

Townsend's Big-Eared Bat (*Corynorhinus townsendii*)

Legal Status

State: Species of
Special Concern

Federal: Bureau of Land
Management Sensitive

Critical Habitat: N/A

Recovery Planning: N/A



Photo courtesy of Rob Schell Photography.

Taxonomy

The taxonomy of Townsend's big-eared bat (*Corynorhinus townsendii*) has undergone some recent revisions. Although the species was originally assigned to the genus *Corynorhinus* (Hall 1981), Handley (1959) reassigned it to the genus *Plecotus*, based on physical measurements, with *Corynorhinus* placed in a subgenus. More recent phylogenetic work using physical characters (Frost and Timm 1992; Tumlison and Douglas 1992) and mitochondrial DNA analysis (Hooper and Van Den Bussche 2001) have resulted in *Corynorhinus* being restored to a separate genus within the plecotine bats.

There has also been past uncertainty in California about the distinction and distributions of two subspecies: *C. t. townsendii* and *C. t. pallescens* (see discussion in CDFG 1998). While the two subspecies occur in geographically discrete locations, their distributions have been recently revised based on mitochondrial DNA, with *C. t. townsendii* occurring throughout western and southwestern Canada and *C. t. pallescens* generally limited to New Mexico and Colorado (Piaggio et al. 2009). There are areas of sympatry in Colorado where the two subspecies are not genetically different (Piaggio et al. 2009), but based on genetic information, the subspecies in California and the Desert Renewable Energy Conservation Plan (DRECP) Area is *C. t. townsendii*. Nonetheless, in California the full species *Corynorhinus townsendii* is designated a Species of Special Concern, so the subspecific distinction in the distribution of *C. t. townsendii* and *C. t. pallescens* is not critically important for planning purposes. The species' physical characteristics are described in detail in Kunz and Martin (1982).

Distribution

General

The Townsend's big-eared bat ranges throughout the western United States; British Columbia, Canada; and Mexico (Kunz and Martin 1982). In the United States, it occurs in a continuous distribution in all of the western states and east into western South Dakota, northwestern Nebraska, southwestern Kansas, western Oklahoma, and western Texas (Piaggio et al. 2009). This continuous distribution comprises three subspecies: *C. t. townsendii*, which based on the recent genetic data (Piaggio et al. 2009) has the largest distribution range from Canada south into Mexico; *C. t. pallescens*, which is primarily limited to Colorado and New Mexico; and *C. t. australis*, which occurs in southwestern Kansas, western Oklahoma, western Texas, and north-central Mexico (Piaggio et al. 2009). The other two subspecies occur in disjunct distributions: *C. t. ingens* in southeastern Kansas, northeastern Oklahoma, southwestern Missouri, and northwestern Arkansas; and *C. t. virginianus* in eastern Kentucky, West Virginia, and Virginia (Piaggio et al. 2009).

Within California, Townsend's big-eared bat occurs throughout the state, with the exception of alpine and subalpine areas of the Sierra Nevada (Figure SP-M08), although they have been found in the subalpine zone in the White Mountains to the east of the Sierra (Szewczak et al. 1998).

Distribution and Occurrences within the Plan Area

Historical

Townsend's big-eared bat may occur throughout the Plan Area, but there are relatively few documented large maternity and/or hibernation roosts. A comprehensive review of the species' distribution was conducted by Pierson and Rainey (CDFG 1998) based on a review of historical records and field surveys conducted from June 1987 to January 1991. Their review included portions of the Plan Area known to support substantial populations, including the Owens Valley and areas east of the Sierra Nevada Range in Inyo County, the Providence Mountains in San Bernardino County, and the lower

Colorado River area in San Bernardino, Riverside, and Imperial counties (see Figure 1 in CDFG 1998). They surveyed all known maternity colonies with at least 30 individuals. Most of the active large maternity roosts within or near the Plan Area were in abandoned mines east of the Sierra Nevada range and the western slopes of the White Mountains bordering the Owens Valley. Active maternity roosts were also found in the Kingston Range area of eastern Inyo County, the Providence Mountains in northeastern San Bernardino County, and along the lower Colorado River in eastern Riverside County. An active maternity roost and a hibernation roost were also found in east San Diego County. No longer active roosts (i.e., previously known roost sites) or roosts made unavailable by human activities (e.g., inappropriate gating) were found in the Coso Range area of southern Inyo County, a site in the Providence Mountains, and two sites along the Lower Colorado River in Riverside and Imperial counties, respectively (see Figure 1 of CDFG 1998). As of 1991, Pierson and Rainey (CDFG 1998) estimated 11 active sites east of the Sierra Nevada (including several sites north of the Plan Area and the site in the Kingston Range) totaling about 1,300 adult females, 1 site in the high desert totaling about 75 adult females, 1 site in the lower desert totaling about 50 adult females, and the 2 east San Diego County sites with an unknown number of adult females. Pierson and Rainey (CDFG 1998) indicate that no large hibernation sites have been found in the desert regions of California and that smaller hibernation sites (5 to 20 individuals) are more typical of the desert; these sites are not included in the data reported by Pierson and Rainey. The lack of documented large hibernation sites in the Plan Area may reflect a lack of extensive exploration of mines and caves at higher elevations where they would more likely hibernate (CDFG 1998). However, because it is unlikely that mines and caves in the Plan Area, which are at lower elevations, have subsurface temperatures low enough for hibernation (i.e., less than 10 degrees Celsius [50.0 degrees Fahrenheit]) (see discussion in Habitat Requirement), additional exploration for hibernation sites may be irrelevant (Szewczak, pers. comm. 2012).

The DRECP database for Townsend's big-eared bat, comprising Bureau of Land Management (BLM) and California Natural Diversity Database (CNDDDB) (CDFW 2013; Dudek 2013) records, includes 13

historical records (pre-1990) for the Plan Area, dating from 1914 to 1983, as well as one record with an unknown observation date. An additional 8 records are from areas within 5 miles of the Plan Area boundary. These data generally accord with the information provided in Pierson and Rainey (CDFG 1998), with clusters of occurrences in the southern Owens Valley–eastern Sierra Nevada area, especially the mountain ranges north of Ridgecrest. Historical records are also known from the Providence Mountains, the Kingston Range, the lower Colorado River, and Hesperia north of the San Bernardino Mountains.

See Figure SP-M08 for current and historical occurrences of Townsend's big-eared bat in the Plan Area.

Recent

There are 39 recent (i.e., since 1990) records in the Plan Area and 42 additional records within the 5-mile buffer area around the Plan Area (CDFW 2013; Dudek 2013). The geographic areas of the recent occurrences are similar to the historical occurrences, with clusters of observations in the Owens Valley–eastern Sierra Nevada area, Providence Mountains, and the Kingston Range. There is also a cluster of recent occurrences north of Barstow and along the northern slopes of the San Bernardino Mountains. There are relatively few recent occurrences from the lower Colorado River, consistent with the information reported by Pierson and Rainey (CDFG 1998).

As with the historical data, the specificity of these recent occurrence data is variable, with some records identifying roosts and others only including general location information for observations. This dataset, therefore, should be viewed as reflecting the recent documented distribution of the species in the Plan Area and should not be used as detailed data for specific roosts sites.

Natural History

Habitat Requirements

Townsend's big-eared bat is primarily associated with mesic habitats characterized by coniferous and deciduous forests and riparian habitat, although it also occurs in xeric areas (Kunz and Martin 1982). In

California, this species was historically associated with limestone caves and lava tubes located in coastal lowlands, agricultural valleys, and hillsides with mixed vegetation. The species also occurs in man-made structures and tunnels (Kunz and Martin 1982), mines (López-González and Torres-Morales 2004), and the basal hollows of old-growth redwood trees (*Sequoia sempervirens*) on the north coast of California (Gellman and Zielinski 1996; Zielinski and Gellman 1999). Within the Plan Area, Townsend's big-eared bat is primarily associated with mines in the California desert and also largely associated with man-made structures, tunnels, caves, and the basal hollows of old-growth redwood trees. In a study in northern Utah, caves and mines were the most frequently used type of roosts. More than 84% of roosts were in caves, and more than 21% of abandoned mines were used as day roosts; notably, no bridges were used (Sherwin et al. 2000). Occupied day roosts typically were subject to little disturbance by humans. Maternity colonies tended to be located in large complex sites with multiple openings (Sherwin et al. 2000). It has been suggested that the Townsend's big-eared bat has become more common in the western United States due to the availability of man-made structures (Kunz and Martin 1982); however, see discussion under Population Status and Trends. Many roosting sites in the California coastal area are in buildings, but in the Plan Area most roosting sites appear to be in abandoned mines (CDFG 1998).

Unlike many cave-roosting bat species, Townsend's big-eared bat only roosts in the open, often hanging from walls and ceilings (CDFG 1998). In the summer maternity roosts, females roost in the warm parts of caves and buildings in clusters (Kunz and Martin 1982). The census of maternity roosts in California found an overall mean colony size of about 112 individuals (CDFG 1998), which is larger than generally reported in the literature (e.g., Kunz and Martin 1982). Males appear to roost solitarily near the maternity roosts. In winter, roosting occurs solitarily or in small clusters, and Townsend's big-eared bat may share hibernacula with other bat species (Kunz and Martin 1982) (see Ecological Relationships). This species may require relatively cold temperatures to hibernate (Humphrey and Kunz 1976). Townsend's big-eared bats roost in relatively cold parts of caves in well-ventilated areas near entrances, but may move to more temperate parts of the cave if temperatures become too cold (e.g., subfreezing) (Clark et al.

2002; Humphrey and Kunz 1976; Kunz and Martin 1982) (also see discussion under Spatial Activity).

Pierson and Rainey (CDFG 1998) provide detailed information for the physical features of roosting sites in California, which is summarized below. The reader is directed to the Pierson and Rainey report for more detailed information.

Pierson and Rainey (CDFG 1998) examined potentially suitable and accessible caves, tunnels (e.g., old mine workings, water diversion tunnels, and abandoned railroad tunnels), abandoned and little-used buildings, and older (pre-1960) bridges throughout California. Censuses of bats at occupied roosts were based on direct counts or estimates for an area covered by a cluster of bats. The physical characteristics of roosts described as follows are summarized from Pierson and Rainey (CDFG 1998).

As of 1998, maternity roosts were distributed among the different structures as follows: 23 (43%) in caves; 21 (39%) in mines; 8 (15%) in buildings; and 2 (4%) in other structures (an abandoned bridge and a diversion tunnel). All roosts could be classified structurally as "cave analogues" that contained a relatively large, but enclosed space with a substantial opening. All but one of the roost entrances ranged from at least 15 centimeters (5.9 inches) in height and 31 centimeters (12.2 inches) in width, with the smallest being 15 centimeters (5.9 inches) high and 46 centimeters (18.1 inches) wide. The one exception was a mine roost in which the opening was about 10 centimeters (3.9 inches) high and 60 centimeters (23.6 inches) wide. All roosting sites were at least 1 meter (3.3 feet), and usually 2.5 to 5.0 meters (8.2 to 16.4 feet) off the ground. All roost sites were classified as semi-dark to dark settings. Mean temperatures of maternity roosts and roosts occupied by single individuals and small clusters were not significantly different. The mean temperature of maternity sites was 24.1 degrees Celsius (75.4 degrees Fahrenheit), and the mean temperature of sites with individuals and small clusters was 22.2 degrees Celsius (72.0 degrees Fahrenheit). The temperature range for maternity sites was typically 18 to 30 degrees Celsius (64.4 to 86.0 degrees Fahrenheit), but was measured as low as 14 degrees Celsius (52.2 degrees Fahrenheit). Roost relative humidity was not a factor, but tended to be relatively dry on average at about 33% (range 19 to 93%).

Assessing and characterizing hibernacula was more difficult than maternity sites because individuals tend to move among different sites during a hibernation season (CDFG 1998; Sherwin et al. 2003). Similar to maternity roosts, hibernacula are typically caves, or cave analogues, but differ in often being L-shaped, with vertical and horizontal entrances that generate a “cold sink” with significant air flow. Consistent with the literature for the species, hibernacula used in California often represent the coldest non-freezing temperature available. In the northern counties of Shasta, Siskiyou, and Lassen, where individuals probably hibernate longer periods of time, mean hibernating roost temperature was 4.3 degrees Celsius (39.7 degrees Fahrenheit). In warmer regions of coastal and Southern California, individuals arouse periodically during the winter and occur in warmer hibernacula. The mean hibernaculum temperature for known sites throughout California is 7.1 degrees Celsius (44.8 degrees Fahrenheit)), and preferred hibernating temperatures are always below 10 degrees Celsius (50.0 degrees Fahrenheit) (CDFG 1998).

Townsend's big-eared bats forage for insects in a variety of habitats, primarily between the canopy and mid-canopy of forests, woodlands, and riparian zones, but also in sagebrush shrubsteppe (Fellers and Pierson 2002). Fellers and Pierson (2002) noted that Townsend's big-eared bats avoided foraging in grasslands. As discussed below in Spatial Activity, most foraging occurs in relatively close proximity to the day roost.

Potential roosting and foraging habitat associations for Townsend's big-eared bat in the Plan Area are provided on Table 1.

Table 1. Habitat Associations for Townsend's Big-Eared Bat

Land Cover Type	Habitat Designation	Habitat Parameters	Supporting Information
Abandoned mines	Day roosts	TBA	CDFG 1998
Woodland, forest, riparian, desert wash	Foraging	Woodland, forest, riparian, desert wash within 6.2 miles of day roosting habitat	Fellers and Pierson 2002

Foraging Requirements

Several studies in various parts of the Townsend's big-eared bat's range found that Lepidoptera (moths) are its primary prey, including in the southwest (Ross 1967), eastern and western Oregon (Whitaker et al., 1977, 1981), and Virginia (Sample and Whitmore 1993). In Oregon, big-eared bats feed almost exclusively on moths (Whitaker et al. 1977, 1981). In Virginia, moths comprised about 90% of the species' diet by volume and percentage, followed by Coleoptera (beetles), Diptera (flies), and Hymenoptera (bees and wasps), and reflected the abundance of these orders in interior forests (Sample and Whitmore 1993).

Reproduction

Reproduction by Townsend's big-eared bats in California is fairly well known, based on a study by Pearson et al. (1952), described herein (Table 2). Breeding begins in autumn, with peak breeding in November through February. Females store the sperm until ovulation in the spring, which may occur during and after females leave hibernation. Upon leaving hibernation, females form maternity colonies in the late spring and early summer; males during this period appear to roost singly (CDFG 1998). Gestation varies from 8 to 14 weeks, depending on degree of torpor and spring temperatures. Females have one pup. In California, birth occurs in the late spring to early summer over a 3- to 5-week period beginning in late May. Although young are born fairly undeveloped, they grow rapidly and reach adult body proportions (i.e., forearm length) in 1 month. They are capable of flying in 2.5 to 3 weeks and are weaned by 6 weeks. Both males and females are reproductive in their first autumn. Immediate postnatal mortality is about 4% to 5%, and 3-year survival is 70% to 80% for adults and 38% to 40% for yearlings (i.e., survival increases with age) (Kunz and Martin 1982).

Female maternity groups are stable and faithful to roost sites that may be used by several generations (CDFG 1998). Females remain in the natal group while males disperse after their first summer (CDFG 1998). Maternity roosts begin to break up in August.

Table 2. Key Seasonal Periods for Townsend's Big-Eared Bat

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Breeding	x	x								x	x	x
Birth/ Development				x	x	x	x	x				
Male Dispersal								x	x			
Hibernacula	x	x	x	x	x					x	x	x

Source: Pearson et al. 1952.

Spatial Activity

Pierson and Rainey (CDFG 1998) characterize Townsend's big-eared bat as "quite sedentary" because marked animals (all females) moved no more than a few kilometers from their natal roost. Also, most activity outside of day roosts (e.g., foraging, night roosting) occurring relatively close to the roost (CDFG 1998). Recorded maximum distance from the day roost in California is 32.2 kilometers (20.0 miles) and 64.4 kilometers (39.9 miles) in Kentucky (Kunz and Martin 1982). Average distance from maternity roosts to winter hibernacula is 11.6 kilometers (7.2 miles) (range: 3.1 to 39.7 kilometers [1.9 to 24.6 miles]) (Kunz and Martin 1982). Based on a personal communication from Pearson, Pierson and Rainey (CDFG 1998) noted that when maternity colonies disband in the fall, a banded individual had never been recorded at hibernacula more than 43 kilometers (27 miles) from the banding site. However, there is also indirect evidence that Townsend's big-eared bats can travel much longer distances than indicated by direct observations of foraging activity and movement between maternity roosts and hibernacula, based on telemetry and banding studies. The genetic work by Piaggio et al. (2009) indicated gene flow by dispersing males in Colorado has occurred between roost sites 310 kilometers (192 miles) apart.

Nightly movements for bats in Marin County, California, were monitored using radiotelemetry by Fellers and Pierson (2002). Bats

typically traveled less than 10.5 kilometers (6.5 miles) from the day roost, and most flight was in the immediate vicinity of native vegetation where foraging was assumed to occur, and particularly along the edges of riparian vegetation. Similarly, on Santa Cruz Island off the coast of California, foraging activity occurred in native forest habitat within 5 kilometers (3.1 miles) of the day roost (Brown et al. 1994). Nightly foraging tended to occur in the same areas at the Marin County site (Fellers and Pierson 2002), but a study in Oregon shows shifts in foraging areas over time related to changes in prey availability (Dobkin et al. 1995). Clark et al. (1993) found that Ozark big-eared bats (*C. t. ingens*) selected foraging habitats non-randomly in relation to their availability, with edge habitats along streams and on mountain slopes used more frequently. In the Marin County study, females generally traveled greater distances than males for foraging, with their centers of activity 3.2 ± 0.5 kilometers (2.0 ± 0.3 miles) from the roost, compared to 1.3 ± 0.2 kilometers (1.1 ± 0.1 miles) for males (Fellers and Pierson 2002). Fellers and Pierson (2002) note, however, that commuting distances and patterns of nighttime activity are likely to be quite variable in relation to factors such as individual differences, sex, season, reproductive condition, and available suitable foraging habitat. For example, females may travel farther from the maternity roost or be more active foraging away from the roost later in the reproductive season when young are more independent and resources are needed to support lactation. Clark et al. (1993, 2002) found that Ozark big-eared bat nightly activity changed relative to birth and maturation of young, with nighttime returns to the maternity roost more frequent when young were totally dependent on the mother, and farther foraging distances by adult females as young matured.

Although fidelity to maternity roosts is high, there may be little fidelity to roost sites at other times of the year, possibly in relation to availability. In Oregon, there was little fidelity to night roosts in the period between emergence from hibernacula and use of maternity sites, possibly because in this study area the lava flow topography provided numerous roost sites (Dobkin et al. 1995). It is expected that use of different roost sites is locally variable in relation to roost availability.

Townsend's big-eared bats are considered to be a hover-gleaner forager based on wing morphology (Norberg and Payner 1987, as cited in Fellers and Pierson 2002), and they are agile and maneuverable

fliers. They have low wing loading and high lift capacity (Kunz and Martin 1982). Fellers and Pierson (2002) found that most flight was at 10 to 30 meters (33 to 98 feet) above ground between the mid-canopy and canopy of trees. Flight through grassland was fast and low to the ground, indicating that bats were not foraging in grasslands.

Spatial activity within roosts sites likely reflects behavioral thermoregulatory adjustments. During hibernation, individuals arouse frequently and change position or move to more temperate areas of the hibernaculum (Kunz and Martin 1982). Disturbances may also cause movements within roosts sites.

Ecological Relationships

Townsend's big-eared bats may share hibernacula with other bat species; in the eastern United States, it has been found in association with Rafinesque's big-eared bat (*C. rafinesquii*) and in the western United States with big brown bat (*Eptesicus fuscus*), cave myotis (*Myotis velifer*), western small-footed myotis (*M. ciliolabrum*), dark nosed small-footed myotis (*M. melanorhinus*),¹ and California myotis (*M. californicus*) (Kunz and Martin 1982), but there is no evidence in the literature of direct competitive or symbiotic relationships with other bats. Congregations with other bat species at both day and night roosts may simply reflect use of limited resources.

With regard to potential resource partitioning, Black (1974) suggested that bats may employ several types of foraging and food partitioning mechanisms that could reduce inter-specific competition, including size and type of prey; periods of activity (most bat prey are active within a few hours of sunset, but different prey have different peak activity periods); spatial partitioning, such as between-, within-, and below-canopy foragers; and flight patterns, such as slow vs. fast flying, maneuverability, and hovering.

Although Townsend's big-eared bat has been characterized as a "relatively late flyer" by Kunz and Martin (1982), there are numerous observations that individuals leave roosts promptly at dusk like other species (Szewczak, pers. comm. 2012). Further, there is no information

¹ Both *M. ciliolabrum* and *M. melanorhinus* were once considered subspecies of *M. leibii*, which is the species listed in Kunz and Martin (1982), but Wilson and Reeder (2005) list both as distinct species.

to suggest resource partitioning or direct competition for prey with other species. Although, artificial lighting may affect competitive predator-prey relationships among some bats (e.g., Frank 1988; Longcore and Rich 2004), the potential for this occurring in Townsend's big-eared bats is low because this species roosts and forages away from human-developed areas (Szewczak, pers. comm. 2012).

Population Status and Trends

Global: Apparently secure (NatureServe 2011)

State: Vulnerable to imperiled (CDFG 2011)

Within Plan Area: Same as state

Townsend's big-eared bat is a California Species of Special Concern, but there are little systematic data to quantitatively assess population status and trends (e.g., numbers of individuals). However, past studies have shown a broad-ranging decline in the species through large parts of its range in the western United States (i.e., mainly the *C. t. townsendii* and *C. t. pallescens* subspecies). Human disturbance has eliminated most historical roosting sites in California and all known previously occupied limestone caves in the state have been abandoned (see discussion in Threats and Stressors). The census by Pierson and Rainey (CDFG 1998) in California, conducted from 1987 to 1991, found substantial population declines over the previous 40 years, with a 52% loss in the number of maternity colonies, a 44% decline in the number of available roosts, a 55% decline in the total number of animals (primarily adult females), and a 32% decrease in the average size of remaining colonies. Fate of roosts sites was related to the type of roost, with 88% of roosts in buildings no longer available, and 50% of roosts in caves and 57% in mines no longer used. Pierson and Rainey (CDFG 1998) also reviewed population information for other western states as of 1998, summarized below.

- Arizona – 13 verified maternity roosts, representing 10 separate colonies, with a total population of about 1,000 adult females. Two cave populations extirpated and another declined by 50% in 2 years after its cave roost was commercialized. Another population historically supporting several hundred adult females numbered fewer than 100 individuals.

- Colorado – hibernaculum with more than 500 individuals in December 1968 apparently reduced to only a few animals. Only four maternity sites had been documented in Colorado since 1970, and the largest had only approximately 80 adult females.
- New Mexico – >10,000 individuals hibernating in a timber-lined 100-meter-deep mine shaft in 1992. The shaft was burned by vandals, and several hundred dead animals were seen still hanging from the walls, and thousands more were presumed dead.
- Idaho – surveys of known hibernating sites indicate a 60% population decline since 1987.
- Nevada – surveys conducted in the late 1980s to late 1990s in 96,000 km² of northeastern Nevada revealed only two small maternity sites.
- Oregon/Washington – severe population declines for both summer and winter populations in Oregon and Washington have been well documented. Known sites in Oregon and Washington contained approximately 2,700 and 800 adult females, respectively.

The isolated populations of *C. t. ingens* and *C. t. virginianus* are considered to be in danger of extinction because of their susceptibility to human disturbance (Kunz and Martin 1982), and both subspecies were federally listed as endangered in 1979 (44 FR 69206–69208).

Threats and Environmental Stressors

Townsend's big-eared bats are very sensitive to human disturbances, and a single disturbance of a maternity roost or hibernation site may cause abandonment (Zeiner et al. 1990; Kunz and Martin 1982). All known limestone cave sites in California, for example, have been abandoned (Zeiner et al. 1990). Sherwin et al. (2000) found that occupied day roosts were typically subject to little human disturbance. As discussed in Population Trends and Status, there has been a significant decline in occupied Townsend big-eared bat roosts in California. The primary cause for the observed declines was determined to be human disturbance of roosting sites (CDFG 1998). As of 1998, 37 known maternity colonies had a total population of

approximately 4,250 adult females, but only three of these colonies were considered adequately protected. Declines were also indicated at four important hibernacula for which past population data were available (CDFG 1998). The selection of relatively cold parts of caves near entrances and where there is good ventilation during hibernation makes Townsend's big-eared bats sensitive to human disturbance (including deliberate vandalism and extermination) during a period when they would be least likely to respond quickly. Also, they tend to hang from ceilings and walls in exposed parts of roosts, making them more susceptible to disturbance (CDFG 1998). It is important that hibernacula be protected from human disturbance because animals can be aroused from hibernation and forced to use fat stores necessary for hibernation.

Pierson and Rainey (CDFG 1998) provided specific information for threats to roosts in the Plan Area. The active roosts in mines on public lands in the eastern Sierra area were considered to be at risk from recreation, mine closure for hazards, and reactivation of old mining claims. An occupied mine at the China Lake Naval Air Weapons Station was vandalized in 1988 and has not been since reoccupied. Other mines have shown evidence of extensive recreational use. Even the colony at Death Valley National Monument was vandalized in 1993, greatly reducing the number of individuals using the site. In the Providence Mountains, the Mitchell Caverns colony located in the State Park was excluded from using the site in 1970 when a bat-proof gate was installed, but replacement of the gate in 1993 resulted in rapid reoccupation. Reactivation of mining in Macedonia Canyon has excluded the species, but individuals appeared to relocate to another mine. In the Colorado River Basin and eastern Mojave Desert, Townsend's big-eared bat was once common at many mine sites, and three maternity sites were known, including the Alice Mine with the largest known colony (>1,000 individuals) in California. Surveys in 1990 and 1992 found only one small maternity site in 1990 but none in 1992. Abandoned mines in this region are subject to intensive recreation, but other apparently undisturbed mines also were unoccupied. Pierson and Rainey (CDFG 1998) suggest the agricultural conversion has reduced foraging habitat and that pesticides may be affecting this species in the region.

Several recent studies have documented substantial mortality of bats at wind facilities (e.g., Baerwald and Barclay 2009; Cryan 2011; Cryan and Barclay 2009). Despite fairly extensive monitoring, with many documented fatalities of other bat species (primarily migrant species), as of 2004, no Ozark or Virginia big-eared bats had been known to be killed at wind facilities (or at communications towers) (Johnson and Strickland 2004). In 2010, TetraTech also reported no documented fatalities of Townsend's big-eared bats at wind facilities (TetraTech EC Inc. 2010). A general review of the wind facility-related literature also failed to reveal evidence for, or discussions of, Townsend's big-eared bat fatalities or assessed risks at wind facilities (e.g., Baerwald and Barclay 2009; Cryan 2011; Cryan and Barclay 2009; Cryan and Brown 2007; Johnson and Strickland 2004; Johnson and Erickson 2008; Kuvlesky et al. 2007; Piorkowski and O'Connell 2010). Nonetheless, the U.S. Fish and Wildlife Service (USFWS) has expressed concern about the potential for fatalities of the endangered Virginia big-eared bats from wind facilities in the eastern United States as they move between caves (e.g., see Johnson and Strickland 2004). Big-eared bats in the Plan Area similarly could be at elevated risk of turbine strikes or other associated causes (e.g., barotrauma) if a wind facility were located within a few miles of a day roost site (where most foraging activity occurs), and strikes would most likely occur during emergence, return to the day roost, or when seeking a night roost between bouts of foraging. Risk of strikes may also be higher when bats are moving between maternity roosts and hibernacula in the fall and spring and when young are dispersing from the maternity roost in late summer.

Conservation and Management Activities

Townsend's big-eared bat is addressed in the West Mojave Plan (BLM 2005). Under Alternative A (the Proposed Action – Habitat Conservation Plan), BLM would implement several conservation measures for Townsend's big-eared bat and other bat species, including:

- Protection of all significant roosts (defined as maternity and hibernation roosts supporting 10 or more individuals) by installing gates over mine entrances and restricting human access. The West Mojave Plan identified two significant maternity roosts and two significant hibernation roosts for Townsend's big-eared bat on BLM-managed lands.

- Protection of bat roosts in the Pinto Mountains by gating known and new significant roosts and notifying claim holders on BLM lands containing significant roosts.
- Continued fencing around (but not over) open, abandoned mine features to provide bats access to roosts and to reduce hazards to the public.
- Required surveys for bats by applicants seeking discretionary permits for projects that would disturb natural caves, cliff faces, mine features, and abandoned buildings or bridges to determine whether significant roost sites are present.
- Safe eviction of bats at a non-significant roost (i.e., less than 10 individuals) prior to disturbance or removal.

BLM would also conduct monitoring and adaptive management for Townsend's big-eared bat. Monitoring actions include:

- Determining bat numbers in all significant roosts
- Conducting periodic surveys in the northern part of the planning area with high potential for containing significant roosts
- Determining and reporting the effectiveness of mitigation measures providing for safe exit of bats
- Reporting take from approved projects that impact bats under to California Department of Fish and Game (CDFG) and USFWS
- Monitoring population numbers using bat houses if installed.²

Adaptive management measures include:

- Gating mines where new significant roosts are found
- Installing bat houses in locations, where appropriate, if populations decline or are threatened³
- Case-by-case review of newly detected significant roosts near open routes within riparian and desert wash habitat. Corrective actions would be taken within the foraging habitat if

^{2,3} The independent scientific reviewer for this profile (J. Szewczak, pers. comm. 2012) indicates that bat houses would not typically provide suitable habitat for Townsend's big-eared bat because this species requires space, not cervices. An artificial roost would have to be a cave-like structure or a building-size roost.

the new roosts are impacted by open routes or new routes would be established to avoid the habitat.

In addition, as a BLM sensitive species, Townsend's big-eared bat is addressed under other land use actions undertaken by BLM. In accordance with the BLM's "6840 – Special Status Species Management" manual, the objectives for sensitive species policy are:

To initiate proactive conservation measures that reduce or eliminate threats to Bureau sensitive species to minimize the likelihood of and need for listing of these species under the ESA (BLM 2008).

Under this policy BLM must consider the impact of actions on sensitive species, including outcomes of actions (e.g., land use plans, permits), strategies, restoration opportunities, use restrictions, and management actions necessary to conserve BLM sensitive species.

Townsend's big-eared bat is also addressed in the Military Integrated Natural Resources Management Plans (INRMP) for the China Lake Naval Air Weapons Station (NAWS and BLM 2004) and the Marine Air Ground Task Force Training Command Marine Corps Air Ground Combat Center, Twentynine Palms (MAGTFTC MCAGCC 2007). As a designated sensitive species in these INRMPs, Townsend's big-eared bat is provided protection and management considerations during the land use planning process defined in the China Lake Comprehensive Land Use Management Plan and military training operations at Twentynine Palms. If it is determined to be at risk from a proposed project or training activities, efforts are made to avoid and minimize impacts. For example, at Twentynine Palms, four bat gates have been installed in three mines to allow bats access to roosts without disturbance from humans. The Twentynine Palms INRMP also includes three objectives:

- Monitoring current bat gates to inspect for trespass and condition
- Evaluating mine entrances for installation of bat gates to those mines that are exceptional bat habitat but not culturally significant
- Evaluating modification of bighorn sheep guzzlers for use by bats and other wildlife to enhance habitat value.

Data Characterization

Although Pierson and Rainey (CDFG 1998) conducted a thorough review of roosting sites for Townsend's big-eared bat, this information is dated. Also, in the Plan Area the current distribution and status of roosts is not well understood. For example, Townsend's big-eared bats may be using deep mine shafts that have not been accessed by qualified biologists (CDFG 1998) or monitored for bats entering or leaving (Szewczak, pers. comm. 2012).

Management and Monitoring Considerations

The primary management and monitoring consideration for Townsend's big-eared bat is protection of day and night roosts from disturbance that may cause abandonment. This species is very sensitive to human disturbance because it tends to roost at the entrances of caves and may be found hanging from ceilings and walls where it is susceptible to disturbance. Occupied maternity and winter roosts should be considered a highly valuable resource, and impacts should be avoided. Maintaining these sites requires protecting them from human disturbances and adjacent land uses that could cause direct mortality or injury of big-eared bats or abandonment of the roost site. Protection of riparian habitats and desert wash near roost sites (e.g., within 5 miles) is also important because these areas are important prey resource areas.

Another consideration for Townsend's big-eared bat for monitoring and management is that their echolocation signals are relatively weak. (Their large pinnae amplify weak echoes from their low amplitude calls, which enable them to more closely approach their primary prey of moths, many of which can hear, and defensively react, to bat echolocation calls [Szewczak, pers. comm. 2012]). O'Farrell and Gannon (1999) found that the big-eared bat was more effectively sampled using capture methods because their calls could only be detected at less than about 5 meters (16 feet) from the bat with the existing bat detectors. New generation acoustic detectors are more sensitive and can be deployed for long time periods, and therefore are better able to detect the species (Szewczak, pers. comm. 2012). Nonetheless, monitoring for this species may remain a challenge

because the probability of detection could still be limited without broad spatial coverage of monitoring stations due to its restricted area around the primary roost used for foraging (Szewczak, pers. comm. 2012). Further, this species is difficult to physically capture due to its slow flight and high maneuverability (Szewczak, pers. comm. 2012).

Species Modeled Habitat Distribution

This section provides the results of habitat modeling for Townsend's big-eared bat, using available spatial information and occurrence information, as appropriate. For this reason, the term "modeled suitable habitat" is used in this section to distinguish modeled habitat from the habitat information provided in Habitat Requirements, which may include additional habitat and/or microhabitat factors that are important for species occupation, but for which information is not available for habitat modeling.

There are 16,824,190 acres of modeled suitable habitat for Townsend's big-eared bat in the Plan Area. Appendix C includes a figure showing the modeled suitable habitat in the Plan Area.

Literature Cited

- 44 FR 69206–69208. Final rule. "Endangered and Threatened Wildlife and Plants; Listing of Virginia and Ozark Big-Eared Bats as Endangered Species, and Critical Habitat Determination." November 30, 1979.
- Baerwald, E.F., and R.M.R. Barclay. 2009. "Geographic Variation in Activity and Fatality of Migratory Bats at Wind Energy Facilities." *Journal of Mammalogy* 90(6):1341–1349.
- Black, H.L. 1974. "A North Temperate Bat Community: Structure and Prey Populations." *Journal of Mammalogy* 55:138–157.
- BLM (Bureau of Land Management). 2005. *Final Environmental Impact Report and Statement for the West Mojave Plan*. A Habitat Conservation Plan and California Desert Conservation Area Plan Amendment. January 2005.

- BLM. 2008. "6840 – Special Status Species Management." BLM manual. Last revised December 12, 2008. Accessed November 30, 2011. http://www.blm.gov/pgdata/etc/medialib/blm/wo/InformationResourcesManagement/policy/im_attachments/2009.Par.13736.File.dat/IM2009-039_att1.pdf.
- Brown, P.E., R. Berry, and C. Brown. 1994. "Foraging Behavior of Townsend's Big-eared Bats (*Plecotus townsendii*) on Santa Cruz Island." In *The Fourth California Islands Symposium: Update on the Status of Resources*, edited by W.L. Halvorson and G.J. Maender, 367–369. Santa Barbara, California: Santa Barbara Museum of Natural History.
- CDFG (California Department of Fish and Game). 1998. *Distribution, Status, and Management of Townsend's Big-Eared Bat (Corynorhinus townsendii) in California*. Final Report. Prepared by E.D. Pierson and W.E. Rainey (University of California, Davis; Wildland Resources Center) for CDFG, Wildlife Management Division, Bird and Mammal Conservation Program (BMCP). BMCP Technical Report, no. 96-7. May 1998. Accessed November 2011. http://www.dfg.ca.gov/wildlife/nongame/publications/bm_research/bm96.html.
- CDFG. 2011. "Special Animals (898 taxa)." California Natural Diversity Database. CDFG, Biogeographic Data Branch. January 2011. Accessed November 21, 2011.
- CDFW (California Department of Fish and Wildlife). 2013. "*Corynorhinus townsendii*." Element Occurrence Query. California Natural Diversity Database (CNDDDB). RareFind, Version 4.0 (Commercial Subscription). Sacramento, California: CDFW, Biogeographic Data Branch. Accessed September 2013. <http://www.dfg.ca.gov/biogeodata/cnddb/mapsanddata.asp>.
- Clark, B.S., D.M. Leslie Jr., and T.S. Carter. 1993. "Foraging Activity of Adult Female Ozark Big-Eared Bats (*Plecotus townsendii ingens*) in Summer." *Journal of Mammalogy* 74(2):422–427.

- Clark, B.S., B.K. Clark, and D.M. Leslie Jr. 2002. "Seasonal Variation in Activity Patterns of the Endangered Ozark Big-Eared Bat (*Corynorhinus Townsendii* Ingens)." *Journal of Mammalogy* 83(2):590–598.
- Cryan, P.M., and R.M.T. Barclay. 2009. "Causes of Bat Fatalities at Wind Turbines: Hypotheses and Predictions." *Journal of Mammalogy* 90(6):1330–1340.
- Cryan, P.M., and A.C. Brown. 2007. "Migration of Bats Past a Remote Island Offers Clues toward the Problem of Bat Fatalities at Wind Turbines." *Biological Conservation* 139:1–11.
- Cryan, P.M. 2011. "Wind Turbines as Landscape Impediments to the Migratory Connectivity of Bats." *Environmental Law* 41:355–370.
- Dobkin, D.S., R.D. Gettinger, and M.G. Gerdes. 1995. "Springtime Movements, Roost Use, and Foraging Activity of Townsend's Big-Eared Bat (*Plecotus Townsendii*) in Central Oregon." *Great Basin Naturalist* 55(4):315–321.
- Dudek. 2013. "Species Occurrences–*Corynorhinus townsendii*." DRECP Species Occurrence Database. Updated September 2013.
- Fellers, G.M., and E.D. Pierson. 2002. "Habitat Use and Foraging Behavior of Townsend's Big-Eared Bat (*Corynorhinus townsendii*) in Coastal California." *Journal of Mammalogy* 83: 167–177.
- Frank, K.D. 1988. "Impact of Outdoor Lighting on Moths: An Assessment." *Journal of the Lepidopterists' Society* 42(2):63–93.
- Frost, D.R., and R.M. Timm. 1992. "Phylogeny of Plecotine Bats (Chiroptera: "Vespertilionidae"): Summary of the Evidence and Proposal of a Logically Consistent Taxonomy." *American Museum Novitates* 3034:1–16.
- Gellman, S.T., and W.J. Zielinski. 1996 "Use by Bats of Old-Growth Redwood Hollows on the North Coast of California." *Journal of Mammalogy* 77(1):255–265.

- Hall, E.R. 1981. *The Mammals of North America*. Volume 2. 2nd ed. New York, New York: John Wiley & Sons. April 20, 1981.
- Handley, C.O. Jr. 1959. "A Revision of American Bats of the Genera *Euderma* and *Plecotus*." In *Proceedings of the United States National Museum* 110(3417):95-246.
- Hooper, S.R., and R.A. Van Den Bussche. 2001. "Phylogenetic Relationships of Plecotine Bats and Allies Based on Mitochondrial Ribosomal Sequences." *Journal of Mammalogy* 82(1):131-137.
- Humphrey, S.R., and T.H. Kunz. 1976. "Ecology of a Pleistocene Relict, the Western Big-Eared Bat (*Plecotus townsendii*), in the Southern Great Plains." *Journal of Mammalogy* 57(3):470-494.
- Johnson, G.D., and M.D. Strickland. 2004. "An Assessment of Potential Collision Mortality of Migrating Indiana Bats (*Myotis sodalis*) and Virginia Big-eared Bats (*Corynorhinus townsendii virginianus*) Traversing between Caves, Supplement to: Biological Assessment for the Federally Endangered Indiana Bat (*Myotis sodalis*) and Virginia Big-eared Bat (*Corynorhinus townsendii virginianus*)." NedPower Mount Storm Wind Project, Grant County, West Virginia. Prepared for NedPower Mount Storm LLC, Chantilly, Virginia.
- Johnson, G.D., and W.P. Erickson. 2008. Final Report Avian and Bat Cumulative Impacts Associated with Wind Energy Development in the Columbia Plateau Ecoregion of Eastern Washington and Oregon. Prepared for Klickitat County Planning Department. October 30, 2008.
- Kunz, T.H., and R.A. Martin. 1982. "*Plecotus townsendii*." American Society of Mammalogists. *Mammalian Species* 175:1-6.
- Kuvlesky, W.P. Jr., L.A. Brennan, M.L. Morrison, K.K. Boydston, B.M. Ballard, and F.C. Bryant. 2007. "Wind Energy Development and Wildlife Conservation: Challenges and Opportunities." *Journal of Wildlife Management* 71(8):2487-2498. Accessed March 26, 2011. doi: 10.2193/2007-248.

Longcore, T., and C. Rich. 2004. "Ecological Light Pollution." *Frontiers in Ecology and the Environment* 2:191–198.

López-González, C., and L. Torres-Morales. 2004. "Use of Abandoned Mines by Long-eared Bats, Genus *Corynorhinus* (Chiroptera: Vespertilionidae) in Durango, Mexico." *Journal of Mammalogy* 85:989–994.

MAGTFTC MCAGCC (Marine Air Ground Task Force Training Command, Marine Corps Air Ground Combat Center). 2007. Marine Air Ground Task Force Training Command, Marine Corps Air Ground Combat Center Integrated Natural Resources Management Plan: Fiscal Years 2007–2011. Twentynine Palms, California: MAGTFTC MCAGCC. Accessed December 16, 2011. [http://www.marines.mil/unit/logistics/Documents/LFL/LFL-1/NaturalResources/Plans/MCAGCC%20Twentynine%20Palms/29Palms INRMP-07.pdf](http://www.marines.mil/unit/logistics/Documents/LFL/LFL-1/NaturalResources/Plans/MCAGCC%20Twentynine%20Palms/29Palms%20INRMP-07.pdf).

NAWS and BLM (Naval Air Weapons Station and Bureau of Land Management). 2004. Environmental Impact Statement for Proposed Military Operational Increases and Implementation of Associated Comprehensive Land Use and Integrated Natural Resources Management Plans. Final. China Lake and Ridgecrest, California: NAWS and BLM. February 2004. Accessed December 16, 2011. http://www.envirostor.dtsc.ca.gov/regulators/deliverable_documents/1967313468/Final%20EIS%20Threatened%20and%20Endangered%20Species.pdf.

O'Farrell, M.J., and W.L. Gannon. 1999. "A Comparison of Acoustic Versus Capture Techniques for Inventory of Bats." *Journal of Mammalogy* 80:24–30.

Pearson, O.P., M.R. Korford, and A.K. Pearson. 1952. "Reproduction of the Lump-nosed Bat (*Corynorhinus rafinesquii*) in California." *Journal of Mammalogy* 33:273–320.

- Piaggio, A.J., K.W. Navoy, and C.W. Stihlerz. 2009. "Intraspecific Comparison of Population Structure, Genetic Diversity, and Dispersal Among Three Subspecies of Townsend's Big-Eared Bats, *Corynorhinus townsendii townsendii*, *C. t. pallescens*, and the Endangered *C. t. virginianus*." *Conservation Genetics* 10:143–159
- Piorkowski, M.D., and T.J. O'Connell. 2010. "Spatial Pattern of Summer Bat Mortality from Collisions with Wind Turbines in Mixed-grass Prairie." *The American Midland Naturalist* 164(2):260–269.
- Ross, A. 1967. "Ecological Aspects of the Food Habits of Insectivorous Bats. In *Proceedings of the Western Foundation of Vertebrate Zoology* 1: 205–263.
- Sample, B.E., and R.C. Whitmore. 1993. "Food Habits of the Endangered Virginia Big-Eared Bat in West Virginia." *Journal of Mammalogy* 74(2):428–435.
- Sherwin, R.E., D. Strickland, and D.S. Rogers. 2000. "Roosting Affinities of Townsend's Big-eared Bat (*Corynorhinus townsendii*) in Northern Utah." *Journal of Mammalogy* 81:939–947.
- Sherwin, R.E., W.L. Gannon, and J.S. Altenbach. 2003. [Abstract] "Managing Complex Systems Simply: Understanding Inherent Variation in the Use of Roosts by Townsend's Big-Eared Bat." *Wildlife Society Bulletin* 31(1):62–72.
- Szewczak, J. 2012. Personal communication (email and profile review comments) from J. Szewczak (Humboldt State University) to M. Unyi (ICF). May 1, 2012.
- Szewczak, J.M., S.M. Szewczak, M.L. Morrison, and L. Hall. 1998. "Bats of the White-Inyo Range." *Great Basin Naturalist* 58(1):66–75.
- TetraTech EC, Inc. 2010. *Bat Likelihood of Occurrence Report Cimarron Wind Energy Project – Phase 1 Gray County, Kansas*. Prepared for CPV Cimarron Renewable Energy Company LLC. Boston, Massachusetts: TetraTech EC Inc.

- Tumlinson, R., and M.E. Douglas. 1992. "Parsimony Analysis and the Phylogeny of the Plecotine Bats (Chiroptera: Vespertilionidae). *Journal of Mammalogy* 73(2):276–285.
- Whitaker, J.O., C. Maser, and L.E. Keller. 1977. "Food Habitat of Bats of Western Oregon." *Northwest Science* 51(1):46–55.
- Whitaker, J.O., C. Maser, and S.P. Cross. 1981. "Food Habitat of Eastern Oregon Bats, Based on Stomach and Scat Analyses." *Northwest Science* 55(4):281–292.
- Wilson, D.E., and D.M. Reeder, eds. 2005. *Mammal Species of the World: A Taxonomic and Geographic Reference*. 3rd ed. Baltimore, Maryland: Johns Hopkins University Press
- Zeiner, D.C., W.F. Laudenslayer Jr., K.E. Mayer, and M. White, eds. 1990. *California's Wildlife: Volume III, Mammals*. Sacramento, California: CDFG.
- Zielinski, W.J., and S.T. Gellman. 1999. "Bat Use of Remnant Old-Growth Redwood Stands." *Conservation Biology* 13(1):160–167.

INTENTIONALLY LEFT BLANK