Utah Bat Conservation Plan

by

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Proposal

Executive summary

There is conservational concern for nearly all bats. Great declines have been observed in some populations of even the most widespread and abundant bat species in America. Of the bat species that inhabit Utah, six are on the Utah Division of Wildlife Resources' Sensitive Species List, Tier II of Utah's Wildlife Action Plan (WAP), one species is in Tier III of WAP, and several were former Category 2 candidates for federal listing by the U. S. Fish and Wildlife Service as threatened or endangered, under provisions of the Endangered Species Act, until Category 2 was eliminated in 1996.

The biology and life histories of most of the bat species that occur in Utah remain poorly and incompletely known, and this lack of knowledge impedes effective efforts to manage and to conserve their populations. Protection of roosting habitats, foraging habitats, and water are obvious conservational needs. To guide appropriate management, improved knowledge of the distributions (geographic inventory) and populations (monitoring of population trends) of the bat species that inhabit Utah is needed. To acquire the understanding needed for informed management, inventory and monitoring must be undertaken and accomplished in a systematic way.

This plan provides an overview of the bats of Utah, it summarizes threats to bats in Utah, it identifies conservational objectives, it recommends needed actions, and it provides tools and informational resources that can be used to carry out the needed actions.

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Purpose

The purpose of this document is (1) to identify deficiencies in the understanding of the biology of the bats that inhabit Utah, (2) to identify anthropogenic threats to the bats of this state, (3) to recommend conservational actions, (4) to direct research efforts to acquire needed knowledge, and (5) thus to guide management of Utah's bat species to ensure the viability of bat populations in the state. It is intended not to be static but instead to be a dynamic or a "living" document that will be updated and expanded in future editions.

General overview of the biology of Utah bats

Utah's known bat fauna comprises 18 species (Hasenyager 1980, Oliver 2000) or perhaps 19 or 20 species, depending on differing taxonomic opinions ("splitting" versus "lumping"). Three additional species have been reported from Utah based on misidentification or presumption (see Oliver 2000, pp 125–127), but some or all of these three species, and perhaps even others, may eventually be found in the state.

Being volant, bats, like birds, are among the most vagile of all organisms, and many species make long-distance seasonal migrations. Their great vagility facilitates their colonization of new areas and the expansion of their geographic

ranges. It also predisposes them to wandering, and it makes them susceptible to passive dispersal by windstorms. Thus bats can quickly reach and exploit new suitable sites that have been artificially created, such as water sources (e.g., livestock tanks), roosts (e.g., buildings, mines, bridges), and altered landscapes (e.g., urban parks, orchards, pastures). Species of bats also sometimes appear in surprisingly unexpected places as "occasional", "accidental", or "vagrant" occurrences, which are temporary (i.e., not resulting in colonization, reproduction, and establishment of a local population). Thus the known bat fauna of an area, like its avifauna, not only can change more rapidly than that of non-volant animals but also can at times include unpredicted, accidental species. As a result, the documented bat fauna of Utah is expected to be less static or fixed than is the rest of Utah's mammalian fauna.

All of the bat species known to occur in Utah, and all but one of the species that may yet be found to occur in the state, belong to two families, Vespertilionidae (vesper bats), which are cosmopolitan, and Molossidae (free-tailed bats), which are mostly pantropical but extend into subtropical and milder parts of temperate latitudes. The one species not known from Utah but of possible occurrence in the state that is not a member of these two families belongs to the family Phyllostomidae (New World leaf-nosed bats), which are neotropical, with a few species ranging into subtropical parts of the New World.

All of the bats that inhabit or potentially inhabit Utah are nocturnal, although a few are also crepuscular. All of the bats that occur or may occur in Utah are insectivorous, most of them strictly so, though at least one consumes some non-insect arthropods, and a few occasionally take vertebrate prey (including other bats). Some Utah bats capture prey in the air, some glean prey from foliage, some glean from rock surfaces, and at least one Utah species often alights on the ground, where it captures prey in terrestrial, quadrupedal fashion. Most Utah bats eat mainly moths, though a few species feed heavily on beetles. Despite frequent claims that bats control mosquitoes, mosquitoes are not an important component of the diet of most bat species in Utah or elsewhere in America.

Some of Utah's bats migrate south out of the state for the winter; others hibernate in Utah, though they may be facultatively active during warmer periods, especially at the lowest latitudes and lowest elevations in the state (e.g., southern Washington County).

Roosts are of critical importance to bats, and different roosting situations may be used for different purposes. Roosts are of four general types: (1) diurnal roosts, (2) nocturnal roosts, (3) maternity roosts, and (4) hibernacula. Some species use a single roost for all of these purposes; others require as many as four roosts with very different physical and structural characteristics. Roosting situations used by different bat species in Utah include caves, mines, buildings, rock crevices, foliage, and crevices, hollows, and spaces under exfoliating bark of trees. It has even been speculated that one species that occurs in Utah may

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roost in burrows of rodents such as those of kangaroo rats. Some Utah bats roost in groups of various sizes, but other species roost singly, almost never being found with others except their own dependent young. Most Utah bats bear single young, but four species typically bear twins, and one species usually produces even larger litters. Only one litter is produced each year. This, together with small litter size, makes the reproductive potential of bats quite low relative to other small mammals. However, bats are much longer lived than most mammals of comparable size, individuals of some Utah species living 40 years or more.

Drinking water is of critical importance to most bats in Utah. Drinking is mostly is accomplished by skimming the water surface with open mandible (jaw). Surface waters also provide rich foraging sites since flying insects are often abundant over even small bodies of water, and surface water often is bordered or surrounded by more luxuriant vegetation that favors insect abundance.

Essentially all habitats that are present in Utah are utilized by bats. Only alpine tundra, vast, sparsely vegetated salt flats, and large hypersaline water bodies (e.g., interior portions of the Great Salt Lake) can be considered marginal or unsuitable habitats for bats in this state. Some Utah bat species are highly selective in their use of habitats, while others utilize a very broad range of habitats. A few species appear to be favored by certain human alterations of the landscape (e.g., livestock tanks and other artificial water sources, mines, buildings, and even cities), but others are affected only negatively by human alterations of the natural environment.

Their ecological requirements (suitable habitats that provide water, insect prey, and particular roost conditions) together with their life history characteristics (low reproductive rate and long life) make Utah's bats especially vulnerable to mortality and population reduction resulting directly or indirectly from many human activities including the use of insecticides, water pollution, timber harvest and forest management, wind turbine energy production, abandoned mine closures, alterations of riparian habitats, and persecution and disturbance at roosts.

As a group, bats are arguably the most widely distributed of non-marine mammals. As discussed above, being volant, they are not limited by most of the barriers that impede dispersal and colonization by other mammalian groups. In terms of living species, the order Chiroptera (bats) is the second largest order of mammals, surpassed only by the order Rodentia (rodents). Despite their diversity, abundance, and worldwide distribution (except for Antarctica and the highest northern latitudes), bats are, as a group, perhaps the most poorly known of living mammals. Most of what is known of their biology has been learned since ca. 1960. The use of mist nets for the capture of bats revolutionized their study, and further technological advances continue to expand possibilities in bat research. Despite the much greater understanding of bats that has been

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achieved in recent decades, much remains to be learned. Various aspects of the basic biology of many common and widely occurring species are still unknown, including several species that are very common in Utah and western North America.

Detailed review and discussion of the biology of bat species in Utah has been provided by Hasenyager (1980) and Oliver (2000). Except for information reported after early 2000, those two sources summarize, in their accounts of species, practically all that is known about bats in this state, and they provide extensive lists of references to pertinent literature. Only minimal repetition of such information is made here (e.g., summaries below, mostly from Oliver 2000), and it is recommended that those reports be used in conjunction with this conservation plan.

The ecological requirements of the 19 bat species known to occur in Utah are presented in tabular form in 19 “ecological integrity tables” in Appendix 1 (Oliver). The concept and the form of ecological integrity tables were developed in 2004 by The Nature Conservancy (TNC).

There are several intended uses of the tables by UDWR. Most of UDWR's intended uses involve rapid assessment of sites when long-term, labor-intensive, expensive surveys, monitoring, and other studies are not options. UDWR's intended uses include:

(1) to estimate the ecological quality or suitability of a site for a particular species that we know inhabits the site, relative to other inhabited sites,

(2) to estimate the ecological value of a site for a particular species when we don't know whether it is present (i.e., to predict the species’ presence or absence and the potential value of the site to the species if it is likely present), this use being especially important for extremely hard-to-detect species,

(3) to determine whether there are actions that can be taken that can be expected to make the site more suitable or actions that should be avoided in order to prevent the site from becoming unsuitable for the species (e.g., management actions, habitat manipulations or treatments),

(4) to guide restoration projects intended to create or re-create suitable habitats and conditions meeting all of the life history requirements and ecological needs of a particular species, and

(5) to evaluate the potential impacts (positive and negative) of habitat restoration or other habitat-altering projects targeted at other species.

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Bat species known to occur in Utah

Various English common names exist for some bat species in Utah, and differing taxonomic opinions result in different scientific names for some Utah species as well. Common and scientific names used here mostly follow the "Texas Tech mammal checklist" (Baker et al. 2003), which is the ninth version of the list (over the 30-year period 1973–2003). Nomenclatural changes pertaining to bats have been seen in most if not all editions of the Texas Tech list, and changes in the names of species occurring in Utah can be expected in its future editions. Although the list is widely followed by mammalogists in America and Canada and is intended to standardize mammal nomenclature, no one is required to follow it. Thus other common and scientific names have been used in the past, others will likely be used in the future, and even others are in current use by various authors who disagree with the current edition of the list. (See Oliver 2000 for discussions of formerly used common and scientific names, taxonomic debates and uncertainties, and nomenclatural stability or instability.) The genus *Parastrellus* (Hoofer et al. 2006) is used in the body of this document (but not in all of the appendices) for the western pipistrelle; it is expected that this name will be endorsed by future editions of the Texas Tech mammal list.

The first 17 species listed below are members of the family Vespertilionidae; the last two species belong to the family Molossidae. The summaries below are strictly Utah-specific, except for number of young and main prey. In the category "main prey" in the synopses below, the generalized data are *not* from Utah, and the term "flies" has been used very loosely to include not only dipterans, the true flies (such as crane flies), but also various other small flying insects such as caddisflies and mayflies. To the extent that a generalization concerning the collective food habits of all Utah bats can be made, moths are overwhelmingly the most important foods for Utah bats, followed by beetles. Despite popular misunderstanding, mosquitoes are *not* important prey of bats in Utah or in America, and bats in Utah do not play an important role in controlling mosquito populations (as discussed later in this document).

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Myotis lucifugus, little brown myotis

- Utah distribution: possibly all, but unreported from parts of northwestern, southwestern, and south-central Utah
- Utah wintering habits: unknown (hibernates and makes short-distance migratory movements elsewhere)
- Utah abundance: common (abundant in northern Utah)
- Utah diurnal roosts: attics, rock crevices
- Utah maternity roosts: attics, bridges
- Utah habitats: highland riparian areas, aspen forests, mixed forests, coniferous forests, cities and towns
- Utah elevational range: 4,300 to 10,000 ft

- number of young: 1
- main prey: “flies” (especially emerging aquatic flying insects), moths

***Myotis occultus*, Arizona myotis**

This putative species had not been reported in Utah until very recently, after the works by Hasenyager (1980) and Oliver (2000). However, Oliver (2000, p 7) mentioned its occurrence, as a race of *M. lucifugus*, very near several parts of southern Utah and briefly reviewed the long-standing debate of its taxonomic status as either a race of *M. lucifugus* or a full species. More recent work (Piaggio et al. 2002) has again argued for specific status, and the currently prevailing view is that it should be treated as a full species (Baker et al. 2003). E. W. Valdez (personal communication, 2003) and M. Siders (personal communication, 2005) have reported recent capture of this taxon in south-central Utah. However, M. A. Bogan (personal communication, 2008) has expressed uncertainty about the identity of *lucifugus*-like bats from southern Utah that have been assigned by others to *occultus*. Hoffmeister (1986), during a time when few mammalogists recognized the taxon as a full species, provided a useful account of *M. occultus*. Because *M. occultus* has only recently again become widely accepted as a species distinct from *M. lucifugus*, it would likely have been called *M. lucifugus* in Utah studies prior to 2002 or 2003, and nothing has been reported concerning its biology in Utah. Reports, if any, of *M. lucifugus* from extreme southern Utah before 2002 or 2003 may pertain to this species, although some such reports could be misidentifications of *M. yumanensis*. It is also possible that *M. occultus* does not occur in Utah and that reports of this species in Utah represent misidentifications of *M. lucifugus*.

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***Myotis yumanensis*, Yuma myotis**

- Utah distribution: all except the northwest corner and extreme north-central; possibly statewide; few records in west and central
- Utah wintering habits: unknown
- Utah abundance: uncommon (fairly common in some places in south, rare elsewhere)
- Utah diurnal roosts: mines, buildings
- Utah maternity roosts: attics
- Utah habitats: lowland riparian and desert scrub to montane forest
- Utah elevational range: ≤2,800 to 10,098 ft
- number of young: 1
- main prey: moths, “flies”

***Myotis evotis*, long-eared myotis**

- Utah distribution: statewide
- Utah wintering habits: unknown
- Utah abundance: common
- Utah diurnal roosts: buildings, caves
- Utah maternity roosts: unknown
- Utah habitats: lowland riparian and sagebrush to montane forest
- Utah elevational range: 4,700 to 9,500 ft (also 2,800 ft, perhaps aberrant)
- number of young: 1
- main prey: moths, beetles

***Myotis thysanodes*, fringed myotis**

- Utah distribution: possibly statewide, but no records from northwest and most of west, few and scattered in central and northeast
- Utah wintering habits: unknown
- Utah abundance: uncommon
- Utah diurnal roosts: unknown
- Utah maternity roosts: attics of abandoned buildings, possibly caves
- Utah habitats: many, from lowland riparian and desert scrub to montane forest and meadows
- Utah elevational range: 2,400 to 8,900 ft
- number of young: 1
- main prey: beetles, moths

***Myotis volans*, long-legged myotis**

- Utah distribution: statewide
- Utah wintering habits: unknown (but there are suggestions of possible migration and possible hibernation)
- Utah abundance: abundant
- Utah diurnal roosts: unknown
- Utah maternity roosts: unknown
- Utah habitats: lowland riparian and desert scrub to montane coniferous forest
- Utah elevational range: 3,150 to >10,000 ft
- number of young: 1
- main prey: moths

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***Myotis californicus*, California myotis**

- Utah distribution: most of state except Uinta Mountains of northeast; no records from extreme north-central, northwest, and mountains of central
- Utah wintering habits: hibernates in mines and is active in winter in southwest; unknown in other parts of state
- Utah abundance: common
- Utah diurnal roosts: unknown
- Utah maternity roosts: unknown
- Utah habitats: cities, towns, ranches, and lowland riparian and desert scrub to montane mixed forest
- Utah elevational range: ≤2,600 to 9,000 ft
- number of young: 1
- main prey: "flies", moths

***Myotis ciliolabrum*, western small-footed myotis**

- Utah distribution: statewide
- Utah wintering habits: hibernates in caves and mines
- Utah abundance: uncommon
- Utah diurnal roosts: unknown
- Utah maternity roosts: unknown
- Utah habitats: lowland riparian and desert scrub to montane forest
- Utah night roosts: mines
- Utah elevational range: 2,950 to 8,900 ft
- number of young: 1
- main prey: moths, beetles

***Lasiurus blossevillii*, western red bat**

- Utah distribution: north–south band from extreme north-central to extreme southwest
- Utah wintering habits: unknown (may migrate)
- Utah abundance: very rare
- Utah diurnal roosts: a mine
- Utah maternity roosts: a cave
- Utah habitats: towns, cottonwood groves in lowland riparian areas
- Utah elevational range: 2,650 to 6,760 ft
- number of young: (2–)3
- main prey: moths, beetles

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***Lasiurus cinereus*, hoary bat**

- Utah distribution: statewide
- Utah wintering habits: presumably migrates; possibly overwinters in southwest
- Utah abundance: uncommon
- Utah diurnal roosts: a tree
- Utah maternity roosts: unknown
- Utah habitats: lowland riparian and desert scrub to montane forest; towns, cities
- Utah elevational range: ~2,500 to 9,200 ft
- number of young: 2
- main prey: moths

***Lasionycteris noctivagans*, silver-haired bat**

- Utah distribution: statewide
- Utah wintering habits: presumed to migrate, but known to remain in winter in southwest
- Utah abundance: common
- Utah diurnal roosts: unknown
- Utah maternity roosts: unknown
- Utah habitats: lowland riparian and desert scrub to montane forest; also urban areas
- Utah elevational range: ~2,500 to 9,670 ft
- number of young: (1–)2
- main prey: "flies", beetles, moths

***Parastrellus hesperus*, western pipistrelle**

- Utah distribution: nearly statewide, but no records from extreme north-central and northwest and from Uinta Mountains, Wasatch Mountains, and mountains of Central High Plateaus
- Utah wintering habits: known to be active in winter in southwest; presumed to hibernate, but no records
- Utah abundance: extremely abundant
- Utah diurnal roosts: under rocks
- Utah maternity roosts: unknown
- Utah habitats: especially lowland riparian and desert scrub, but also sagebrush, juniper, piñon, mountain brush, mountain meadow; ranch and farmland
- Utah elevational range: ≤2,500 to ≥8,710 ft
- number of young: 2

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- main prey: moths, leafhoppers, flying ants

***Eptesicus fuscus*, big brown bat**

- Utah distribution: statewide
- Utah wintering habits: hibernates in caves and mines
- Utah abundance: abundant
- Utah diurnal roosts: a mine
- Utah maternity roosts: buildings (e.g., attics)
- Utah habitats: desert scrub to montane forest; cities, towns
- Utah elevational range: ≤2,500 to ≥9,200 ft
- number of young: 2
- main prey: beetles

***Euderma maculatum*, spotted bat**

- Utah distribution: probably statewide, but records lacking from west (except southwest) and extreme north
- Utah wintering habits: hibernates in caves and is active during winter in southwest
- Utah abundance: rare
- Utah diurnal roosts: unknown
- Utah maternity roosts: unknown
- Utah habitats: lowland riparian and desert scrub to montane coniferous forest
- Utah elevational range: 2,700 to 9,200 ft
- number of young: 1
- main prey: moths

***Idionycteris phyllotis*, Allen's big-eared bat**

- Utah distribution: south and southeast
- Utah wintering habits: unknown
- Utah abundance: rare
- Utah diurnal roosts: unknown
- Utah maternity roosts: unknown
- Utah habitats: lowland riparian and desert scrub to mountain brush and mixed forest
- Utah elevational range: ~2,500 to ≥7,860 ft
- number of young: 1
- main prey: moths

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***Corynorhinus townsendii*, Townsend's big-eared bat**

- Utah distribution: statewide
- Utah wintering habits: hibernates in caves and mines
- Utah abundance: common
- Utah diurnal (and nocturnal) roosts: caves, abandoned mines, buildings
- Utah maternity roosts: caves, abandoned mines, buildings
- Utah habitats: desert scrub to montane forest
- Utah elevational range: 3,300 to ≥8,851 ft
- number of young: 1
- main prey: moths

***Antrozous pallidus*, pallid bat**

- Utah distribution: possibly statewide, but no records in most of north-central and northwest or in Wasatch and Uinta mountains and mountains of the Central High Plateaus
- Utah wintering habits: hibernates in caves; active in winter in southwest
- Utah abundance: common (at lower, drier sites)
- Utah diurnal roosts: unknown
- Utah maternity roosts: unknown
- Utah habitats: lowland riparian and desert scrub to mountain meadows; towns
- Utah elevational range: 2,700 to ≥8,700 ft
- number of young: 2
- main prey: various insects, non-insect terrestrial arthropods

***Tadarida brasiliensis*, Brazilian free-tailed bat**

- Utah distribution: possibly statewide, except perhaps for the northernmost counties
- Utah wintering habits: some populations migrate, some (southwest) remain and are active at times, even in freezing weather, some presumably hibernate
- Utah abundance: abundant
- Utah diurnal roosts: buildings, rock crevices
- Utah maternity roosts: attics of buildings
- Utah habitats: lowland riparian and desert scrub to ponderosa pine forest; cities and towns
- Utah elevational range: ≤2,600 to ≥8,000 ft
- number of young: 1
- main prey: moths

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***Nyctinomops macrotis*, big free-tailed bat**

- Utah distribution: southern half of state, perhaps north to the Wyoming border in the east
- Utah wintering habits: unknown, presumed to migrate
- Utah abundance: rare (but may be fairly common in some places)
- Utah diurnal roosts: unknown
- Utah maternity roosts: unknown
- Utah habitats: lowland riparian, desert scrub, montane forest
- Utah elevational range: ≤2,700 to 9,200 ft
- number of young: 1
- main prey: moths

Conservational status of Utah bats

The Western Bat Working Group (WBWG) produced (1998) a "Regional Bat Species Priority Matrix" of imperilment and thus priority for funding, planning, and conservation actions. Three levels of conservational priority—high, medium, and low—were assigned to species in each of up to six regions, based on Bailey's (U. S. Forest Service) ecoregions, in western North America. Four of the possible six regions are represented in Utah. The following adaptation (under column headed "WBWG") summarizes these conservational classifications, by bat species, within the four ecoregions that are present in Utah. "High" represents the greatest level of conservational concern. For some species, combining the four regional ranks into a single assessment for Utah is problematical, and a second possibility is given in parentheses. "High" means the species is "considered the highest priority for funding, planning, and conservation actions" and is "imperiled or at high risk of imperilment"; "medium" "indicates a level of concern that should warrant closer evaluation, more research, and conservation actions of both the species and possible threats"; and "low" means that, "[w]hile there may be localized concerns, the overall status of the species is believed to be secure" (WBWG 1998).

The Utah Division of Wildlife Resources, in its Wildlife Action Plan (formerly called the Comprehensive Wildlife Conservation Strategy or CWCS, Sutter et al. 2005), assigned Utah animal species of conservational concern to three tiers. Tier I contains species that are federally listed, candidate, or conservation agreement species; there are no bats in Utah with special federal status (i.e., none in Tier I). Tier II contains species identified by UDWR as Utah Species of Concern in the Utah Sensitive Species List (UDWR 2005). Tier III contains species for which there may be conservational concern and (usually) for which there is a lack of information adequate to assess their status in Utah. In the list below (under column headed "UDWR"), bat species that are in neither Tier II nor Tier III are indicated with a dash (—).

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species	WBWG	UDWR
Myotis lucifugus, little brown myotis	low	—
Myotis occultus, Arizona myotis	medium	—
Myotis yumanensis, Yuma myotis	medium, (low)	III
Myotis evotis, long-eared myotis	medium	—
Myotis thysanodes, fringed myotis	medium, (high)	II
Myotis volans, long-legged myotis	low	—
Myotis californicus, California myotis	medium, (low)	—
Myotis ciliolabrum, western small-footed myotis	medium, (low)	—
Lasiurus blossevillii, western red bat	high	II
Lasiurus cinereus, hoary bat	medium	—
Lasionycteris noctivagans, silver-haired bat	medium	—
Parastrellus hesperus, western pipistrelle	low	—
Eptesicus fuscus, big brown bat	low	—
Euderma maculatum, spotted bat	medium, (high)	II
Idionycteris phyllotis, Allen's big-eared bat	high	II
Corynorhinus townsendii, Townsend's big-eared bat	high	II
Antrozous pallidus, pallid bat	low, (medium)	—
Tadarida brasiliensis, Brazilian free-tailed bat	low	—
Nyctinomops macrotis, big free-tailed bat	medium, (high)	II

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As can be seen from the above, the conservational prioritizations of Utah bat species by WBWG and UDWR are generally comparable.

Objectives and actions

The objectives for the conservation of bats in Utah are the maintenance of sustainable natural populations and distributions of all species of bats in Utah through the minimization of threats to, or stressors on, their populations. Bats are vulnerable to many threats, both anthropogenic and natural. Their roosting requirements, roost fidelity, colonial habits (most species), low fecundity, and remarkable longevity all contribute to the vulnerability of their populations. Additionally, bat conservation in Utah is hampered by the need for more complete information about the ecology, life history, population biology, and distribution of the bat species of this state; the acquisition of this information is needed in order to inform and to guide management.

Natural threats that negatively impact Utah bats include:

- **drought:** Reduction or complete loss of surface water causes impoverishment of riparian and other vegetation, reduction of associated insect food sources, and loss of required drinking water.

- **fire:** Fire results in loss of bat foraging and roosting habitat.

- **bark beetle kill:** Bark beetles kill vast stands of trees (e.g., spruce), resulting in loss of forest habitat. (Although some kinds of beetles are important prey for several species of bats that occur in Utah, bark beetles are not, being too small.)

Minimization or control of these natural factors is carried out for human purposes, mostly economic, and special attention to these threats and special actions to control them in order to benefit bats in Utah is unnecessary. (Spraying of forests with insecticides to control bark beetles or other forest pests, however, can be very injurious to bats and should be carried out with caution.)

Thus, it is the minimization of anthropogenic threats and the acquisition of knowledge needed to guide management of bats in Utah that are the focus of this plan. Nineteen objectives and 51 needed actions for bat management in Utah are provided below.

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Objective

- Minimize bat mortality or injury from scientific research and collection.

Problem

- Collecting of some species is considered a serious threat (e.g., see Oliver 2000, especially p 91 but also pp 12, 112, 123–124).
- Banding is also a threat, some species being especially vulnerable to debilitating effects, disease, and death as a result of banding (e.g., Townsend's big-eared bat, *Corynorhinus townsendii*).

- Collecting and researcher disturbance in nursery colonies also results in reduction of the colony or abandonment (see Oliver 2000, pp 20, 30, 83, 96, 104, 105, 118).
- Release of bats in daylight results in high rates of unnatural predation by hawks (see Oliver 2000, pp 83, 90–91, 112, 118).
- Some bat species are fragile, being especially susceptible to injury and death during capture and handling (see Oliver 2000, pp 89–90).
- Researcher disturbance of hibernating bats causes premature arousal and depletion of fat reserves and reduces likelihood of survival (see Oliver 2000, pp 12–13).
- Transmission of diseases such as white nose syndrome cause very serious population declines, and it is believed that bat research and other human activities may be involved in such disease transmission.

Actions

- Continue to protect all bats in Utah, under State Rule R657-3-23, as prohibited for collection, importation, or possession, except by special permit from UDWR (see below).
- Continue to control and to regulate research activities pertaining to bats in Utah, including collecting, handling, banding, and disturbance of Utah bats, through the Certificate of Registration (COR) permitting process of the UDWR, which involves review of requests to capture, handle, or collect bats in Utah. Discourage or prohibit attachment of radiotelemetric devices (transmitters) or chemoluminescent devices to bats. Discourage or prohibit taking of wing punches from bats.
- Require that mist nets used for the capture of bats be monitored at all times or at intervals not exceeding 15 minutes.
- Require that captured bats be released only at night and be held for the shortest time possible.
- Encourage special care, when mist nets are used, in the handling of the spotted bat (*Euderma maculatum*) if this species is captured intentionally or inadvertently, and require release of this species within 15 minutes of capture.
- Discourage banding of all bats, and prohibit banding of most species, especially plecotine bats (Townsend's big-eared bat, *Corynorhinus townsendii*, Allen's big-eared bat, *Idionycteris phyllotis*, and the spotted bat, *Euderma maculatum*).
- Discourage entry into occupied roosts (e.g., mines, caves, attics, abandoned buildings)—especially maternity, nursery, and hibernation roosts. If there are needs to enter roosts in order to obtain information necessary for management (e.g., for population monitoring), prohibit touching or handling or bats, and encourage minimization of disturbances from sound, light, and close approach.
- Encourage and require appropriate biosecurity in bat research and other bat work in Utah. Between uses, wash bags or other containers used for temporary holding of live bats. Between entries into roosts (such as caves or mines), especially during cool seasons, thoroughly decontaminate

Proposal

clothing, shoes, and equipment. See the Western Bat Working Group's recommendations concerning white nose syndrome,

http://www.wbwg.org/conservation/whitenosesyndrome/Rationale%20WBWG%20Final%205-5-08.pdf

Objective

- Minimize bat mortality, especially the destruction of maternity and nursery colonies, from eradication or extermination ("pest" or nuisance control).

Problem

- Bats inhabiting homes (attics, walls) and other buildings frequently are exterminated or are entombed (sealed in) (see Oliver 2000, p 13, 105, 112). Since such roosts frequently are maternity and nursery colonies, the impacts of "control" are especially severe.

Actions

- Minimize the use of lethal methods in dealing with nuisance bats, such as colonies in houses or other buildings.
- Encourage proper methods for exclusion of bats from houses or buildings or alteration of illumination (see Oliver 2000, p 13). See Bat Conservation International's recommendations for the exclusion of bats:

http://www.batcon.org/home/index.asp?idPage=51
http://www.batcon.org/home/index.asp?idPage=51&idSubPage=48
http://www.batcon.org/home/index.asp?idPage=51&idSubPage=49

- Continue to require pest control companies to obtain Certificates of Registration for any work that they do with bats. Consider providing on-line (web-based) training and testing for pest control workers who wish to do bat exclusions or other work with nuisance bats.
- When exclusions are carried out, strongly encourage that this be done between 15 September and 31 October or between 15 March and 30 April in order to avoid exclusion when the bats are entering hibernation (winter) and when maternity and nursery activities are taking place (summer).

Objective

- Minimize persecution of bats and vandalism of bat roosts.

Problem

- Deliberate, malicious persecution of bats commonly occurs in Utah and elsewhere (see Oliver 2000, pp 37, 83, 105–106, 112). The bats most susceptible to persecution are those that roost communally and that prefer roosts that are easily accessible to people, such as abandoned buildings, abandoned mines, and natural caves. Not only are bats maliciously killed, but such vandalism also results in abandonment of roosts, including maternity and nursery roosts.

Proposal

Actions

- Protect cave (McCracken 1989) and abandoned mine roosts using bat gates or enforcement. See the Bat Conservation International (BCI) web site ("Bats and Mines"),

http://www.batcon.org/home/index.asp?idPage=53&idSubPage=87

and (caves, mines, bat gates),

http://www.mcrcc.osmre.gov/PDF/Forums/Bat%20Gate%20Design/TOC.pdf

- Since persecution and vandalism are largely the result of ignorance, provide education concerning bats—their natural value and their benefits to human economic and other interests—and education concerning the protected status of bats in Utah. Continue UDWR's Conservation Outreach Section's workshops and educational activities for students, teachers, and the public concerning bats, and continue to make the education trunk of bat educational materials available to teachers. Provide educational material pertaining to bats and informational materials pertaining to the protected status of bats in Utah at UDWR's web site.
- Inform UDWR's Law Enforcement Section and other enforcement agencies in Utah concerning the various kinds of persecution and vandalism problems, including destruction of bat gates at mines and caves, and work with these agencies to provide more effective enforcement of laws that protect bats.

Proposal

Objective

- Minimize of bat mortality from the use of pesticides.

Problem

- Pesticides used for mosquito abatement, for control of agricultural pests, and for control of forest (timber) pests have seriously negative effects on bats and bat populations in Utah and elsewhere (see Oliver 2000, pp 12, 37, 43, 67, 75, 83, 118). The use of pesticides is a serious threat to bats because of their food habits, their metabolism, their migratory habits, and their longevity, and is also a threat to other wildlife (e.g., peregrine falcon, osprey, bald eagle) and to people.

Actions

- Encourage use of alternatives to pesticides for mosquito abatement. For example, encourage use of fish (e.g., the least chub) that feed on the larvae of mosquitoes, such as in backyard artificial fish pools or ponds.
- Encourage development of alternatives for control of agricultural pests and forest (timber) pests (e.g., gypsy moth traps).

Objective

- Maintain artificial roosts used by bats, and minimize of negative effects caused by closures.

Problem

- Closures of abandoned mines (and similar artificial landscape features such as old highway or railroad tunnels) negatively impact bats that utilize these sites (see Oliver 2000, p 51, 96, 106). Since abandoned mines are among the preferred sites used for maternity and nursery roosts and as hibernacula by various Utah bat species (especially Townsend's big-eared bat, *Corynorhinus townsendii*), and since natural caves that might serve as substitute roost sites are exceedingly scarce in Utah, the negative impacts of such closures can be great. Abandoned uranium mines and other abandoned mines with high levels of natural radiation present special problems, especially to maternity and nursery colonies of bats, and require special consideration.

Actions

- Encourage the Utah Division of Oil, Gas and Mining's (UDOGM) Abandoned Mine Reclamation Program (AMRP) to continue to conduct its surveys of abandoned mines to determine bat use.
- Encourage UDOGM's AMRP to continue, whenever feasible, not to close abandoned mines used by bats but instead to install bat gates at entrances to such mines to ensure human safety and to prevent vandalism of bat colonies.
- Encourage others such as the Utah Department of Transportation (UDOT) and railroad companies not to close or to destroy inactive highway or railway tunnels and bridges used as roosts by bats.
- When gating of abandoned mines is not possible or practical, encourage exclusion of bats prior to closures to prevent entombment of bats.
- When exclusions are carried out, require or strongly encourage that this be done between 15 September and 31 October or between 15 March and 30 April in order to avoid exclusion when the bats are entering hibernation (winter) and when maternity and nursery activities are taking place (summer).
- Create and provide a policy to guide closure versus bat-gating of abandoned uranium mines and other abandoned mines that have radiation levels potentially dangerous or injurious to bats.

Objective

- Minimize bat mortality from toxic ponds associated with resource extraction.

Problem

- Toxic ponds associated with mining operations and oil and gas extraction (settling ponds and basins) poison bats that drink from these ponds. "This problem may be particularly severe in desert areas, where water

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associated with mining operations may be the only water in an area" (Pierson et al. 1999).

Actions

- Strongly encourage that toxic ponds associated with mining (e.g., cyanide, sulfuric acid) and hydrocarbon extraction (e.g., oil and gas drilling) be covered with wire netting or otherwise made inaccessible to bats and other wildlife.
- Encourage use of closed-loop systems for drilling muds in hydrocarbon extraction instead of open ponds whenever possible to avoid creation of settling ponds.

Objective

- Minimize loss or degradation of habitat of forest-dwelling bats.

Problem

- Timber harvesting can eliminate or degrade habitats of forest-dwelling bats (see Oliver 2000, pp 67). "Forest management", in which practices such as thinning of trees, removal of fuel loads (including snags), and creation of open understories are carried out, can degrade critical habitats for forest-dwelling bats. For example, one of the rarest bats in Utah and America, Allen's big-eared bat (*Idionycteris phyllotis*), almost completely disappeared from forests in New Mexico after forest management was implemented (Lewis 2005).

Actions

- Timber harvest should be carefully planned and practiced in limited block sizes when possible, especially in areas where rare bat species occur.
- Encourage appropriate consideration (e.g., in forest plans) to the balance between forest management practices and the management for wildlife species including bats, on a site-by-site basis.

Objective

- Minimize loss or degradation of riparian habitats used by bats.

Problem

- Practices such as phreatophyte control destroy riparian habitats. Impoundment (reservoir building), channelization, and diversion degrade or destroy riparian habitats.

- **Actions**
- Encourage, when possible, and to the extent that is practical, the exclusion of livestock from riparian zones or certain parts of riparian zones. Strongly discourage all phreatophyte control practices such as clearing of riparian corridors and use of phytocides, especially those added to streams.

Proposal

- Provided information to stockmen concerning livestock tank design and escape features for bats and other wildlife (e.g., birds)—see BCI web site, "Water for Wildlife",

http://www.batcon.org/news2/pdf/bciwaterforwildlife.pdf

- Discourage channelization of watercourses.
- Encourage planning for road building to avoid riparian zones, and encourage bridge building projects to minimize destruction of riparian vegetation and negative impacts to streams.

Objective

- Minimize disturbance of bat roosts.

Problem

- Recreational caving and rock climbing result in disturbance and potential abandonment of bat roosts.

Actions

- Encourage the National Park Service (NPS), the Utah Division of Parks and Recreation (UDPR), and other land management agencies to regulate recreational caving and rock climbing carefully in state and national parks and on other public lands in Utah with consideration of the fact that most of the bat species in Utah roost in either crevices in cliff faces or caves.
- Provide information concerning bas and their roosts to rock-climbing and caving groups.

Proposal

Objective

- Minimize loss or degradation of water sources of critical importance to bats.

Problem

- Draining, depletion, and diversion of surface water, as well as other alterations that make water unavailable to or unsuitable for bats (e.g., boxing, capping, or filling of springs), negatively impacts all bats. Bat species that have smaller foraging ranges or typically fly only short distances in a single night, species that are strongly associated with water, and species that have poor urine-concentrating ability are especially vulnerable to water removal (e.g., the little brown myotis, *Myotis lucifugus*, the Yuma myotis, *Myotis yumanensis*, the long-legged myotis, *Myotis volans*, and Townsend's big-eared bat, *Corynorhinus townsendii*).

Action

- Discourage alterations that remove surface water or that make surface water unavailable to bats, such as draining of wetlands, stream diversions, and most alterations of springs.

Objective

- Minimize loss of critical habitats (plant associations) used by bats in Utah

Problem

- Bats inhabit and are dependent upon all habitats (plant associations) that exist in Utah except for extensive salt flats and alpine tundra. Loss of riparian habitat negatively impacts most, if not all, Utah bats, but is most critical for foliage roosting species and foliage gleaning species. Conversion of piñon–juniper woodland to other habitat types can be expected to impact some bat species (e.g., the long-eared myotis, *Myotis evotis*) negatively. Clear-cutting of forests negatively impacts forest-dwelling bats. Clearing of natural habitats for agriculture, grazing, urban expansion, and other purposes destroys bat habitats. (See Oliver 2000, pp 25, 58, 62, 75.)

Action

- Encourage consideration of habitat requirements for bats in plans for, or that involve, habitat conversions.

Objective

- Minimize bat mortality from wind energy production.

Problem

- There is much recent concern about the effects of arrays of wind turbines (wind farms) on bats. Direct mortality, especially of migratory bat species, has been found to be very high in some studies. Some recent research has shown that bats are pulled or perhaps even attracted to the turbine blades, thus maximizing mortality. Design of the turbines (e.g., slower moving blades), site placement of wind farms, and times of operation are important factors that can be controlled and that should be considered in the planning, the construction, and the operation of wind farms. See Kunz et al. (2007),

  http://www.nationalwind.org/pdf/Nocturnal_MM_Final-JWM.pdf

  the National Wind Coordinating Collaborative's "Wind Turbine and Interactions with Birds and Bats: A summary of Research Results and Remaining Questions",

  http://www.nationalwind.org/publications/wildlife/wildlife_factsheet.pdf

  and U. S. Fish and Wildlife Service's recommendations concerning wind farms,

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http://www.fws.gov/habitatconservation/wind.pdf

Actions

- Encourage or require that prospective wind farm sites be surveyed for bats during spring and fall (migration) and during summer (breeding) prior to site development.
- Encourage or require that wind farm site placement be adjusted to avoid areas of greatest bat use and movements and as far as feasible from known roosts of colonial bats.
- Encourage or require that wind turbines of designs known to be less destructive to bats be used instead of those that are more destructive to bats.
- Encourage or require that wind turbines be operated during daylight rather than during darkness.
- Encourage or require that wind turbines be operated at wind speeds and turbine speeds that result in the fewest bat strikes and at turbine speeds that do not cause negative pressure that is lethal or debilitating to bats.

Objective

- Acquire knowledge of the biology of bat species in Utah.

Problem

- Aspects of the basic biology of many of the bat species that occur in Utah are unknown (e.g., where they roost during the day, what they do during winter, where they give birth to and nurse their dependent young). See "unknown" entries in species summaries above and species accounts in Oliver 2000.

Action

- Conduct and encourage research focused on aspects of basic biology, ecology, and life history of Utah bats, especially those aspects that are relevant to the management of these species. Many of the unknown aspects of the biology of Utah bats would be suitable subjects for graduate student research.

Objective

- Acquire knowledge of the geographical distribution and abundance of bat species in Utah, as well as trends (changes) in their distribution and abundance.

Problem

- Incomplete knowledge of distribution and abundance and complete lack of knowledge of population trends of bat species in Utah currently impedes effective management. Population monitoring is the most important tool for guiding, evaluating, and adapting bat management.

Actions

Proposal

- Conduct systematic statewide surveys of all bat species in order to clarify their distributions in Utah, to determine their abundances in Utah, and to detect changes in both abundance and distribution.
- Develop methods, currently lacking, for monitoring of bat populations.

Objective

- Acquire knowledge of the locations of all surface water bodies in Utah.

Problem

- All bats in Utah are dependent upon surface water (i.e., fresh water, for drinking and in some species for foraging); thus knowledge of the locations of these aquatic sites is of critical importance for the effective management of bats in Utah, especially those species that are most strongly tied to water sources because of short flight distance, strong association with water, and poor urine-concentrating ability.

Action

- Create a catalogue of all surface fresh waters in Utah, including very small ones such as livestock tanks.

Objective

- Acquire knowledge concerning migration patterns of bats in Utah.

Problem

- If corridors and stop-over sites are used by migratory species of bats in Utah, this information is needed to enable planning that would reduce the negative impacts of wind energy development and placement of communication towers.

Action

- Investigate migration and identify migratory corridors and stop-over sites, if any, of bats in Utah.

Objective

- Acquire knowledge of responses of bat species in Utah to habitat alterations.

Problem

- Effects (positive and negative) of habitat management and habitat manipulations on bats in Utah are unknown.

Action

- Evaluate effects of specific habitat management practices and habitat treatments on bat populations and bat communities for all habitat types in Utah. Such research may be appropriate for graduate student projects.

Proposal

Objective

- Acquire knowledge of responses of bat species in Utah to invasive nonnative plant species.

Problem

- The effects of invasive nonnative plant species (e.g., cheatgrass, tamarisk) on bats are unknown.

Action

- Investigate the effects of invasive nonnative plant species on bats, and, if effects are negative, evaluate the potential for restoration of invaded areas in Utah.

Objective

- Acquire knowledge concerning the effects of various forms of development on bats in Utah.

Problem

- Development is proceeding very rapidly in Utah in conjunction with rapid growth of the human population. Understanding of ways to make development more compatible with maintaining bat populations (i.e., less deleterious to bats, more favorable to bats) is needed.

Action

- Encourage developers to incorporate bat-friendly practices in project planning.
- Evaluate practices and designs intended to reduce negative impacts on bats for various kinds of development including wind farms, communication towers, oil and gas exploration and extraction, mining, agriculture, and urban expansion.
- Investigate and promote practices and designs (e.g., bat-friendly bridges) that benefit bats.

Proposal

Implementation of data collection

Beginning in 2006, the U. S. Department of Defense (DoD) funded an on-going series of initiatives that are being carried out in collaboration with UDWR. The initiatives are intended to address and to fill many of the knowledge gaps and the information needs that limit informed guidance of bat management in Utah, as discussed in this conservation plan. These initiatives are called Legacy I, Legacy II, and Legacy III. For detailed description of Legacy I, see

https://utahbats.org/docs/phase1.pdf

and for Legacy II see

https://utahbats.org/docs/phase2.pdf

Brief summaries of Legacy I–III are provided below.

Legacy I

Assemblage of all locational and associated data for bats in Utah was accomplished under Legacy I, resulting in the compilation of many thousands of records in a database completed in 2008.

Legacy II

Beginning in 2008, the main goal of Legacy II is to analyze the data assembled under Legacy I. Field work (bat inventory and monitoring) will also be carried out as part of Legacy II. A Utah bat database, "BatBase", is being constructed. Bat researchers are encouraged to contribute Utah bat data to this database.

Legacy III

It is anticipated that Legacy III will implement intensive inventory and monitoring of Utah bats.

Proposal

Tools for implementing actions

Species identification and collection of data

Various published references can be used for field (and laboratory) identification of bats found in Utah. A field key for identification of bats in hand in Utah is provided as Appendix 2 (Witt, Kozlowski, and Oliver), a field protocol for recording bat data as Appendix 3 (Kozlowski), and a field key for acoustic identification of Utah bats as Appendix 4 (Probasco). See also O'Farrell et al. (1999) concerning acoustic identification of bats and Miller (2001) for use of acoustic methods to determine relative activity of bats.

Survey methods

The Western Bat Working Group (2003) produced a "Recommended Survey Methods Matrix" for bat species in western America and Canada using four methods commonly used in bat field surveys: mist-net capture, roost survey, "passive acoustic" (i.e., electronic bat sonar detection device alone), and "active acoustic" (i.e., electronic bat sonar detection device together with visual observation of behavior or appearance). This survey methods matrix is intended as a first step in the development of a bat survey protocol being produced by some of the participants in the WBWG. (If such a protocol becomes available, it will be referenced, summarized, or included in a future edition of this conservation plan.) For the 19 bat species known to occur in Utah, the survey

methods matrix (WBWG 2003) is provided below. The possible values for the four methods, as applied to each bat species (WBWG 2003), are:

1 = preferred or highly effective
2 = effective in most habitats
3 = effective in some habitats
4 = presenting serious challenges
5 = generally not effective
U = unknown

species	net	roost	acoust. (pass.)	acoust. (act.)
M. lucifugus, little brown myotis	2	3	4	3
M. occultus, Arizona myotis	2	3	4	4
M. yumanensis, Yuma myotis	1	2	3	1
M. evotis, long-eared myotis	1	3	2	2
M. thysanodes, fringed myotis	1	3	2	2
M. volans, long-legged myotis	2	2	4	3
M. californicus, California myotis	1	4	3	1
M. ciliolabrum, w. small-footed myotis	2	3	4	4
L. blossevillii, western red bat	3	5	2	1
L. cinereus, hoary bat	3	5	2	1
L. noctivagans, silver-haired bat	1	5	4	2
P. hesperus, western pipistrelle	2	5	1	1
E. fuscus, big brown bat	1	3	3	1
E. maculatum, spotted bat	3	5	2	1
I. phyllotis, Allen's big-eared bat	3	3	2	2

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C. townsendii, Townsend's big-eared b.	3	2	4	4
A. pallidus, pallid bat	1	3	2	1
T. brasiliensis, Brazilian free-tailed bat	2	1	1	1
N. macrotis, big free-tailed bat	3	5	1	1

Additional notes provided by the WBWG (2003) for use with the above matrix are reproduced below (very slightly modified here for clarity). Some of the bat species mentioned in comparisons below do not occur in or near Utah and are not mentioned elsewhere in this document.

***Myotis lucifugus*, little brown myotis**. **Netting**. Capture: Readily netted in some areas; net-avoidant in others. ID: Morphologically similar to *M. yumanensis* and *M. occultus*. Can be reliably identified using combination of morphological and acoustic data. **Roost**. Location: Frequently in man-made roosts (mines, bridges, buildings) in parts of its range. Difficult to find in most natural roosts (e.g., trees and rock crevices). Sometimes found in night roosts. ID: Highly colonial and easy to detect in man-made roosts. Often requires handling for positive identification. **Passive acoustic**. Detection: Easy to detect acoustically. ID: Some calls/sequences diagnostic, though probably not distinguishable from *M. occultus* in areas of geographic overlap. Difficult to distinguish from other 40-kHz *Myotis*. **Active acoustic**. Flight behavior sometimes distinctive, particularly over water.

***Myotis occultus*, Arizona myotis**. **Netting**. Capture: Fairly easy to capture in nets. ID: May be difficult to distinguish from *M. lucifugus* in areas of overlap. **Roost**. Location: Roost in man-made roosts, but natural roosts dominate. Can often be found in night roosts. ID: Easy to detect in man-made roosts; difficult in most natural roosts. Often requires handling for positive identification. **Passive acoustic**. Detection: Easy to detect acoustically. ID: Issues currently unresolved but probably difficult to distinguish acoustically from other 40-kHz *Myotis*. **Active acoustic.** Difficult to distinguish visually.

***Myotis yumanensis*, Yuma myotis**. **Netting**. Capture: Water-skimming foraging style makes this species highly vulnerable to capture in mist-nets set over still water. ID: Morphologically similar to *M. lucifugus* and *M. occultus*. Can be distinguished from *M. lucifugus* and *M. occultus* by combination of capture and recording of hand-release echolocation call. **Roost**. Location: Commonly in man-made roosts. Form large aggregations in night roosts (particularly bridges). Difficult to locate most natural roosts. ID: Highly colonial and easy to detect in man-made roosts. Requires handling for positive identification. **Passive acoustic**. Detection: Easy to detect acoustically. ID: Difficult to distinguish from

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M. californicus, though some calls diagnostic (50-kHz *Myotis*). **Active acoustic**. Flight behavior, particularly water skimming, distinctive.

***Myotis evotis*, long-eared myotis**. **Netting**. Capture: Readily captured in mist nets at both aquatic and terrestrial sites. ID: Morphologically distinct except in areas of overlap with *M. auriculus*, *M. keenii*, or *M. septentrionalis*. Also similarity to *M. thysanodes* in some regions. **Roost**. Location: Can be detected in man-made roosts, but often cryptic; difficult in most natural roosts (e.g., trees and rock crevices). Natural roosts dominate. Sometimes in night roosts, particularly mines and bridges, although extent to which these features are used varies regionally. ID: Small colonies. Generally crevice roosting. Often requires handling for positive identification. **Passive acoustic**. Detection: Intermediate intensity calls. ID: Subset of sequences diagnostic except in area of geographic overlap with *M. auriculus*, *M. septentrionalis*, or possibly *M. keenii*. Also possible confusion under some habitat conditions with 40-kHz *Myotis*. **Active acoustic**. May be helpful in distinguishing it from short-eared *Myotis*.

***Myotis thysanodes*, fringed myotis**. **Netting.** Capture: Readily captured in mist nets (often on secondary streams in northwestern portion of range). ID: Generally easy, but morphologically similar to *M. evotis* in some regions. **Roosts**. Location: Can be detected in man-made roosts, but difficult in most natural roosts (e.g., trees and rock crevices). Natural roosts dominate. Sometimes found in night roosts. ID: Small colonies and often in crevices. Requires handling for positive identification. **Passive acoustic**. Detection: Intermediate intensity calls. ID: Many sequences/calls diagnostic. Possible confusion with *A. pallidus*. **Active acoustic**. Flight behavior, in combination with call morphology, sometimes helpful.

***Myotis volans*, long-legged myotis**. **Netting**. Capture: Effectiveness of netting varies regionally, and setting makes a difference. ID: Morphologically distinct. **Roost**. Location: Can be found in man-made roosts; difficult in most natural roosts. Natural roosts dominate. Often found in night roosts. ID: Requires handling for positive identification. **Passive acoustic**. Detection: Easy to detect acoustically. ID: Issues currently unresolved with other 40-kHz *Myotis*. **Active acoustic**. Flight behavior can be distinctive (long tail membrane).

***Myotis californicus*, California myotis**. **Netting**. Capture: Readily captured in mist nets. ID: Morphologically similar to *M. ciliolabrum*. Can be distinguished from *M. ciliolabrum* by combination of capture and recording of hand-release echolocation call. **Roost**. Location: Can be found in man-made roosts, but generally non-colonial and crevice-roosting; most roosts not man-made and difficult to find. Sometimes found in night roosts. ID: Requires handling for positive identification. **Passive acoustic**. Detection: Easy. ID: Difficult to distinguish from *Myotis yumanensis* (50-kHz *Myotis*). **Active acoustic**. Flight behavior distinguishes it from *M. yumanensis* in most settings.

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***Myotis ciliolabrum*, western small-footed myotis**. **Netting**. Capture: Readily captured in nets in some portions of its range, but vulnerability to netting may vary regionally. ID: Morphologically similar to *M. californicus*. Can be reliably identified using combination of morphological and acoustic data. **Roost**. Location: Predominantly non-colonial. Frequently in mines, but natural roosts likely dominate and difficult to find. Sometimes found in night roosts. ID: Roost in small groups. Requires handling for positive identification. **Passive acoustic**. Detection: Easy to detect acoustically. ID: Not currently distinguishable from other 40-kHz *Myotis*. **Active acoustic**. Can sometimes be distinguished when observed in flight, but requires experience.

***Lasiurus blossevillii*, western red bat**. **Netting**. Capture: Sometimes captured in mist nets, but foraging areas often not suitable for netting (e.g., over large water sources). ID: Morphologically distinct except where overlaps with *L. borealis*. **Roost**. Location: Non-colonial. Very difficult to locate tree roosts. ID: Difficult to locate bats in foliage, easy to ID except where overlaps with *L. borealis*. **Passive acoustic**. Detection: Easy to detect acoustically. ID: Most sequences diagnostic in areas without *L. borealis*. In areas with *L. borealis*, extensive acoustic overlap, but probably distinguishable statistically. Some acoustic overlap with *P. hesperus*. **Active acoustic**. Distinctive in flight except in areas with *L. borealis*.

***Lasiurus cinereus*, hoary bat**. **Netting**. Capture: Fly high; often under-represented in net captures. Often foraging in areas that cannot be feasibly netted. ID: Morphologically distinct. **Roost**. Location: Non-colonial. Very difficult to locate tree roosts. ID: Difficult to locate bats in foliage but easy to distinguish from other species. **Passive acoustic**. Detection: Easy to detect acoustically. ID: Many calls diagnostic throughout much of its range; subset of calls overlap with *T. brasiliensis* and *N. femorosaccus*. **Active acoustic**. Distinctive in flight.

***Lasionycteris noctivagans*, silver-haired bat**. **Netting**. Capture: Vulnerability to net capture varies with habitat, but generally quite susceptible to capture. Captured over water sources (large and small). ID: Morphologically distinct. **Roost**. Location: Very difficult to locate in natural roosts (e.g., trees and snags). ID: Unlikely to locate via roost search but, can be distinguished visually in flight upon exit. **Passive acoustic**. Detection: Easy to detect acoustically. ID: Some calls distinctive, but overlap with *T. brasiliensis* and *E. fuscus*. In areas without *T. brasiliensis*, many sequences are diagnostic. **Active acoustic**. With experience can be distinguished visually in flight.

***Parastrellus hesperus*, western pipistrelle**. **Netting**. Capture: Captured in nets fairly readily, although often fly high. ID: Morphologically distinct. **Roost**. Location: Predominantly cliff-roosting. Some roosting in man-made structures, particularly mines. ID: Usually non-colonial or small colonies. Can be identified visually at very close range. **Passive acoustic**. Detection: Easy to detect

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acoustically. ID: Most calls diagnostic, although some overlap with *L. blossevillii*. **Active acoustic**. Visually distinctive.

***Eptesicus fuscus*, big brown bat**. **Netting**. Capture: Readily captured in mist nets, but problematic in open areas, especially where water is abundant. ID: Morphologically distinct. **Roost**. Location: Easy to locate man-made roosts; difficult in most natural roosts (e.g., trees and rock crevices). Natural roosts dominate throughout much of range. Night roost surveys often effective. ID: Colonies often conspicuous, species easy to ID. **Passive acoustic**. Detection: Easy. ID: subset of sequences diagnostic acoustic overlap with *L. noctivagans* and *T. brasiliensis*. **Active acoustic**. Visually distinctive in flight.

***Euderma maculatum*, spotted bat**. **Netting**. Capture: Can be effective where water is a limiting factor in xeric conditions, although netting is not effective in many portions of range. ID: Morphologically distinct. **Roost**. Location: Non-colonial, cliff-roosting; very difficult to locate and generally inaccessible. ID: Unknown; no roosts have been visually inspected; only locations have been from a distance using radio-telemetry. **Passive acoustic**. Detection: Easy to detect acoustically (with microphones sensitive to audible frequencies). Calls are audible to many people. ID: Most sequences diagnostic, except in areas of geographic overlap with *I. phyllotis*. **Active acoustic**. Difficult to distinguish from *I. phyllotis*; otherwise distinctive in flight.

***Idionycteris phyllotis*, Allen's big-eared bat**. **Netting**. Capture: Captured infrequently in mist nets; show loyalty to particular water sources, but may be difficult to locate in initial surveys. ID: Morphologically similar to *C. townsendii*. **Roost**. Location: Easy to detect in man-made roosts (e.g., mines); difficult in natural roosts (e.g., trees, rock crevices). ID: Easy: roost in clusters on open surface (e.g., domes of mines). May be confused with *C. townsendii*. **Passive acoustic**. Detection: Easy to detect acoustically (with low frequency microphone). ID: Most sequences diagnostic, except can be difficult to distinguish from *E. maculatum*. Geographic overlap with *E. maculatum* throughout much of its range. Highly distinctive social call. **Active acoustic**. Can be difficult to distinguish from *E. maculatum*.

***Corynorhinus townsendii*, Townsend's big-eared bat**. **Netting**. Capture: Effective at avoiding mist-nets. ID: Morphologically similar to *I. phyllotis*. **Roost**. Location: Most effectively found by searching for colonial roosts, in mines and caves. Roosts in buildings in coastal portion of range. Some portions of range, particularly Canada and some desert areas, roosts very difficult to locate. ID: Easy to locate and ID in roost. **Passive acoustic**. Detection: Difficult to detect acoustically, low intensity calls ("whispering bat"). ID: Calls, when detected, are diagnostic. **Active acoustic**. Visually distinctive in most settings.

***Antrozous pallidus*, pallid bat**. **Netting**. Capture: Fly low to ground and readily captured in nets (often in upland habitats). ID: Morphologically distinct. **Roost**.

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Location: Easy to detect colonies in man-made roosts; difficult in most natural roosts (e.g., trees and rock crevices). Frequently uses man-made roosts (mines, bridges, buildings) in parts of its range. Often found in night roosts, especially mines and bridges. ID: Roost conspicuously, easy to ID. Guano with characteristic culled insect parts (particularly Jerusalem crickets and scorpions) often distinctive. **Passive acoustic**. Detection: Easy to detect acoustically. ID: Subset of calls diagnostic, particularly if it gives a "directive" call. **Active acoustic**. Visually distinctive.

***Tadarida brasiliensis*, Brazilian free-tailed bat**. **Netting**. Capture: While sometimes captured in mist nets, this species flies high and is generally more abundant than net captures would suggest. ID: Generally distinctive, but potentially confused with *N. femorosaccus*. **Roost**. Location: Highly colonial and easy to detect in man-made roosts; difficult in most natural roosts. Natural roosts (e.g., cliff roosts) dominate in large portion of range. Commonly in man-made roosts in portion of its range. ID: Easy to locate and ID in most roosts. Guano and odor distinctive. **Passive acoustic**. Detection: Easy to detect acoustically. ID: Some calls overlap with other species (*L. noctivagans*, *E. fuscus*, *L. cinereus*, *N. femorosaccus*), but fair proportion are diagnostic. In most settings this would be the easiest way to detect the species. **Active acoustic**. Visually distinctive except where overlaps with *N. femorosaccus*.

***Nyctinomops macrotis*, big free-tailed bat**. **Netting**. Capture: Records extremely limited suggesting serious challenges. ID: Morphologically distinct. **Roost**. Location: Generally cliffs and rock crevices; often inaccessible. Also known to use building and tree roosts. Guano deposits and chatter can potentially be used to locate roosts, but generally not effective. ID: Generally requires monitoring at emergence. **Passive acoustic.** Detection: Easy to detect acoustically (best with low frequency microphone); calls in audible range for some people. ID: Most calls diagnostic, but overlap with *E. underwoodi* and possibly *E. perotis*. Species poorly known. **Active acoustic**. Indistinguishable from *Eumops* spp. in flight.

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Predictive bat habitat model

A model of predictive habitat suitability for bats, adapted from that of Keinath (2001) for use in bat surveys, has been developed by Green and Kozlowski (UDWR, TNC, UBCC) for Utah (Appendix 5). This predictive model of bat habitat suitability has been used to produce a map of predicted important bat habitat in Utah, which can be used in field surveys and for other purposes.

Frequently asked questions

How can I get rid of bats in my attic, walls, or other parts of my house?

It is illegal to kill bats in Utah. All bats in Utah are protected wildlife under state rule and are under the management authority of the Utah Division of Wildlife Resources. If you work with a pest control company, choose a responsible one that has a permit, called a Certificate of Registration, from the Utah Division of Wildlife Resources, and be certain that the pest control company and its employees understand that they are not allowed to harm or to kill any bats. However, it is easy and much less expensive to do it yourself. In most cases homeowners can easily exclude bats from a residence without harming the bats and at little or no cost. The web sites of Bat Conservation International (BCI) and Internet Center for Wildlife Damage Management provide details on how to do this:

http://www.batcon.org/home/index.asp?idPage=51
http://www.batcon.org/home/index.asp?idPage=51&idSubPage=48
http://www.batcon.org/home/index.asp?idPage=51&idSubPage=49
http://icwdm.org/wildlife/bat/bat.asp

Be sure not to touch the bats—there is no need to touch any bats when using this procedure. Basically, you would need to observe your house in the evening to determine where the bats exit the attic and then to tape plastic sheeting over the exit openings. (There may be several places that the bats exit and enter the attic.) The tape should attach the top and both sides of the piece of plastic sheeting to the structure, but not the bottom, which should extend down several inches below the opening. The plastic could be whatever you have available, even pieces cut from a plastic bag. Bats in the attic will crawl down and out through the unattached bottom of the plastic. When the bats return, they will not be able to find a way back into the attic because of the plastic, provided that you put plastic, in the way mentioned, over all of their exit and entrance points.

It is best to do this between 15 September and 31 October or between 15 March and 30 April in order to avoid exclusion when the bats are going into hibernation (winter) and when maternity and nursery activities are taking place (summer). In summer there may be young bats, perhaps still nursing and too young to fly, that would die in the attic as a result of having their mothers prevented from caring for them. In winter there is some bat activity on warmer nights, and bats could be excluded when access to the hibernation roost is critical for their survival.

You could also consider allowing the bats to remain in the attic. Unless you or your family members regularly enter the attic, it is unlikely that the presence of the bats would represent any health threat to you or your family. Another option would be to provide bats with other roost options by installing bat houses on your property. The BCI web site mentioned above provides plans for constructing bat

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houses and suggestions for their placement (see below). Bat houses could be used in combination with the exclusion technique mentioned above.

How can I attract bats to my property?

Bats often are not very noticeable and can easily be missed even when they are present. Most of the bat species that occur in Utah produce vocalizations that are not audible to people. Thus, you may already have bats on your property or at least in the air space above your property. There are, however, various things that could enhance the attractiveness of your property to bats. You may wish to consider installing bat houses (artificial roosts) on your property. Bats require drinking water, and ponds are attractive to them. Many bats pick their prey from foliage, rather than in the air, and trees can provide suitable foraging sites. Trees also provide suitable roosts for some species of Utah bats. Some Utah bats roost among foliage and others use cavities in the trunks of trees.

Where can I get, or how can I build, a bat house?

Most commercially available bat houses are not adequate, being of poor design and too small. The web site of Bat Conservation International (BCI) provides very good plans for building bat houses:

http://www.batcon.org/home/index.asp?idPage=47
http://www.batcon.org/pdfs/BatHouseCriteria.pdf
http://www.batcon.org/pdfs/SingleChamberBHPlans.pdf

How can I get bats to use a bat house?

Success using bat houses is quite unpredictable. Installing a bat house of good design and of adequate size does not guarantee that the bats will use the bat house, even if many bats are present. Why this is so is not well understood, but it appears to be related to the placement of the bat house, especially relative to the sun, since temperatures in side the bat house must be within a certain range required by the bats. If you have installed bat houses but had no success in attracting bats to them even when bats are present, try, after a failed summer season, moving the bat houses to different locations, experimenting with whether the bat house is exposed to the sun, at what time of day its gets sun (if any), height above the ground, and its placement relative to trees, buildings, etc. The BCI web site discusses suitable placement for bat houses:

http://www.batcon.org/pdfs/BatHouseCriteria.pdf
http://www.batcon.org/pdfs/AttractingBats.pdf

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If I attract bats to my property, will they control mosquitoes?

Despite much misinformation in the popular media, bats in Utah and America do not control mosquitoes. While it may be true that many species of bats that occur in America *potentially* could eat 600 mosquitoes in an hour, it is unlikely that any actually do this. Most of the bats species that occur in Utah eat primarily moths, and those that do not eat primarily moths eat primarily beetles. Some of them probably do eat some mosquitoes, especially if they are not finding many moths to eat on a particular night, but none prefer or specialize in eating mosquitoes. If moths are available, even a medium-sized moth contains many times the energy or food value of a mosquito. Thus it's not worth the bat's expenditure of energy to pursue tiny prey like mosquitoes when there are bigger prey like moths to eat.

None of the above is meant to discourage you from trying to attract bats, such as by providing bat houses, but only to be truthful and not to create unrealistic expectations. Assuming that you were successful in attracting bats to occupy bat houses on your property, they might actually reduce the mosquito population somewhat.

There are many good reasons, aside from mosquito control, to seek to attract bats to your property. Bats are fascinating animals, and watching their evening exit flights from a bat house on summer nights can be very enjoyable. Also, some people put buckets or other containers beneath a bat house to collect the guano that falls from an occupied bat house. Bat guano is one of the best fertilizers known, and it is natural. It is sold in some nurseries and gardening stores in Utah for very high prices.

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If I find a bat, should I send it to be tested for rabies?

If you find a bat, it is best to leave it alone. Generally, unless a bat is known to have bitten someone or has been in room with a person who has been asleep or who is unable to communicate, there is no need to have the bat tested for rabies. However, if you have doubts, concerns, or questions about whether a bat should be tested for rabies, contact the Utah Department of Health.

The BCI web site answers many questions pertaining to bats and rabies:

http://www.batcon.org/home/index.asp?idPage=91&idSubPage=62

You can safely move a bat outside or away from a dwelling by scooping it up in a box or other container or, wearing heavy gloves, with your hands. If it is summer, place the bat in the shade, preferably in a tree or in an elevated situation and out of the reach of cats and dogs. If it is winter, place the bat in a sunny location,

near some protective cover that it can retreat to, and in an elevated situation from which it may be able to take flight.

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Appendix 1. Ecological integrity tables for Utah bats

Note: The *contents* of the following tables are in the public domain and may be freely shared. However, no one may take the integrity table blank template, which is the property of The Nature Conservancy, and claim ownership of it or attempt to sell it.

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Appendix 2. Field key for identification of bats in hand in Utah

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Appendix 3. Field protocol for recording bat data

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Appendix 4. Field key for acoustic identification of Utah bats

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Appendix 5. Predictive Utah bat habitat model

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