Townsend’s Big-eared Bat

Corynorhinus townsendii

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Written by Kent Woodruff and Howard Ferguson

GENERAL RANGE AND WASHINGTON DISTRIBUTION

Townsend’s big-eared bat (Townsend’s bat) occurs from Williams Lake in south-central British Columbia to Baja California, Sonora, and Oaxaca in Mexico, north through the central highlands of Mexico, central Texas, western Oklahoma, eastern Colorado, and central South Dakota, and northwest through central Montana to Creston, British Columbia. Isolated populations occur in the limestone regions of Missouri, Arkansas, Oklahoma, Kentucky, Virginia, and West Virginia (Barbour and Davis 1969, Hall 1981, Kunz and Martin 1982, van Zyll de Jong 1985, Nagorsen and Brigham 1993, Verts and Carraway 1998).

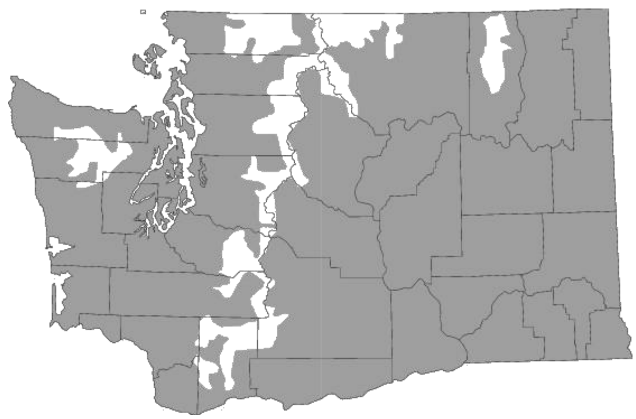

Figure 1. Potential range of the Townsend’s big-eared bat (*Corynorhinus townsendii*) in Washington based on Johnson and Cassidy’s (1997) habitat modeling analysis.

Townsend’s bats have been documented in nearly every county in Washington (Johnson and Cassidy 1997, Washington Department of Fish and Wildlife 2005). This species occurs statewide where there is suitable habitat (see Figure 1; Johnson and Cassidy 1997).

RATIONALE

The U.S. Fish and Wildlife Service has designated the Townsend’s bat as a Federal Species of Concern. Locally, this bat is a Candidate for the Washington Department of Fish and Wildlife’s Threatened and Endangered species list, and the U.S. Forest Service has designated it as a sensitive species for Washington (U.S. Forest Service 2004). Townsend’s bats are considered rare throughout their North American range (Fellers and Pierson 2002). Population declines have been noted in Washington (Senger 1973), Oregon (Perkins and Levesque 1987), and California (Pierson and Rainey 1998).

HABITAT REQUIREMENTS

Most bats in temperate climates have a strategy for survival where part of the time is spent foraging in various habitats, while the remaining time (daytime in summer, or for extended periods in winter) is spent in roosts. Most habitats in Washington are suitable for feeding by Townsend’s bats. However, the distribution of suitable roosts influences the actual locations where they are able to feed. Another limiting factor may be the availability of water, particularly in the arid regions of the Great Basin (Geluso 1978).

This species uses caves, mines, hollow trees, and built structures for roosting (Pearson et al. 1952, Graham 1966, Humphrey and Kunz 1976, Pierson 1988, Pierson et al. 1999). During summer, females roost in communal maternity colonies, while males roost solitarily or in small groups (Sherwin et al. 2003). Mixed-gender colonies have been documented in winter hibernacula (Doering 1996). No comprehensive studies of year-round habitat use by Townsend's bats exist. Therefore, a complete picture of this species' life history is unknown.

Vegetation

In Washington, Townsend's bats are found in westside lowland conifer-hardwood forest, ponderosa pine (*Pinus ponderosa*) forest and woodlands, mixed highland conifer forest, eastside mixed conifer forest, shrub-steppe, and both eastside and westside riparian-wetlands (Johnson and Cassidy 1997, Washington Department of Fish and Wildlife 2005). The current extent of suitable habitat is similar to the historical distribution for Townsend's bats in the interior Columbia basin (Wisdom et al. 2000).

Information about the effects of land management on habitat use by Townsend's bats is limited. In western Washington, Erickson and West (1996) found minor use of clearcuts and pre-commercially thinned Douglas-fir (*Pseudotsuga menziesii*) / western hemlock (*Tsuga heterophylla*) stands, and no use of young or mature stands.

Snags and large trees may be important roosts for this species. In northwestern California, Fellers and Pierson (2002) documented individual Townsend's bats using tree hollows created by fire or rot in very large redwood (*Sequoia sempervirens*) and California bay trees (*Umbellularia californica*). A nursery colony was found using the basal hollows of large redwood trees in northwestern California (Mazurek 2004) and in Muir Woods National Monument near San Francisco (Heady and Frick 2001).

Water

For many insectivorous bats, daily water requirements are mainly met through metabolic water (i.e., water generated by the biochemical processing of digested nutrients) or water contained in captured prey. Remaining water needs are met through drinking water gathered at ponds, streams, and artificial impoundments (Kurta 2000). Townsend's bats may depend to a greater extent on drinking water compared to other species (Geluso 1978). This species is known to lick water from the ceilings of caves (J. Nieland, Personal Communication).

Food

Townsend's bats are moth specialists but consume a variety of other arthropods when available (Ross 1967, Whitaker et al. 1977, Bauer 1986, Dalton et al. 1986, Sample and Whitmore 1993, Burford and Lacki 1998). The most common food gathering strategies are gleaning insects from foliage and hawking insects in flight (Fellers and Pierson 2002).

Townsend's bats lose an average of 1/4 to 1/2 of their body weight during winter hibernation (Humphrey and Kunz 1976, Wackenhut 1990). Therefore, when bats emerge from hibernation in early spring, fat reserves are depleted, and survival depends on finding insects. Females also need abundant food to provide nutrition to nursing young.

Insect populations change, sometimes drastically (e.g., moth "outbreaks") over the course of a season, a year, or several years (Wickman et al. 1993). It is probable that Townsend's bats opportunistically forage on the most available or abundant food and will alter their diet when another suitable food source becomes available. It is also possible that nursing females have different food and water requirements than males (Whitaker et al. 1977, Bauer 1986). The difficulty in determining specific food habits over time and space limits our understanding of how these bats adjust to changing insect fauna.

Roosts

Suitable roosts are critical components for survival of Townsend's bats. Roosts are used for hiding, resting, and to conserve energy or to meet various other needs. Temperature and substrate are likely key factors in determining which structures will be used for roosting. Pearson et al. (1952) noted that in all seasons, bats of either sex tended to be awake when roosting in places warmer than 17°C (62°F), while those roosting at lower temperatures were usually torpid (i.e., lowered body temperature to reduce energy loss).

Day Roosts. Day roosts are structures used during daylight hours in the active season (as opposed to the hibernation season) to rest or hide. In Washington, old buildings, silos, concrete bunkers, barns, caves, and mines are common roost structures (Washington Department of Fish and Wildlife 2005). Sherwin et al. (2000a) surveyed 820 potential roost sites in northern Utah in bridges, caves, and mines. One hundred ninety-six were used as day roosts by Townsend's bats. Caves and mines were found to be valuable day roosts while bridges were not. Individual males occasionally day-roosted in cave-like bridge abutments in California (Pierson et al. 2001)

Maternity/Nursery Roosts. These are day roosts used by females during the spring and summer to bear and care for young. Nursery roosts in Washington have been found in caves, mines, barns, abandoned houses, actively used buildings, concrete silos and bunkers, and large "rooms" in concrete dams (Washington Department of Fish and Wildlife 2005). Colonies typically contain 20 to 250 females (Pearson et al. 1952, Turner and Jones 1968, Humphrey and Kunz 1976, Perkins 1992, Pierson and Rainey 1998) that give birth to one young after a gestation period of 55-100 days (Pearson et al. 1952). Annual production in nursery colonies ranges from 20–90% of females raising volant (i.e., capable of flight) young (Pearson et al. 1952, Humphrey and Kunz 1976, Fellers 1993, Pierson and Fellers 1998).

Temperature within nursery roosts has long been considered a key factor for survival and development of young; however, recent studies at a number of Washington and Oregon sites indicate that a wide range of temperatures is tolerated by nursery colonies (H. Ferguson unpublished data, K. Woodruff unpublished data). Temperatures at maternity roosts in California ranged from 19^{o}C-30^{o}C (Pierson et al. 1991).

Newborn young have been observed in nursery colonies in Washington between June-mid July (Scheffer 1930, Dalquest 1947, H. Ferguson unpublished data, K. Woodruff unpublished data). Young can fly feebly at about three weeks of age, and are weaned by six weeks (Pearson et al. 1952). Summer colonies in Washington begin breaking up by early September (D. Young, Personal Communication, H. Ferguson unpublished data).

Although a comprehensive survey of available roosts has not been done in Washington, buildings are the most commonly reported nursery sites in the state (Washington Department of Fish and Wildlife 2005). In Washington and Oregon, Townsend's bats are known to use individual caves for both maternity roosting and winter hibernation. This phenomenon likely occurs at caves with complex features that produce appropriate airflow and temperatures in summer and winter (J. Nieland, Personal Communication).

Night Roosts. Night roosts are sites where bats digest food, rest, and seek safety from predators (Kunz and Martin 1982). These sites also facilitate social interaction among Townsend's bats (Kunz and Martin 1982). Unlike day roosts, these are very short-term roosts used for minutes to hours during the night as stopover hiding and resting places between feeding bouts. Beyond chance encounters with Townsend's bats in locations that are easy to access, little is known about the use of night roosts. Keely and Tuttle (1999) reported the use of bridges as day and night roosts by Townsend's bats in southwestern Oregon in July. Of 744 bats recorded at night roosts on bridges in western Oregon, only a single bridge had a Townsend's bat (Adam and Hayes 2000). Occasionally, Townsend's bats have been encountered night-roosting under bridges in eastern Washington and California (Pierson et al. 2001, Washington Department of Fish and Wildlife 2005).

Winter Roosts/Hibernacula. Townsend's big-eared bats require "rooms" for hibernation that provide 1) protection from predation, 2) cold, but not freezing, temperatures, and 3) a degree of solitude that limits unwanted arousal from torpor. These are long-term roosts used for weeks to months at a time. Hibernacula frequently serve as breeding sites (Pearson et al. 1952). Townsend's bats in northern temperate latitudes have been found hibernating in caves, lava tubes, mines, and occasionally built structures (Dalquest 1948, Pearson et al. 1952, Humphrey and Kunz 1976, Pierson 1988, Pierson and Rainey 1998). In Washington, the few known hibernacula are mostly in caves and mines (Senger 1973, Adler 1977, Perkins 1990, Washington Department of Fish and Wildlife 2005).

Townsend's bats hibernate singly or in clusters. They tend not to roost close to other bat species, although individuals of other species are often present elsewhere in the roost (Marcot 1984, Genter 1986, Stihler and Brack 1992, Choate and Anderson 1997, Kuenzi et al. 1999, Hendricks et al. 2000, Sherwin et al. 2000b). Large numbers of Townsend's bats have been found in single hibernacula, including 3,500 before 1959 and 1,187 in 1992 in Jewel Cave South Dakota (Choate and Anderson 1997), and 2,000 in 1994 and 1,672 in 2003 in a cave in Idaho (S. Earl, Personal Communication).

Although cold temperatures are a critical quality of hibernacula, temperature variations have been documented. Doering (1996) found successful hibernacula to have temperatures less than that of deep soil in Idaho. Townsend's bats chose locations where temperatures ranged from 0.0-2.5°C (32-37°F), despite higher temperatures found in surrounding areas. In contrast, Townsend's bats in another Idaho study inhabited significantly warmer regions of caves even when cooler areas existed (Genter 1986). In a third Idaho study, Wackenhut (1990) recorded a wide range of temperatures (0.6 to 13.7°C [33 - 57°F]) and humidity (44 to 90%) in 13 caves occupied by over 500 Townsend's bats. This study found no relationship between relative humidity and bat numbers.

Movements

Tracking bats equipped with radio transmitters is the most effective method to obtain information on movement. However, limitations of this technology and difficulties while tracking individuals in the field typically result in information for only a small number of individuals over short time periods. Townsend's bats typically move up to 5 km (3 mi) from roosts to foraging sites during the summer. In eastern Washington, one individual traveled 23 km (14 mi) in a single night (H. Ferguson, unpublished data). In California, Townsend's bats traveled up to 10.5 km (6.5 mi) from day roost to foraging area and were loyal to foraging sites over consecutive nights. Centers of activity from roosts in this study averaged 3.2 km (2 mi) for females and 1.3 km (0.8 mi) for males (Fellers and Pierson 2002).

Lactating females have high-energy demands and may travel several kilometers to meet these demands. Maximum foraging distances from nursery roosts ranged between 5 and 13 km (3-8 mi) in Kentucky (Adam et al. 1994), California (Brown et al. 1994), and Oklahoma (Clark et al. 1993, Wethington et al. 1996). Bradley (1996) found females in east-central Nevada commonly foraging up to 7 km (4 mi) from nursery roosts and repeatedly returning to the same locations. As the nursery season progressed, females in Oklahoma traveled farther from nursery sites to forage, averaging about 1 km (0.6 mi) early in the season, and eventually averaging 4 km (2.5 mi; Clark et al. 1993).

The distance traveled between hibernacula and nursery sites is more difficult to discern. Individuals apparently use a series of interim roosts between hibernacula and nursery sites and show little fidelity to any interim roost. In Oregon, an individual Townsend's bat migrated 24 km (15 mi) from hibernaculum to its foraging areas and stayed in temporary roosts before arriving at the nursery site (Dobkin et al. 1995). The choice of interim roost sites likely depends on availability of suitable foraging locations (Dobkin et al. 1995). Wackenhut (1990) reported that the longest distance moved between caves over different seasons was 8.3 km (5 mi).

Townsend's bats are thought to frequently survey their environment for alternate summer roosts and may easily adapt to new roost structures. Townsend's bats in Nevada appeared to have a working knowledge of alternate summer roost locations, using alternate caves up to 6 km (4 mi) away (Bradley 1996). Individual bats in California were found using nine alternate roosts (Fellers and Pierson 2002). In eastern Washington, up to three alternate nursery sites in buildings have been documented (H. Ferguson unpublished data, K. Woodruff unpublished data). Also, the use of newly constructed buildings (e.g., buildings with windows not open previously, or broken windows) as day roosts and maternity sites has been noted (K. Woodruff unpublished data). In one instance, a building containing a nursery roost in eastern Washington was physically moved 1 km (0.6 mi) and subsequently reoccupied (McCreary 2003).

Movements also occur between nursery sites (Pearson et al. 1952, Graham 1966, Humphrey and Kunz 1976, Clark et al. 1996, Szewczak et al. 1998; J. Nieland, Personal Communication). Bats in nursery colonies in Nevada moved an average of 2.3 times, and as many as 5 times during one nursery season using three distinct roosts on average (Sherwin et al. 2000b). Fellers and Pierson (2002) located nine alternate roosts during a recent study of a colony in coastal California.

Movements between winter roosts have also been observed (Twente 1955, Senger 1973, Humphrey and Kunz 1976, Adler 1977, Wackenhut 1990, St. Hillaire 2005). In a survey of 1200 mines and 43 caves in Utah and Nevada, winter movement among sites was found to be common (Sherwin et al. 2000b).

LIMITING FACTORS

Disturbance of roosts by humans (e.g., recreation, mining, bat research, vandalism) is noted as a concern by many researchers (Graham 1966, Barbour and Davis 1969, Senger 1973, Humphrey and Kunz 1976, Perkins and Levesque 1987, Pierson and Rainey 1998, Ellison et al. 2003). However, in some cases, what has been interpreted as roost abandonment might actually reflect normal movements (Sherwin et al. 2000a, Sherwin et al. 2000b, Sherwin et al. 2003).

While careful monitoring of Townsend's bats in hibernacula appears to have had little effect on long-term population stability (Choate and Anderson 1997, Jagnow 1998, St. Hillaire 2005), research-related handling at roosts has apparently resulted in declines of hibernating populations in later years (Graham 1966, Humphrey and Kunz 1976, Pierson 1988, Brown et al. 1994, Choate and Anderson 1997, Pierson and Rainey 1998). Because it is difficult to thoroughly identify and census discrete populations, actual effects of human activity at roosts is still unclear.

The loss of old buildings, barns, warehouses, silos, and other buildings, and the physical closure or reactivation of underground mines reduces available roosts. Normal hillside erosion can also close entrances to mines used by bats. The loss of roosts is a critical limiting factor because new mines are not being created at the rate they are being lost, and abandoned buildings are becoming much less common.

Forest and range management with fire is becoming common and the effect of vegetation changes resulting from fire is unknown. With the exception of loss of large hollow trees that might serve as valuable roosts, our knowledge of the effect of vegetation changes following timber management on Townsend's bat habitat also is limited.

Several mammals are known to prey on Townsend's bats (Clark et al. 1990, Pierson et al. 1999, Fellers 2000). Domestic cats are a problem in some areas (Pierson et al. 1999). Black rats (*Rattus rattus*) were a serious problem at a roost in California (Fellers 2000).

While there is much to learn regarding the impact of wind turbines to bat populations, initial indications suggest that consequences for Townsend's bats are minor (Erickson et al. 2002).

The degree that insecticides and other chemicals affect bats is largely unknown (see Clark and Hothem 1991, Clark et al. 1997, Clark 2001, and Clark and Shore 2001, O'Shea et al. 2001, O'Shea and Clark 2002 for discussion of effects of pesticide). However, insecticides reduce insects that are potential sources of prey (Sample 1991). Because nursing bats and those leaving hibernacula have high insect demands (Humphrey and Kunz 1976, Wackenhut 1990), insecticide use near hibernacula and nursery roosts likely limits populations. Bats may be harmed by ingesting water containing toxic chemicals (Clark 1991, Clark and Hothem 1991). Water quality can have indirect effects on bats by influencing insect abundance (Vaughan et al. 1996).

MANAGEMENT RECOMMENDATIONS

Our ability to assess the current and future use of roosting habitat for Townsend's bats is limited. Incomplete protection of existing and potential roosts could greatly impact this species (Humphrey 1975, Sheffield et al. 1992, Altenbach and Sherwin 2000). Where caves and mines are proposed for management (especially mine closures or reactivations), carefully assess the site's potential as summer and/or winter roosting habitat (Altenbach et al. 2000).

Limit the potential for vandalism and other disturbances at all known and suspected Townsend's bat roosts. Periodically evaluate the effectiveness of methods used to deter disturbance. Posting signs, closing roads and trails, erecting fences, requiring licensed visitation, and closure with vandalism-resistant structures are options that should be considered. If monitoring shows that protective measures are insufficient, more restrictive methods should be applied. If it is necessary to exclude human activity from a cave or mine, close entrances using bat-friendly designs (see http://www.batcon.org/home/index.asp?idPage=53&idSubPage=87 for examples; Nieland 1998, Tuttle and Taylor 1998, Vories and Throgmorton 2002). Populations of Townsend's bats have increased when caves and mines are seasonally or completely closed (Pierson et al. 1991). Where recreational use in caves and mines can be accomplished without affecting habitat, provide access only when bats are known to be absent. For hibernacula this is May 15 to September 15. For nursery sites this is September 15 to April 1. If bats are encountered during these periods, use by humans should be terminated. For sites where both nursery and hibernation roosts occur, recreational use is incompatible.

Support entrances to caves and mines used by bats to keep them from caving in or sliding shut.

When old mines are reopened for mining or other situations occur that are hazardous to bats, eviction of colonies should only be a last resort. If such action is warranted, consult and follow guidelines in Brown et al. (2000) (see http://www.mcrcc.osmre.gov/PDF/Forums/Bats%20and%20Mining/Proceedings/3i.pdf).

When surveying to determine if abandoned mines are occupied by colonies, follow protocol developed by Altenbach et al. (2000) (see http://www.mcrcc.osmre.gov/PDF/Forums/Bat Gate/TOC.pdf). Sherwin et al. (2003) noted that in surveys of over 1300 mines and caves in Utah and Nevada, an average of more than 8 visits was required to reliably determine the absence of Townsend's bats from a site. Analysis of bat guano can also confirm use by Townsend's bats (Zinck et al. 2004).

Assess old buildings, caves, and mines in spring, summer, and fall near proposed projects to determine the presence or absence of bats before beginning any project. Consult a qualified biologist to inventory sites using standard, accepted methods described in the Townsend's Big-eared Bat Conservation Assessment and Conservation Strategy (Pierson et al. 1999). Favor acoustic and visual inventory methods over internal surveys. Protect all sites where bat roosting has been documented. Maintain and repair buildings used by Townsend's bats to reduce loss of roosting habitat. Local fire departments should survey abandoned buildings for bat colonies prior to selecting them for practice burns.

Because Townsend's bats use bridges (Barbour and Davis 1969, Keely and Tuttle 1999), all new or repaired bridges should use bat-friendly designs (e.g., concrete cast in place "open beam" or "I-beam" construction) (Keeley and Tuttle 1999). Such designs can be accomplished in bridges or culverts at little or no extra cost. For a discussion on designs see http://www.batcon.org/bridge/ambatsbridges/index.html.

Restrict bat access to contaminated water such as cyanide impoundments, standing water at "heap leach" facilities, water at pulp facilities, standing water at landfills, spilled/sprayed pesticides associated with agriculture, and waste water at livestock and poultry facilities by using netting or other non-lethal means.

Insecticides often eliminate prey that would otherwise be consumed by bats. Specific insecticides, such as those designed to kill only moths (e.g., controls used in agriculture and forestry) likely have negative consequences to bats by reducing potential prey. Use pesticides only in accordance with labels and consistent with Material Safety Data Sheets. Because Townsend's bats routinely forage up to 5 km (3 mi) from roosting colonies, do not use insecticides within 5 km of known nursery or winter roosts.

Retain the largest trees in timber management activities consistent with historic conditions for the site, and retain all trees >50 cm (20 inch) diameter with hollows and cavities. Follow Timber Fish and Wildlife guidelines for timber management activities.

Healthy riparian and aquatic systems provide a valuable source of insect prey and, consequently, are important for bats (Diaz and Mellen 1996, Knutson and Naef 1997). Recommendations for managing riparian habitat are available in WDFW's *Management Recommendations for Washington's Priority Habitats: Riparian* (see PHS Riparian).

Limit domestic predator access to bat roosts (Pierson et al. 1999) and, if necessary, conduct live trapping and removal. Such removal is critical at sites where feral cats or rats are present.

During research activities, follow approved methods for bat surveys that are consistent with Sheffield et al. (1992), Province of British Columbia (1998), Pierson et al. (1999), and Altenbach et al. (2000) to reduce disturbance.

Carefully assess any proposed wind projects near known Townsend's bat colonies (Kunz 2004). Follow guidelines identified in *Interim Guidelines to Avoid and Minimize Wildlife Impacts From Wind Turbines* (see http://www.blm.gov/nhp/what/lands/realty/FWS_wind_turbine_guidance_7_03.pdf).

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PERSONAL COMMUNICATIONS

Scott Earl, Director
Idaho Cave Survey
Idaho Falls, Idaho

Debbie Young, Natural Resources Manager
Tacoma Power
Tacoma, Washington

Jim Nieland, Regional Cave Specialist
US Forest Service
Amboy, Washington

KEY POINTS

Habitat Requirements and Natural History

- Forages nightly during spring, summer, and fall in various habitats, while remaining time (mostly daytime in summer, or for extended periods in winter) is spent in roosts.
- Uses caves, mines, large snags and trees, and built structures for roosting.
- Found in a diverse range of vegetative communities throughout Washington.
- Consumes moths primarily, but will opportunistically forages on the most available food.
- Suitable roosts are critical to survival:
  - *Day Roosts*. Structures used during daylight hours to rest or hide. Old buildings, silos, concrete bunkers, barns, caves, and mines are common roost structures.
  - *Maternity/Nursery Roosts.* Sites include caves, mines, barns, abandoned houses, actively used buildings, concrete silos, bunkers, and large "rooms" in concrete dams to bear and care for young. Young are present between June and mid August, and colonies leave nursery sites by early September.
  - *Night Roosts.* Sites that assist with social interaction, digestion, rest, and serve as refuge from predators. Little is known about locations or use of night roosts.
  - *Winter Roosts/Hibernacula.* Sites must provide protection from predation; cold, but not freezing temperatures; and a degree of solitude that limits unwanted arousal. The few known hibernacula in Washington are mostly in caves and mines.
- Lactating females may travel up to 13 km to forage for insects.
- The distance traveled between hibernacula and nursery sites is difficult to discern. Individuals use a series of interim roosts between hibernacula and nursery sites, showing low fidelity to interim roosts.
- Townsend's bats possibly survey for alternate maternity, nursery, and day roosts during the summer and may easily adapt to new roost structures. Movements between winter roosts have also been documented.

Management Recommendations

- Where caves and mines are proposed for management (especially mine closures or reactivations), carefully assess the site's potential for roosting in all seasons.
- Limit vandalism and other disturbances at known and suspected roosts. Posting signs, closing roads and trails, erecting fences, requiring licensed visitation, and closing with vandalism resistant structures should be considered. If human exclusion is required, close cave/mine entrances with bat-friendly gates (see http://www.batcon.org/ home/ index.asp?idPage= 53&idSubPage=87 for examples).
- Where cave/mine recreation can be done without affecting habitat, provide access only when bats are known to be absent. For hibernacula this is May 15 to September 15. For nursery sites this is September 15 to April 1. If bats are found during these periods, use by humans should be terminated. At sites used as both nurseries and hibernacula, recreational use is incompatible.
- When old mines are reopened for mining or other situations occur that are hazardous to bats, colony eviction should be a final resort.
- When surveying to see if abandoned mines contain colonies, follow protocol at http://www.mcrcc.osmre.gov/PDF/Forums/Bat Gate/TOC.pdf.
- Before beginning any project, use qualified biologists to assess nearby old buildings, caves, and mines in spring, summer, and fall to determine the presence or absence of bats.
- Maintain and repair buildings used by Townsend's bats to reduce loss of roosting habitat. Fire departments should survey abandoned buildings prior to selecting them for practice burns.

- Because Townsend's bats use bridges, all new or repaired bridges should use bat-friendly designs (see www.batcon.org/bridge/ambatsbridges/index.html).
- Where forests stands are being used for roosting, retain all trees >50 cm (20 inch) diameter with hollows and cavities.
- Maintain healthy riparian/aquatic systems as a source of insect prey (see the PHS riparian publication for details).
- Limit and remove domestic predators, especially feral cats and rats, by qualified animal damage specialists.
- Follow approved methods for bat surveys and research.
- Assess proposed wind projects near known colonies (see http://www.fws.gov/r9dhcbfa/wind.pdf).