Pacific Northwest. They are highly associated with forested habitats in the West.
- II. **STATUS**: Global Rank - G5. State Ranks: AZ - S3; CA - S5; CO - S5; ID - S5; MT - S4; NM - S5; NV - S?; OR - S4?; TX - S4; UT - S3; WA - S?; WY - S4; AL - S2?; BC - S4.
- III. **LIFE HISTORY**: Hoary bats can be distinguished from all other species by a combination of large size (forearm of 46 to 58 mm), frosted fur, golden coloration around the face, rounded ears, blunt tragus and furred uropatagium. Hoary bats are solitary and roost primarily in foliage of both coniferous and deciduous trees, near the ends of branches, 3 to 12 m above the ground. Roosts are usually at the edge of a clearing. Some unusual roosting situations have been reported in caves, beneath a rock ledge, in a woodpecker hole, in a gray squirrel nest, under a driftwood plank, and clinging to the side of a building. Although thought to be highly migratory, wintering sites have not been well documented, and no specific migration routes have been discerned. Hoary bats are often found flying in waves of large groups during fall migration, whereas spring migration is apparently less organized. This species tolerates a wide range of temperatures as illustrated by captures at air temperatures between 0 and 22°C. The ambient temperature at which individuals employ torpor also appears to be variable, as entry into torpor was observed in one study to vary from 5 to 13°C. Hoary bats probably mate in the fall, followed by delayed implantation and birth from May through July. Females have from one to four pups annually, with two being the norm. Hoary bats usually emerge late in the evening to forage although they occasionally have been observed flying during late winter afternoons or just before sunset. Evening emergence and capture times range from just over one hour after sunset to after midnight. The swift, direct flight of this species makes it identifiable on the wing from all other US bats except molossid. Hoary bats reportedly have a strong preference for moths, but are also known to eat beetles, flies, grasshoppers, termites, dragonflies, and wasps. Reported predators include jays, kestrels, and snakes, and likely include hawks and owls as well.

IV. THREATS: Loss of roosting habitat due to timber harvest is likely the biggest threat to this species. Use of pesticides on public forestlands may also be a potential source of mortality to roosting bats and their insect prey. In suburban settings, where jays thrive in association with humans, jays may pose a major threat to sleeping or hibernating hoary bats.

V. GAPS IN KNOWLEDGE: The habitat use and relationships of hoary bats, especially regarding wintering sites, needs to be investigated more thoroughly. The impact of current timber harvest practices on roosting and foraging also should be examined.

VI. SELECTED LITERATURE:

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Yuma myotis (*Myotis yumanensis*)

Prepared by: M. A. Bogan, E. W. Valdez, and K. W. Navo

I. DISTRIBUTION: The Yuma myotis (*Myotis yumanensis*), a member of the Family Vespertilionidae, ranges across the western third of North America from British Columbia to Baja California and southern Mexico. In the US it occurs in all the Pacific coastal states, western Montana in the north, and as far east as western Oklahoma in the south.

II. STATUS: Global Rank - G5. State Ranks: AZ - S3S4; CA - S5; CO - S3; ID - S3; MT - S3; NM - S5; NV - S?; OR - S3; TX - S4; UT - S3; WA - S?; WY - S2?; BC - S4S5. Former category 2 candidate species. Take is regulated by permit in some states.

III. IDENTIFYING CHARACTERISTICS AND LIFE HISTORY: The Yuma myotis is a small bat that is usually gray or brown to pale tan dorsally with a paler venter of tan or gray; ears and membranes are frequently pale brown to gray. In some areas this bat is difficult to distinguish from *M. lucifugus* and caution is required. Both species are usually associated with permanent sources of water, typically rivers and streams, but Yuma myotis also use tinajas in the arid West. It occurs in a variety of habitats including riparian, arid scrublands and deserts, and forests. The species roosts in bridges, buildings, cliff crevices, caves, mines,

and trees. Individuals become active and forage just after sunset, feeding primarily on aquatic emergent insects. Their diet is known to include caddis flies, flies, midges, small moths and small beetles. After feeding, they periodically rest at night roosts where the food is digested. Mating is typically in the fall and females give birth to one young from mid-spring to mid-summer in maternity colonies that may range in size up to several thousand; males tend to roost singly in the summer.

IV. THREATS: May be affected by closure of abandoned mines without adequate surveys, some forest management practices, and disturbance of maternity roosts in caves and buildings. Since this species frequently occurs in structures, it is vulnerable to destructive pest control activities. Some riparian-management practices may be detrimental.

V. GAPS IN KNOWLEDGE: No information known on use and acceptance of bat gates, impacts of grazing and riparian habitat management, winter range, and winter roost requirements. Information is needed on geographic variation in roosting and foraging requirements.

VI. SELECTED LITERATURE:

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Brazilian free-tailed bat (*Tadarida brasiliensis mexicana*)

Prepared by: Bat Conservation International

I. DISTRIBUTION: The Brazilian free-tailed bat (*Tadarida brasiliensis*), a member of the Family Molossidae, is one of the most widely distributed mammalian species in the Western

Hemisphere. There are nine recognized subspecies, two in the US. *T. b. mexicana* is primarily western, occurring from southern Oregon to eastern Nebraska and south through Mexico. *T. b. cynocephala* is primarily a southeastern species, from eastern Kentucky into South Carolina and south through Florida. *T. brasiliensis* ranges southward through most of Central America. In the western US, *T. brasiliensis* is most commonly associated with dry, lower elevation habitats, yet it also occurs in a variety of other habitats and is found up to 3000 m in some of the western mountain ranges.

II. STATUS: Global Rank - G5. State Ranks: AZ - S3/S4; CA - S4/S5; CO - S1; NM - S2; NV - S?; OR - S2; TX - S5; UT - S3/S4; WY - S5. *T. brasiliensis* is widely regarded as one of the most abundant mammals in North America and is not on any federal lists. However, its proclivity towards roosting in large numbers in relatively few roosts makes it especially vulnerable to human disturbance and habitat destruction. Documented declines at some roosts are cause for concern. It is considered a Species of Special Concern due to declining populations and limited distribution in Utah.

III. IDENTIFYING CHARACTERISTICS AND LIFE HISTORY: Like other molossid (free-tail) species, the Brazilian free-tailed bat has a tail that extends well beyond the back edge of the interfemoral membrane. *T. brasiliensis* can be distinguished from the other molossids occurring in the US by its ears which are not joined basally at the mid-line. This species is highly colonial with maternity colonies ranging in size from a few hundred to 20 million. The most commonly used natural roosts are caves and rock crevices on cliff faces. This species also roosts in abandoned mines and tunnels, highway bridges and large culverts, buildings, and bat houses. Maternity roosts are usually warmer and larger than bachelor or non-reproductive female roosts. *T. brasiliensis* will, during spring cold snaps, take refuge in cliff swallow nests. Brazilian free-tailed bats often fly more than 50 km to reach foraging areas. Such flight is rapid, direct, and often involves gliding. Bats from one colony may cover areas as large as 400 km² and move at speeds over 40 km/hour and at altitudes of 3000 m or more. Foraging occurs at high elevations and also at heights of 6 to 15 m. This species consumes a large variety of agricultural pests, mostly moths, but also flying ants, weevils, stinkbugs and ground beetles. The Mexican free-tailed bat (*T. b. mexicana*) is primarily migratory, with large numbers of females returning to large, warm caves in Texas, New Mexico, Arizona, and Oklahoma each spring. Few adult males return northward; mating probably occurs in lower latitudes of the winter range. Seasonal patterns elsewhere in the West are less clear. Birth usually occurs between mid-June and mid-July. Adult mass is reached in as little as three weeks and first flight occurs 2 to 3 weeks later.

IV. THREATS: Besides the human disturbance and habitat destruction, or alteration of suitable caves, mines, bridges, and old buildings noted above, there are problems with pesticide poisoning and deliberate eradication attempts. Human rabies deaths attributed to Brazilian free-tailed bats foster attitudes for the destruction of their roosts and colonies.

V. GAPS IN KNOWLEDGE: Although most major maternity roosts in the US are now protected, much remains to be done with winter roosts in Mexico. More documentation of the role of the Mexican free-tailed bat in agriculture, and the use of artificial roosts to attract

them, is needed. Its ecology, distribution, and seasonal patterns are not well understood in some parts of its range, particularly California, Nevada, southern Oregon, and Utah.

VI. SELECTED LITERATURE:

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Silver-haired bat (*Lasionycteris noctivagans*)

Prepared by: M. Perkins

- I. DISTRIBUTION: The silver-haired bat (*Lasionycteris noctivagans*), a member of the Family Vespertilionidae, is found from southern Alaska, throughout southern Canada and most of the US into the San Carlos Mountains of northeastern Mexico. Silver-haired bats are primarily forest bats, associated primarily with North Temperate Zone conifer and mixed conifer/hardwood forests. They have been found in winter and during seasonal migrations in low elevation, more xeric habitats.
- II. STATUS: Global Rank - G5. State Ranks: AZ - S3; CO - S4; ID - S5; MT - S4; NM - S5; NV - S?; OR - S4?; SD - S4; TX - S4; UT - S3S4; WA - S?; WY - S4; AL - S3; BC - S4.
- III. IDENTIFYING CHARACTERISTICS AND LIFE HISTORY: The silver-haired bat is a medium-sized vespertilionid with black or dark brown hairs that are silver-tipped. The interfemoral membrane is partially furred. Its ears are short and rounded with a blunt tragus. Females form small nursery colonies of up to 70 individuals. Maternity roosts appear to be almost exclusively in trees -- inside natural hollows and bird-excavated cavities or under loose bark of large diameter snags. Roosting sites are generally at least 15 m above the ground. Both males and females change roosts frequently and use multiple roosts within a limited area throughout the summer, indicating that clusters of large trees are necessary. Some records exist for roosts in other structures. Based on recent radio telemetry, these appear to be largely anomalies. This species has been found hibernating in hollow trees, under sloughing bark, in rock crevices, and occasionally under wood piles, in leaf litter, under foundations, and in buildings, mines and caves. Silver-haired bats forage above the canopy, over open meadows, and in the riparian zone along watercourses. Radiotracking has shown that they travel considerable distances from roost sites to foraging areas. Although the species is known to take a wide variety of insects including chironomids, moths appear to be a major portion of diet. This species appears to have gestation of 50 to 60 days and give birth to twins in mid to late June. The young require over 36 days to become volant. Seasonal records suggest considerable north/south migration, with animals moving to warmer, more southern climates in the winter. The few overwintering silver-haired bats that have been found in Oregon and Washington were juveniles from the previous summer. In some subpopulations there appears to be summer segregation of the sexes (e.g., whereas both adult males and females are captured during the summer reproductive season in parts of northern California, males and females are geographically separated in most of Oregon).
- IV. THREATS: The primary threat to silver-haired bats is likely to be loss of roosting habitat due to logging practices that fail to accommodate the roosting needs of this species (e.g., clusters of large snags). Loss of temporary roosts within migration corridors could also be important. Loss of foraging habitat in riparian areas and reduction of prey base due to broadcast application of pesticides are other potential threats.

V. GAPS IN KNOWLEDGE: More information is needed on the distribution of breeding populations, on regional differences in roosting requirements, the timing and patterns of migration for each sex throughout the West, and the location of possibly important mating and migratory stopover sites. Information is also needed on what factors (e.g., temperature, and local food availability) determine year-to-year variation in local distribution and abundance.

VI. SELECTED LITERATURE:

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Big free-tailed bat (*Nyctinomops macrotis*)

Prepared by: K. W. Navo

- I. **DISTRIBUTION:** The big free-tailed bat (*Nyctinomops macrotis*), a member of the Family Molossidae, ranges from most of South America northward to include Mexico, Arizona, New Mexico, southern and western Texas, southern California and southeastern Nevada, southern Utah, and north to central Colorado. The species is migratory and there are some extralimital records from British Columbia, Iowa, Kansas, and South Carolina. The known elevational range is from near sea level to about 2600 m.
- II. **STATUS:** Global Rank - G5. State Ranks: AZ - S2S3; CA - S2; CO - S1?; NM - S2; NV - S?; TX - S3; UT - S2. The big-free-tailed bat was proposed as a federal candidate C2 species in 1994. This species is currently on the BLM's special status species list for Utah and Colorado. It is considered a Species of Special Concern by the states of California and Utah.
- III. **IDENTIFYING CHARACTERISTICS AND LIFE HISTORY:** The big free-tailed bat can be distinguished from other molossids (= free-tailed bats) based on size. With an adult forearm of 58 to 64 mm it is larger than Brazilian free-tailed bats (*Tadarida brasiliensis*) or the pocketed free-tailed bat (*N. femorosaccus*), and smaller than either of the mastiff bats (*Eumops* spp.). It also has vertical grooves or wrinkles on the upper lip that are lacking in mastiff bats (*Eumops* spp.). Big free-tailed bats appear to mainly inhabit rugged, rocky habitats in arid landscapes. It has been found in a variety of plant associations including desert shrub, woodlands, and evergreen forests. It appears to be associated with lowlands, but has been documented at around 2400 m in New Mexico. This species is a seasonal migrant and a powerful flyer. It roosts mainly in the crevices of cliff rocks although there is some documentation of roosting in buildings, caves, and tree cavities. The species forms maternity colonies and females bear one young in late spring or early summer. Lactating females have been taken in July, August and September, and volant juveniles recorded on 8 and 27 August. Maternity roosts have been documented in rock crevices, with evidence of long-term use of the crevices reported. It appears that the return to the roost site by this bat involves ritualized behavior, including a general reconnaissance of the site and several landing trials before entry. Big free-tailed bats forage almost entirely on large moths, but some data exists to document occasional foraging on other insects including grasshoppers, beetles, crickets, leafhoppers and flying ants. Owls appear to be the only documented predator of this species. Big free-tailed bats have an audible echolocation call that is characterized as loud and with a frequency range of 17 to 30 kHz. Surveys based on echolocation calls for this species may be possible since captures appear to be uncommon (outside of Big Bend National Park where the most animals in North America have been documented). Easterla (1973), however, reports that the populations at Big Bend fluctuate greatly from year to year. Little is known about the species population dynamics and ecology.
- IV. **THREATS:** No known threats to the species have been identified to date. However, some of the general threats to bats could apply to big free-tailed bats. These could include impacts to

foraging areas from grazing, riparian management, the use of pesticides, and in some places disturbance to the roost site (e.g., blasting of cliffs or constructing water impoundments).

- V. GAPS IN KNOWLEDGE: Information is needed on big free-tailed bats regarding roosting ecology, seasonal movement patterns, and breeding colony distribution. Current evidence suggests that the species breeds farther north than previously thought including southern Utah and Colorado. Vocalization recordings are needed to help train researchers and managers that may survey for the species based on audible call detection. Reference calls need to be established, geographically verified, and made available at a depository and/or establish a site where recordings can be sent for verification. It will be important for bat biologists to be able to distinguish between the different audible bats in the Southwest.

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Pallid bat (*Antrozous pallidus*)

Prepared by: R. Sherwin

- I. DISTRIBUTION: The pallid bat (*Antrozous pallidus*), a member of the Family Vespertilionidae, is distributed from southern British Columbia and Montana to central Mexico, and east to Texas, Oklahoma and Kansas. An isolated population also occurs in Cuba. Pallid bats occur in a number of habitats ranging from rocky arid deserts to grasslands into higher elevation coniferous forests. They are most abundant in the arid Sonoran life zones below 1800 m, but have been found up to 3050 m in the Sierra Nevada.
- II. STATUS: Global Rank - G5. State Ranks: AZ- S4/S5; CA- S3; CO - S4; ID - S3; MT - S1; NM - S5; NV - S?; OR - S3; TX -S5; UT - S3/S4; WA - S3; WY - S3?; BC - S1. California Species of Special Concern.
- III. IDENTIFYING CHARACTERISTICS AND LIFE HISTORY: Pallid bats are a large (forearm 48 to 60 mm) pale bat with large ears, blunt snout (with ridge across the top), and a

distinctive skunk-like odor. Pallid bats roost in rock crevices, tree hollows, mines, caves and a variety of structures including vacant and occupied buildings. Tree roosting has been documented in large conifer snags (e.g., ponderosa pine), inside basal hollows of redwoods and giant sequoias, and bole cavities in oaks. They have also been reported roosting in stacks of burlap sacks and stone piles. They are primarily insectivorous, feeding on large prey that is taken on the ground or sometimes in flight. Prey items also include cicadas and flightless arthropods such as scorpions and ground crickets. They are gregarious and often roost in colonies of between 20 and several hundred individuals. Pregnant females gather in summer maternity colonies within warm rock crevices, abandoned mines, caves, hollow trees and in cavern-like building features (e.g., attics). Copulation takes place between October and February, with parturition generally occurring between May and July depending on local climate. Females can give birth to a single pup, twins or triplets, with twins being most common. Young are generally weaned in mid to late August. Maternity colonies disband between August and October. The bats are relatively inactive during the winter. They are not known to migrate and are believed to hibernate as solitary individuals or in small numbers. Occasional winter activity has been reported in southern portions of its range.

IV. THREATS: This species use of mines places them in jeopardy regarding mine closure projects. Additional threats include human vandalism within roost sites, roost site destruction, extermination in buildings, and pesticide use. Loss of tree roosts could occur through commercial timber harvest (including selective hardwood removal), and loss of oaks to suburban expansion, or vineyard development.

V. GAPS IN KNOWLEDGE: Data are lacking regarding seasonal movements (it is currently believed that they do not migrate long distances between summer and wintering sites). Additional information is required on winter activity patterns (i.e., roost sites, activity levels, etc.). More information is needed on roosting requirements in natural roosts (e.g., rock crevices and tree hollows).

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Western pipistrelle (*Pipistrellus hesperus*)

Prepared by: P. E. Brown

- I. DISTRIBUTION: The western pipistrelle (*Pipistrellus hesperus*), a member of the Family Vespertilionidae, occurs from the desert lowlands of the southwestern US, north into southern Washington. In Mexico it ranges throughout Baja California and on the mainland to Michoacan and Hidalgo. While most commonly associated with arid, desert landscapes, it also occurs around significant rock features in lower elevation mixed conifer forest in mountain ranges in California, and up to the spruce-fir forest in Arizona.
- II. STATUS: Global Rank - G5. State Ranks: AZ - S5; CA - S5; CO - S4; ID - S3; NM - S5; NV - S?; OR - S4; TX - S5; UT - S4; WA - S4?.
- III. IDENTIFYING CHARACTERISTICS AND LIFE HISTORY: The western pipistrelle is the smallest of all North American bats and can be distinguished from the small *Myotis* species (*californicus* or *ciliolabrum*) by the club-shaped tragus compared to the pointed tragus of *Myotis*. All three of these small bats have a keeled calcar. In Texas there is a slight overlap in range with the eastern pipistrelle (*P. subflavus*) which is larger with an unkeeled calcar and tri-colored fur. Western pipistrelles are also commonly known as canyon bats due to their association with rocky canyons and outcrops (usually at elevations below 2000 m), where they roost in small crevices. Occupied crevices may also be in mines and caves. They have been observed at dusk flying over creosote bush scrub several miles from rocky areas and they may roost under rocks or in rodent burrows. They emerge early in the evening, often before sunset, and may be active after sunrise. Near rocky canyons, their small fluttery forms can fill the sky in the fading desert light. They are often the first bats captured in an evening in mist nets set over isolated desert water holes or across mine entrances as they enter to roost. Stomach content analysis suggests they feed on small swarming insects such as flying ants, mosquitoes, fruit flies, leafhoppers, and ants. During cooler winter months, pipistrelles hibernate in rock crevices (sometimes in mines), although on warm winter days they may emerge to forage. Females give birth to twins in late May through June and mothers with their young may roost alone or in groups of less than 20. The young are volant within a month.
- IV. THREATS: Destruction of rocky areas due to renewed mining or other development activities (e.g., road construction, housing developments, and water impoundments) can kill roosting bats and remove roosting habitat.
- V. GAPS IN KNOWLEDGE: Since this bat is too tiny to carry a transmitter, no data exist on individual foraging areas or range. Although the western pipistrelle is a ubiquitous bat throughout the arid Southwest, limited information is available on social structure, microhabitat roost requirements, roost fidelity, or longevity. Without more knowledge of natural history it is difficult to assess potential threats to this species.

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California myotis (*Myotis californicus*)

Prepared by: M. A. Bogan, E. W. Valdez, and K. W. Navo

- I. **DISTRIBUTION**: The California myotis (*Myotis californicus*), a member of the Family Vespertilionidae, ranges across much of western North America -- from southeastern Alaska and southwestern British Columbia, through most of the US west of the Rocky Mountains, south to Baja California and much of mainland Mexico, and into Guatemala. This species occurs in a wide variety of habitats. While typical of deserts and interior basins in the western US, it also occurs in forested and montane regions.
- II. **STATUS**: Global Rank - G5. State Ranks: AZ - S4S5; CA - S5; CO - S3S4; ID - S3; MT - S4; NM - S5; NV - S?; OR - S4; TX - S4; UT - S3S4; WA - S?; WY - S4; BC - S4S5. Take is usually regulated by permit.
- III. **IDENTIFYING CHARACTERISTICS AND LIFE HISTORY**: The California myotis is a small bat with dark brown to black ears and wing membranes, a distinctly keeled calcar, and pelage that varies from dark brown to pale reddish-yellow to blond. It is an acrobatic flyer and uses small waterholes to obtain needed moisture; its kidneys are adapted for arid environments. California myotis differs from the western small-footed myotis (*M. ciliolabrum*), which is sympatric and similar in appearance, by having a more globose skull, narrower rostrum, a more delicate appearance overall, and no black mask. These two species are often difficult to distinguish in the field. Individuals are most active soon after sunset and periodically rest at a night roost. They typically feed on moths and flies, but have been known to eat other insects. The California myotis mates during autumn and perhaps in the spring in California. In spring or early summer, females form maternity colonies where they give birth to one pup. Individuals have been known to live up to 15 years. During summer, this species roosts alone or in small groups in caves, mines, rocky hillsides, under tree bark, and in buildings. Recent studies in Canada have documented maternity colonies of up to 52 individuals roosting under sloughing bark, and in cracks and hollows of large diameter,

intermediate stage snags (preferably ponderosa pine). In winter, solitary individuals and small groups have been found in caves, mines, and buildings. Individuals are known to be active periodically in winter, even at temperatures below freezing.

IV. THREATS: May be affected by closure of abandoned mines without adequate surveys and by recreational caving. This species may be affected by some timber harvest practices, particularly the removal of large diameter snags. Like all bats, it also could be subject to contaminant poisoning.

V. GAPS IN KNOWLEDGE: No information is known on population trends, and use and acceptance of bat gates. More information is needed on roosting and foraging requirements.

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Red Bat (*Lasiurus borealis*)

Prepared by: C. A. Jones

I. DISTRIBUTION: Red bats occur from southern Canada throughout most of the US and Central America, to Argentina and Chile. They live in most of the continental US wherever trees are found. Reports of this bat from Colorado are generally from riparian woodlands; possibly the species is spreading westward along riparian forests, as are the eastern fox squirrel (*Sciurus niger*) and raccoon (*Procyon lotor*). One specimen represents a bat tangled in barbed wire in Las Animas County. A second specimen, from Jefferson County, was donated to the Denver Museum of Nature and Science by the Colorado Department of Public Health in 1998.

II. STATUS: No state or federal status.

III. IDENTIFYING CHARACTERISTICS AND LIFE HISTORY: Red bats are readily recognized by their color. Dorsal hair is dark to rusty red and the hairs frequently have a frosted appearance. There is a white patch on the front of the shoulder and the wings are narrow. Underparts are paler in color and females tend to be paler than males. Like other members of the genus *Lasiurus*, the interfemoral membrane is furred. The extension of the tail in flight distinguishes this species from others in its range. *Lasiurus borealis* rarely is found with other species of bats. These solitary bats roost in trees and shrubs. Day roosts occur in American elms and other trees in edge habitats near streams and open fields. Winter roosts include trees and caves. Many individuals migrate hundreds of kilometers to Cuba and other destinations. Red bats start to forage 1 to 2 hours after sunset. Foods include moths, crickets, beetles, cicadas, and other insects; many prey species are considered crop pests. Red bats can sometimes be seen hunting near lights along streets or under lights on the sides of barns and other buildings. These bats can be captured 2 to 3 m above the ground. The species reproduces in Kansas, Oklahoma, and other states; reproduction in Puerto Rico was recently documented. Members of the genus *Lasiurus* typically bear more than one young; nearly all other North American bats bear only one young at a time. Female red bats may have 1 to 5 pups (the average is about 3). The young start to fly at about 3 weeks of age and are weaned by the fifth or sixth week.

IV. THREATS: The overall status of the red bat is thought to be secure.

V. GAPS IN KNOWLEDGE: Relatively little is known about population dynamics and winter biology of this species, given its solitary and migratory nature.

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Eastern pipistrelle (*Pipistrellus subflavus*)

Prepared by: C. A. Jones and M. B. Wunder

- I. DISTRIBUTION: From Wisconsin, Michigan, and Maine, south through eastern Kansas, Oklahoma, northeastern New Mexico and eastern Central America to northeastern Honduras. A common species in the woodlands of the eastern US. The two specimens of the eastern pipistrelle known from Colorado are from Arapahoe and Weld counties. Ranges of western and eastern pipistrelles overlap slightly in Texas. Data from Texas suggest that the distribution of *P. subflavus* may be spreading westward.
- II. STATUS: Unknown in Colorado. No federal or state status.
- III. IDENTIFYING CHARACTERISTICS AND LIFE HISTORY: One of the smallest North American bats, its total length is 70 to 90 mm -- only slightly larger than our western pipistrelle. The bat has distinctly tricolored dorsal hairs -- yellowish-brown or yellowish-gray on dorsum with a paler belly. It has rounded ears with a straight, slender tragus. Eastern pipistrelles emerge relatively early in the evening to forage, usually above waterways and open clearings. Its flight pattern is slow and erratic, or moth-like. It may be solitary in summer, but forms maternity colonies of up to 29. Roost switching has been reported for colonies in Indiana. Hibernacula can contain thousands of these bats, roosting singly or in small groups. Hibernation is marked by very deep torpor relative to other bats, and individuals might be covered by condensation. Foods reported in the eastern US include moths, flies, and other small insects, generally 10 mm or less in length. In Colorado, eastern pipistrelles are more likely to be found in woodlands and pastures than western pipistrelles, which are primarily known from rocky areas in western and southeastern parts of the state. A male from Illinois was captured 14.8 years after it was banded.
- IV. THREATS: Specific threats are unknown. Individuals can be vulnerable at roosts; Jones observed hibernating individuals less than 1 m above the floor of a cave in Mississippi.
- V. GAPS IN KNOWLEDGE: Many aspects of diet, reproduction, and other ecology remain poorly known, especially in western parts of the range. Most information regarding maternity roosts has been reported for caves, rock crevices, and buildings; almost nothing is known about roosts in trees.

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Cave myotis (*Myotis velifer*)

Prepared by: C. A. Jones

- I. **DISTRIBUTION**: The cave myotis (*Myotis velifer*), a member of the Family Vespertilionidae, occurs from Kansas, Oklahoma, and western Texas to southern Nevada, and southeastern California (along the Colorado River only), south through Mexico to Honduras. At least some populations are migratory. Hibernacula have been discovered in Mexico, Arizona, and Kansas. It is not yet verified, but expected in Colorado. Within the US it is most widely distributed in Arizona. This species is found primarily at lower elevations (the Sonoran and Transition life zones) of the arid Southwest, in areas dominated by creosote bush, palo verde, brittlebush, and cactus.
- II. **STATUS**: Global Rank - G5. State Ranks: AZ - S3S4; CA - S1S2; CO - S?; NM - S4; NV - S?; TX - S4. Hayward (1961) claimed that the cave myotis was very common in southern Arizona with at least 500,000 individuals during the summer months. Current status is not well known. The US Geological Survey's Bat Population Database has 584 records of counts at colonies as of 27 March 2002. Current status of these colonies is unknown. Very severe declines have been documented along the Colorado River in California.
- III. **IDENTIFYING CHARACTERISTICS AND LIFE HISTORY**: The cave myotis is a large *Myotis* with a forearm of 37 to 47 mm. It can be distinguished from other large *Myotis* by the presence of a conspicuous bare patch on the back between the scapulae and the absence of either a keel on the calcar or fringe on the interfemoral membrane. As implied by the vernacular name, caves are the main roosts for this southwestern species although it also uses mines, and occasionally buildings and bridges. It is primarily a "crevice dweller," preferring "crevices, pockets, and holes in the ceilings of its underground retreats" (Stager 1939). This species is also known to roost in barn swallow nests. Colonies of 2000 to more than 10,000 have been reported. This bat is reported to fly less erratically and more strongly than other species of *Myotis*. It has been reported foraging over dense riparian vegetation and in drier

desert washes. Dietary studies in Arizona, Kansas, and Mexico indicate that lepidopterans and coleopterans are typical prey. Known predators include rat snakes, hawks, barn owls, and raccoons. In southern Arizona this species has been found in the winter occupying wet mine tunnels above 1800 m, where roost temperatures are 8 to 11°C.

IV. THREATS: Potential threats include recreational caving, mine closures and subsequent roost destruction, and loss of foraging habitat in riparian zones.

V. GAPS IN KNOWLEDGE: Information is needed on the status of historically identified colonies, trends in population numbers, more information on roosting and foraging requirements, and basic life history information.

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Allen's lappet-eared bat (*Idionycteris phyllotis*)

Prepared by: M. J. O'Farrell

- I. DISTRIBUTION: One of the rarest bats in the North America, Allen's lappet-eared bat (*Idionycteris phyllotis*), a member of the Family Vespertilionidae, has a relatively broad distribution from central Mexico through much of the southwestern US. It is currently known from Arizona, New Mexico, southern Nevada, and southern Utah. It is not yet verified, but expected in California and Colorado. Recorded locations range from Mojave Desert scrub to fir forest at elevations ranging from 855 to 3225 m, although most captures are from elevations between 1100 to 2500 m in oak-juniper woodland and ponderosa pine forest.
- II. STATUS: Global Rank - G4. State Ranks: AZ - S2; CA - S1; CO - no ranking; NV - no ranking; NM - S2; UT - S1. Distribution is based on relatively few localities and this species appears to be extremely rare. Rankings should be re-evaluated as more information is available. It is listed as a Species of Special concern, based on limited distribution, in Utah.
- III. IDENTIFYING CHARACTERISTICS AND LIFE HISTORY: Allen's lappet-eared bat can be distinguished from all other species by the presence of a pair of lappets projecting over the forehead from the median bases of the ears. The preponderance of captures associated with scrub woodland and forest are also associated with cliffs and rocky slopes, suggesting a roosting relationship with caverns and rock fissures. Maternity colonies have been found within passages in a large boulder pile and in abandoned mine tunnels. Recent work in northern Arizona reveals this species to use dead tree snags (M. J. Rabe, per. comm.). Pregnant individuals have been found in June, parturition occurs in mid to late June, and lactation extends through July and early August. A single young is produced annually. Food appears to consist primarily of microlepidopterans (6 to 12 mm long) although other items are eaten, at least opportunistically. Winter status is not well understood. Individuals may move from higher elevation summer ranges to low elevation winter habitats (M. J. O'Farrell, unpublished data).
- IV. THREATS: Maternity roosts appear to be the critical limiting factor. Use of abandoned mine tunnels put the bats at risk; abandoned mines are subject to closure or vandalism. An important mine roost has been destroyed by relocation of a nearby highway (Cockrum et al. 1996). Specific physical requirements and the ephemeral nature of exfoliating bark on tree snag roosts appear to be highly limiting (Rabe et al., in press). It is critical that proper forest management provides sufficient roosts for this species. The rarity and patchy distribution of this species, as well as its apparent high degree of specialized feeding strategy, compounds its sensitivity to disturbance.
- V. GAPS IN KNOWLEDGE: Very little is known of maternity roost requirements or the range of roost types used. Nothing is known of winter roosts. By deduction, it appears there are at least some elevational movements between summer and winter ranges. Very little is known concerning foraging behavior and requirements. Reproductive biology and population dynamics are poorly understood. It will be necessary to gather these data to properly evaluate potential threats and provide adequate management protocols. The current lack of knowledge suggests the need for the same intensity of focused surveys throughout the geographic range as has been accorded to the more widespread, and apparently more common, spotted bat (*Euderma maculatum*).

VI. SELECTED LITERATURE:

- Cockrum, E. L., B. Musgrove, and Y. Petryszyn. 1996. Bats of Mohave County, Arizona: populations and movements. Occasional Papers, The Museum, Texas Tech University 157:1-71.
- Czaplewski, N. J. 1983. *Idionycteris phyllotis*. Mammalian Species 208:1-4.
- Hoffmeister, D. F. 1986. Mammals of Arizona. University of Arizona, Tucson. 602 pp.
- Rabe, M. J., T. E. Morrell, H. Green, J. C. deVos, Jr., and C. R. Miller. 1997. Characteristics of ponderosa pine snag roosts used by reproductive bats in northern Arizona. Journal of Wildlife Management, in press.
- Tumlison, R. 1993. Geographic variation in the lappet-eared bat, *Idionycteris phyllotis*, with descriptions of subspecies. Journal of Mammalogy 74:412-421.

APPENDIX C

SPECIES RANKINGS FOR COLORADO BATS

Each of the following tables shows the summary scores for categories and for range for a species. See Species Rankings section for description of categories and scores. Tables are ordered by Conservation Priority Score (see Table 3).

| Townsend's big-eared bat (<i>Corynorhinus townsendii</i>) | | | | | | | | | | |
|---|--------|--------------------------------------|------------------------------------|--|--------------------------------|-------------------|---------------------|---------------------|--------------------|----------------|
| CATEGORIES | | | | | | | | | | |
| Rating Criteria * | Weight | Mining | Forest Management Practices | Caves and Crevice Management Practices | Rangeland Management Practices | Urban Development | Summer Roost Status | Winter Roost Status | Status in Colorado | Summary Scores |
| Management*5 | | 3 | 1 | 3 | 1 | 1 | 0 | 0 | | |
| Research*3 | | 3 | 2 | 3 | 2 | 2 | 3 | 3 | | |
| Knowledge gaps*2 | | 3 | 2 | 3 | 2 | 1 | 0 | 0 | | |
| Total (weighted and summed scores) | | 30 | 15 | 30 | 15 | 13 | 9 | 9 | 5 | 126 |
| RANGE | | | | | | | | | | |
| | | Central Shortgrass Prairie Ecoregion | Southern Rocky Mountains Ecoregion | Colorado Plateau Ecoregion | Wyoming Basin Ecoregion | | | | | |
| Ubiquitous*2 | | 0 | 1 | 1 | 1 | | | | | |
| Peripheral*1 | | 1 | 0 | 0 | 0 | | | | | |
| Habitat requirement*5 | | 3 | 3 | 3 | 3 | | | | | |
| Total (weighted and summed scores) | | 16 | 17 | 17 | 17 | | | | | 67 |
| Conservation Priority Score | | | | | | | | | | 193 |

Fringed myotis (*Myotis thysanodes*)

CATEGORIES

| Rating Criteria * | Weight | Mining | Forest Management Practices | Caves and Crevice Management Practices | Rangeland Management Practices | Urban Development | Summer Roost Status | Winter Roost Status | Status in Colorado | Summary Scores |
|------------------------------------|--------|--------------------------------------|------------------------------------|--|--------------------------------|-------------------|---------------------|---------------------|--------------------|----------------|
| Management*5 | | 2 | 2 | 3 | 1 | 1 | 0 | 0 | | |
| Research*3 | | 2 | 2 | 2 | 1 | 1 | 3 | 3 | | |
| Knowledge gaps*2 | | 2 | 2 | 2 | 1 | 1 | 0 | 0 | | |
| Total (weighted and summed scores) | | 20 | 20 | 25 | 10 | 10 | 9 | 9 | 5 | 108 |
| RANGE | | | | | | | | | | |
| | | Central Shortgrass Prairie Ecoregion | Southern Rocky Mountains Ecoregion | Colorado Plateau Ecoregion | Wyoming Basin Ecoregion | | | | | |
| Ubiquitous*2 | | 0 | 1 | 1 | 0 | | | | | |
| Peripheral*1 | | 1 | 0 | 0 | 0 | | | | | |
| Habitat requirement*5 | | 2 | 2 | 3 | 3 | | | | | |
| Total (weighted and summed scores) | | 11 | 12 | 17 | 15 | | | | | 55 |
| Conservation Priority Score | | | | | | | | | | 163 |

Little brown bat (*Myotis lucifugus*)

CATEGORIES

| Rating Criteria * Weight | Mining | Forest Management Practices | Caves and Crevice Management Practices | Rangeland Management Practices | Urban Development | Summer Roost Status | Winter Roost Status | Status in Colorado | Summary Scores |
|--|---|---|---|--------------------------------------|----------------------|---------------------------|---------------------------|-----------------------|-------------------|
| Management*5 | 2 | 1 | 2 | 1 | 2 | 0 | 0 | | |
| Research*3 | 1 | 1 | 1 | 1 | 2 | 1 | 3 | | |
| Knowledge gaps*2 | 2 | 1 | 2 | 1 | 1 | 0 | 0 | | |
| Total (weighted and summed scores) | 17 | 10 | 17 | 10 | 18 | 3 | 9 | 1 | 78 |
| RANGE | | | | | | | | | |
| | Central Shortgrass Prairie Ecoregion | Southern Rocky Mountains Ecoregion | Colorado Plateau Ecoregion | Wyoming Basin Ecoregion | | | | | |
| Ubiquitous*2 | 1 | 1 | 1 | 1 | | | | | |
| Peripheral*1 | 0 | 0 | 0 | 0 | | | | | |
| Habitat requirement*5 | 1 | 1 | 2 | 1 | | | | | |
| Total (weighted and summed scores) | 7 | 7 | 12 | 7 | | | | | 33 |
| Conservation Priority Score | | | | | | | | | 111 |

Long-eared myotis (*Myotis evotis*)

CATEGORIES

| Rating Criteria * | Weight | Mining | Forest Management Practices | Caves and Crevice Management Practices | Rangeland Management Practices | Urban Development | Summer Roost Status | Winter Roost Status | Status in Colorado | Summary Scores |
|------------------------------------|--------|--------------------------------------|------------------------------------|--|--------------------------------|-------------------|---------------------|---------------------|--------------------|----------------|
| Management*5 | | 2 | 2 | 2 | 1 | 0 | 0 | 0 | | |
| Research*3 | | 1 | 2 | 2 | 1 | 0 | 1 | 3 | | |
| Knowledge gaps*2 | | 1 | 1 | 2 | 1 | 0 | 0 | 0 | | |
| Total (weighted and summed scores) | | 15 | 18 | 20 | 10 | 0 | 3 | 9 | 5 | 80 |
| RANGE | | | | | | | | | | |
| | | Central Shortgrass Prairie Ecoregion | Southern Rocky Mountains Ecoregion | Colorado Plateau Ecoregion | Wyoming Basin Ecoregion | | | | | |
| Ubiquitous*2 | | 0 | 1 | 1 | 1 | | | | | |
| Peripheral*1 | | 0 | 0 | 0 | 0 | | | | | |
| Habitat requirement*5 | | 0 | 1 | 2 | 2 | | | | | |
| Total (weighted and summed scores) | | 0 | 7 | 12 | 12 | | | | | 31 |
| Conservation Priority Score | | | | | | | | | | 111 |

Spotted bat (*Euderma maculatum*)

CATEGORIES

| Rating Criteria * Weight | Mining | Forest Management Practices | Caves and Crevice Management Practices | Rangeland Management Practices | Urban Development | Summer Roost Status | Winter Roost Status | Status in Colorado | Summary Scores |
|------------------------------------|--------------------------------------|------------------------------------|--|--------------------------------|-------------------|---------------------|---------------------|--------------------|----------------|
| Management*5 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | | |
| Research*3 | 0 | 1 | 1 | 2 | 0 | 1 | 3 | | |
| Knowledge gaps*2 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | | |
| Total (weighted and summed scores) | 7 | 12 | 12 | 18 | 0 | 3 | 9 | 5 | 67 |
| RANGE | | | | | | | | | |
| | Central Shortgrass Prairie Ecoregion | Southern Rocky Mountains Ecoregion | Colorado Plateau Ecoregion | Wyoming Basin Ecoregion | | | | | |
| Ubiquitous*2 | 0 | 0 | 1 | 1 | | | | | |
| Peripheral*1 | 0 | 1 | 0 | 0 | | | | | |
| Habitat requirement*5 | 0 | 1 | 3 | 3 | | | | | |
| Total (weighted and summed scores) | 0 | 6 | 17 | 17 | | | | | 40 |
| Conservation Priority Score | | | | | | | | | 107 |

Western small-footed bat (*Myotis ciliolabrum*)

CATEGORIES

| Rating Criteria * Weight | Mining | Forest Management Practices | Caves and Crevice Management Practices | Rangeland Management Practices | Urban Development | Summer Roost Status | Winter Roost Status | Status in Colorado | Summary Scores |
|--|---|---|---|--------------------------------------|----------------------|---------------------------|---------------------------|-----------------------|-------------------|
| Management*5 | 2 | 1 | 2 | 1 | 0 | 0 | 0 | | |
| Research*3 | 1 | 1 | 1 | 1 | 0 | 1 | 2 | | |
| Knowledge gaps*2 | 1 | 1 | 2 | 1 | 0 | 0 | 0 | | |
| Total (weighted and summed scores) | 15 | 10 | 17 | 10 | 0 | 3 | 6 | 5 | 66 |
| RANGE | | | | | | | | | |
| | Central Shortgrass Prairie Ecoregion | Southern Rocky Mountains Ecoregion | Colorado Plateau Ecoregion | Wyoming Basin Ecoregion | | | | | |
| Ubiquitous*2 | 1 | 1 | 1 | 1 | | | | | |
| Peripheral*1 | 0 | 0 | 0 | 0 | | | | | |
| Habitat requirement*5 | 1 | 1 | 2 | 2 | | | | | |
| Total (weighted and summed scores) | 7 | 7 | 12 | 12 | | | | | 38 |
| Conservation Priority Score | | | | | | | | | 104 |

Big brown bat (*Eptesicus fuscus*)

CATEGORIES

| Rating Criteria * | Weight | Mining | Forest Management Practices | Caves and Crevice Management Practices | Rangeland Management Practices | Urban Development | Summer Roost Status | Winter Roost Status | Status in Colorado | Summary Scores |
|------------------------------------|--------|--------------------------------------|------------------------------------|--|--------------------------------|-------------------|---------------------|---------------------|--------------------|----------------|
| Management*5 | | 2 | 1 | 2 | 1 | 2 | 0 | 0 | | |
| Research*3 | | 1 | 1 | 1 | 0 | 1 | 1 | 3 | | |
| Knowledge gaps*2 | | 1 | 1 | 1 | 0 | 1 | 0 | 0 | | |
| Total (weighted and summed scores) | | 15 | 10 | 15 | 5 | 15 | 3 | 9 | 1 | 73 |
| RANGE | | | | | | | | | | |
| | | Central Shortgrass Prairie Ecoregion | Southern Rocky Mountains Ecoregion | Colorado Plateau Ecoregion | Wyoming Basin Ecoregion | | | | | |
| Ubiquitous*2 | | 1 | 1 | 1 | 1 | | | | | |
| Peripheral*1 | | 0 | 0 | 0 | 0 | | | | | |
| Habitat requirement*5 | | 1 | 1 | 1 | 1 | | | | | |
| Total (weighted and summed scores) | | 7 | 7 | 7 | 7 | | | | | 28 |
| Conservation Priority Score | | | | | | | | | | 101 |

Hoary bat (*Lasiurus cinereus*)

CATEGORIES

| Rating Criteria * Weight | Mining | Forest Management Practices | Caves and Crevice Management Practices | Rangeland Management Practices | Urban Development | Summer Roost Status | Winter Roost Status | Status in Colorado | Summary Scores |
|--|---|---|---|--------------------------------------|----------------------|---------------------------|---------------------------|-----------------------|-------------------|
| Management*5 | 0 | 2 | 0 | 2 | 1 | 0 | 0 | | |
| Research*3 | 0 | 2 | 0 | 2 | 0 | 1 | 0 | | |
| Knowledge gaps*2 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | | |
| Total (weighted and summed scores) | 0 | 18 | 0 | 18 | 7 | 3 | 0 | 1 | 47 |
| RANGE | | | | | | | | | |
| | Central Shortgrass Prairie Ecoregion | Southern Rocky Mountains Ecoregion | Colorado Plateau Ecoregion | Wyoming Basin Ecoregion | | | | | |
| Ubiquitous*2 | 1 | 1 | 1 | 1 | | | | | |
| Peripheral*1 | 0 | 0 | 0 | 0 | | | | | |
| Habitat requirement*5 | 2 | 2 | 2 | 2 | | | | | |
| Total (weighted and summed scores) | 12 | 12 | 12 | 12 | | | | | 48 |
| Conservation Priority Score | | | | | | | | | 95 |

Yuma myotis (*Myotis yumanensis*)

CATEGORIES

| Rating Criteria * Weight | Mining | Forest Management Practices | Caves and Crevice Management Practices | Rangeland Management Practices | Urban Development | Summer Roost Status | Winter Roost Status | Status in Colorado | Summary Scores |
|--|---|---|---|--------------------------------------|----------------------|---------------------------|---------------------------|-----------------------|-------------------|
| Management*5 | 1 | 1 | 2 | 2 | 0 | 0 | 0 | | |
| Research*3 | 0 | 0 | 2 | 2 | 0 | 1 | 3 | | |
| Knowledge gaps*2 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | | |
| Total (weighted and summed scores) | 7 | 5 | 20 | 18 | 0 | 3 | 9 | 5 | 67 |
| RANGE | | | | | | | | | |
| | Central Shortgrass Prairie Ecoregion | Southern Rocky Mountains Ecoregion | Colorado Plateau Ecoregion | Wyoming Basin Ecoregion | | | | | |
| Ubiquitous*2 | 0 | 0 | 1 | 0 | | | | | |
| Peripheral*1 | 1 | 1 | 0 | 0 | | | | | |
| Habitat requirement*5 | 1 | 1 | 3 | 0 | | | | | |
| Total (weighted and summed scores) | 6 | 6 | 17 | 0 | | | | | 29 |
| Conservation Priority Score | | | | | | | | | 96 |

Brazilian free-tailed bat (*Tadarida brasiliensis mexicana*)

CATEGORIES

| Rating Criteria * Weight | Mining | Forest Management Practices | Caves and Crevice Management Practices | Rangeland Management Practices | Urban Development | Summer Roost Status | Winter Roost Status | Status in Colorado | Summary Scores |
|------------------------------------|--------|-----------------------------|--|--------------------------------|-------------------|---------------------|---------------------|--------------------|----------------|
| Management*5 | 2 | 0 | 2 | 1 | 1 | 0 | 0 | | |
| Research*3 | 1 | 0 | 2 | 1 | 2 | 3 | 0 | | |
| Knowledge gaps*2 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | | |
| Total (weighted and summed scores) | 15 | 0 | 18 | 10 | 18 | 9 | 0 | 1 | 71 |

RANGE

| | Central Shortgrass Prairie Ecoregion | Southern Rocky Mountains Ecoregion | Colorado Plateau Ecoregion | Wyoming Basin Ecoregion | | | | | |
|------------------------------------|--------------------------------------|------------------------------------|----------------------------|-------------------------|--|--|--|--|-----------|
| Ubiquitous*2 | 0 | 0 | 1 | 0 | | | | | |
| Peripheral*1 | 1 | 1 | 0 | 0 | | | | | |
| Habitat requirement*5 | 1 | 1 | 2 | 0 | | | | | |
| Total (weighted and summed scores) | 6 | 6 | 12 | 0 | | | | | 24 |
| Conservation Priority Score | | | | | | | | | 95 |

Silver-haired bat (*Lasionycteris noctivagans*)

CATEGORIES

| Rating Criteria * Weight | Mining | Forest Management Practices | Caves and Crevice Management Practices | Rangeland Management Practices | Urban Development | Summer Roost Status | Winter Roost Status | Status in Colorado | Summary Scores |
|--|---|---|---|--------------------------------------|----------------------|---------------------------|---------------------------|-----------------------|-------------------|
| Management*5 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | | |
| Research*3 | 0 | 2 | 0 | 1 | 0 | 1 | 0 | | |
| Knowledge gaps*2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | | |
| Total (weighted and summed scores) | 0 | 18 | 0 | 8 | 0 | 3 | 0 | 1 | 30 |
| RANGE | | | | | | | | | |
| | Central Shortgrass Prairie Ecoregion | Southern Rocky Mountains Ecoregion | Colorado Plateau Ecoregion | Wyoming Basin Ecoregion | | | | | |
| Ubiquitous*2 | 1 | 1 | 1 | 1 | | | | | |
| Peripheral*1 | 0 | 0 | 0 | 0 | | | | | |
| Habitat requirement*5 | 2 | 2 | 2 | 2 | | | | | |
| Total (weighted and summed scores) | 12 | 12 | 12 | 12 | | | | | 48 |
| Conservation Priority Score | | | | | | | | | 78 |

Big free-tailed bat (*Nyctinomops macrotis*)

CATEGORIES

| Rating Criteria * Weight | Mining | Forest Management Practices | Caves and Crevice Management Practices | Rangeland Management Practices | Urban Development | Summer Roost Status | Winter Roost Status | Status in Colorado | Summary Scores |
|--|---|---|---|--------------------------------------|----------------------|---------------------------|---------------------------|-----------------------|-------------------|
| Management*5 | 0 | 0 | 0 | 2 | 1 | | | | |
| Research*3 | 0 | 1 | 1 | 2 | 1 | 2 | 0 | | |
| Knowledge gaps*2 | 0 | 1 | 0 | 2 | 1 | | | | |
| Total (weighted and summed scores) | 0 | 5 | 3 | 20 | 10 | 6 | 0 | 5 | 49 |
| RANGE | | | | | | | | | |
| | Central Shortgrass Prairie Ecoregion | Southern Rocky Mountains Ecoregion | Colorado Plateau Ecoregion | Wyoming Basin Ecoregion | | | | | |
| Ubiquitous*2 | 0 | 0 | 1 | 0 | | | | | |
| Peripheral*1 | 1 | 1 | 0 | 0 | | | | | |
| Habitat requirement*5 | 1 | 1 | 3 | 0 | | | | | |
| Total (weighted and summed scores) | 6 | 6 | 17 | 0 | | | | | 29 |
| Conservation Priority Score | | | | | | | | | 78 |

Pallid bat (*Antrozous pallidus*)

CATEGORIES

| Rating Criteria * Weight | Mining | Forest Management Practices | Caves and Crevice Management Practices | Rangeland Management Practices | Urban Development | Summer Roost Status | Winter Roost Status | Status in Colorado | Summary Scores |
|--|---|---|---|--------------------------------------|----------------------|---------------------------|---------------------------|-----------------------|-------------------|
| Management*5 | 2 | 0 | 1 | 2 | 0 | | | | |
| Research*3 | 1 | 0 | 1 | 2 | 0 | 1 | 2 | | |
| Knowledge gaps*2 | 1 | 0 | 1 | 1 | 0 | | | | |
| Total (weighted and summed scores) | 15 | 0 | 10 | 18 | 0 | 3 | 6 | 1 | 53 |
| RANGE | | | | | | | | | |
| | Central Shortgrass Prairie Ecoregion | Southern Rocky Mountains Ecoregion | Colorado Plateau Ecoregion | Wyoming Basin Ecoregion | | | | | |
| Ubiquitous*2 | 0 | 0 | 1 | 0 | | | | | |
| Peripheral*1 | 1 | 0 | 0 | 0 | | | | | |
| Habitat requirement*5 | 1 | 0 | 3 | 0 | | | | | |
| Total (weighted and summed scores) | 6 | 0 | 17 | 0 | | | | | 23 |
| Conservation Priority Score | | | | | | | | | 76 |

Western pipistrelle (*Pipistrellus hesperus*)

CATEGORIES

| Rating Criteria * | Weight | Mining | Forest Management Practices | Caves and Crevice Management Practices | Rangeland Management Practices | Urban Development | Summer Roost Status | Winter Roost Status | Status in Colorado | Summary Scores |
|------------------------------------|--------|--------------------------------------|------------------------------------|--|--------------------------------|-------------------|---------------------|---------------------|--------------------|----------------|
| Management*5 | | 1 | 0 | 1 | 2 | 0 | 0 | 0 | | |
| Research*3 | | 0 | 0 | 1 | 1 | 0 | 1 | 3 | | |
| Knowledge gaps*2 | | 0 | 1 | 1 | 1 | 0 | 0 | 0 | | |
| Total (weighted and summed scores) | | 5 | 2 | 10 | 15 | 0 | 3 | 9 | 1 | 45 |
| RANGE | | | | | | | | | | |
| | | Central Shortgrass Prairie Ecoregion | Southern Rocky Mountains Ecoregion | Colorado Plateau Ecoregion | Wyoming Basin Ecoregion | | | | | |
| Ubiquitous*2 | | 0 | 0 | 1 | 0 | | | | | |
| Peripheral*1 | | 1 | 0 | 0 | 0 | | | | | |
| Habitat requirement*5 | | 1 | 0 | 3 | 0 | | | | | |
| Total (weighted and summed scores) | | 6 | 0 | 17 | 0 | | | | | 23 |
| Conservation Priority Score | | | | | | | | | | 68 |

California myotis (*Myotis californicus*)

CATEGORIES

| Rating Criteria * Weight | Mining | Forest Management Practices | Caves and Crevice Management Practices | Rangeland Management Practices | Urban Development | Summer Roost Status | Winter Roost Status | Status in Colorado | Summary Scores |
|--|---|---|---|--------------------------------------|----------------------|---------------------------|---------------------------|-----------------------|-------------------|
| Management*5 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | | |
| Research*3 | 1 | 0 | 1 | 1 | 0 | 1 | 2 | | |
| Knowledge gaps*2 | 2 | 1 | 2 | 1 | 0 | 0 | 0 | | |
| Total (weighted and summed scores) | 17 | 7 | 7 | 10 | 0 | 3 | 6 | 1 | 51 |
| RANGE | | | | | | | | | |
| | Central Shortgrass Prairie Ecoregion | Southern Rocky Mountains Ecoregion | Colorado Plateau Ecoregion | Wyoming Basin Ecoregion | | | | | |
| Ubiquitous*2 | 0 | 0 | 1 | 0 | | | | | |
| Peripheral*1 | 0 | 1 | 0 | 0 | | | | | |
| Habitat requirement*5 | 0 | 1 | 2 | 0 | | | | | |
| Total (weighted and summed scores) | 0 | 6 | 12 | 0 | | | | | 18 |
| Conservation Priority Score | | | | | | | | | 69 |

Red bat (*Lasiurus borealis*)

CATEGORIES

| Rating Criteria * | Weight | Mining | Forest Management Practices | Caves and Crevice Management Practices | Rangeland Management Practices | Urban Development | Summer Roost Status | Winter Roost Status | Status in Colorado | Summary Scores |
|------------------------------------|--------|--------------------------------------|------------------------------------|--|--------------------------------|-------------------|---------------------|---------------------|--------------------|----------------|
| Management*5 | | 0 | 1 | 0 | 2 | 0 | 0 | 0 | | |
| Research*3 | | 0 | 1 | 0 | 2 | 0 | 3 | 0 | | |
| Knowledge gaps*2 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | | |
| Total (weighted and summed scores) | | 0 | 8 | 0 | 15 | 0 | 9 | 0 | 3 | 35 |
| RANGE | | | | | | | | | | |
| | | Central Shortgrass Prairie Ecoregion | Southern Rocky Mountains Ecoregion | Colorado Plateau Ecoregion | Wyoming Basin Ecoregion | | | | | |
| Ubiquitous*2 | | 1 | 0 | 0 | 0 | | | | | |
| Peripheral*1 | | 0 | 0 | 0 | 0 | | | | | |
| Habitat requirement*5 | | 1 | 0 | 0 | 0 | | | | | |
| Total (weighted and summed scores) | | 7 | 0 | 0 | 0 | | | | | 7 |
| Conservation Priority Score | | | | | | | | | | 42 |

Eastern pipistrelle (*Pipistrellus subflavus*)

CATEGORIES

| Rating Criteria * Weight | Mining | Forest Management Practices | Caves and Crevice Management Practices | Rangeland Management Practices | Urban Development | Summer Roost Status | Winter Roost Status | Status in Colorado | Summary Scores |
|--|---|---|---|--------------------------------------|----------------------|---------------------------|---------------------------|-----------------------|-------------------|
| Management*5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | | |
| Research*3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | | |
| Knowledge gaps*2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | | |
| Total (weighted and summed scores) | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 1 | 11 |
| RANGE | | | | | | | | | |
| | Central Shortgrass Prairie Ecoregion | Southern Rocky Mountains Ecoregion | Colorado Plateau Ecoregion | Wyoming Basin Ecoregion | | | | | |
| Ubiquitous*2 | 0 | 0 | 0 | 0 | | | | | |
| Peripheral*1 | 1 | 0 | 0 | 0 | | | | | |
| Habitat requirement*5 | 1 | 0 | 0 | 0 | | | | | |
| Total (weighted and summed scores) | 6 | 0 | 0 | 0 | | | | | 6 |
| Conservation Priority Score | | | | | | | | | 17 |