State of California
Department of Fish and Wildlife

Memorandum

Date: June 15, 2016

To: Valerie Termini
Executive Director
Fish and Game Commission

From: Charlton H. Bonham
Director

Subject: Status Review of Townsend's Big-eared Bat

The Department of Fish and Wildlife (Department) has prepared the attached Status Review for the Fish and Game Commission (Commission) regarding the Center for Biological Diversity's Petition to list Townsend's big-eared bat (*Corynorhinus townsendii*) as threatened or endangered pursuant to the California Endangered Species Act (CESA, specifically Fish and Game Code section 2074.6). The Commission received the petition on November 1, 2012. The attached status review represents the Department's final written review of the status of Townsend's big-eared bat and is based upon the best scientific information available to the Department. The status review contains the Department's recommendation that listing of Townsend's big-eared bat as threatened or endangered is not warranted.

Regarding the scientific determinations of the threats to Townsend's big-eared bat, the Department finds that the species is not at serious risk of extinction or endangerment due to the threats identified in the Petition and addressed in the attached Status Review.

If you have any questions or need additional information, please contact Kari Lewis, Acting Chief, Wildlife Branch at (916) 445-3789.

Attachment

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STATE OF CALIFORNIA
NATURAL RESOURCES AGENCY
DEPARTMENT OF FISH AND WILDLIFE

REPORT TO THE FISH AND GAME COMMISSION

A STATUS REVIEW OF TOWNSEND'S BIG-EARED BAT (*CORYNORHINUS TOWNSENDII*) IN CALIFORNIA

CHARLTON H. BONHAM, DIRECTOR
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

June 6, 2016

Report to the Fish and Game Commission
A Status Review of Townsend's Big-Eared Bat in California

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Executive Summary

On November 1, 2012, the California Fish and Game Commission (Commission) received the "Petition to List the Townsend's big-eared bat *(Corynorhinus townsendii*) as endangered under the California Endangered Species Act" (dated October 18, 2012; hereafter, the Petition), as submitted by the Center for Biological Diversity. At its public meeting on June 26, 2013 in Sacramento, California, the Commission considered the Petition, the Evaluation and recommendation by the California Department of Fish and Wildlife (CDFW), and comments received and found that sufficient information existed to indicate the petitioned action may be warranted and accepted the Petition for Consideration. Upon publication of the Commission's notice of its findings, Townsend's big-eared bat was designated a candidate species on November 14, 2013 (Cal. Reg. Notice Register 2013, No. 52-Z, p. 2092).

This report contains the results of CDFW's status review, including independent peer review of the draft report by scientists with expertise relevant to the Townsend's big-eared bat. This report provides the Commission with the most current, scientifically-based information available on the status of Townsend's big-eared bat in California and serves as the basis for CDFW's recommendation to the Commission.

Species Description. Townsend's big-eared bat is a medium sized bat. Among western North American bats, Townsend's big-eared bat is unique with its combination of a two-pronged, horseshoe-shaped lump on the muzzle and large, long ears. Townsend's big-eared bat ranges throughout much of the western United States and Canada (Figure 1). In California, its geographic range is generally considered to encompass the entire state, except for the highest elevations of the Sierra Nevada (Figure 2).

Townsend's big-eared bat is a colonial species. Maternity colonies form between March and June, with the timing varying based on local climate, elevation, and latitude. Colonies typically range from a few dozen to several hundred individuals, although colonies of over 1,000 have been documented. A single pup is born between May and July. While adult males are typically solitary during the maternity season, adult females and their pups cluster together in colonial roosts. Nursery colonies typically begin to disperse in August about the time the young are weaned and break up altogether in September and October. Maximum fecundity per adult female is one pup per year.

Once a roost site has been successfully colonized by Townsend's big-eared bat (whether for the warm or hibernation season), it is likely to be used in subsequent years, so long as it remains suitable (Humphrey and Kunz 1976). However, it is not unusual for individuals to move among multiple maternity colonies and even for entire maternity colonies to switch roosts during the course of the season (Fellers and Pierson 2002, Sherwin et al. 2000, 2003). Some roosts are only used for short periods of time or during occasional years. Townsend's big-eared bat's perceived susceptibility to human disturbance at roost sites is usually cited as a key behavioral characteristic putting the species at conservation risk (Twente 1955, Barbour and Davis 1969, Humphrey and Kunz 1976). Roost abandonment (sometimes resulting in death of pups) has been documented following human entry into roosts.

Diet of Townsend's big-eared bat has not been examined in detail in California; however, it is likely that as elsewhere they are lepidopteran specialists, feeding primarily on medium-sized moths, supplemented with occasional captures of other insects, including flies, beetles, and aquatic insects.

Townsend's big-eared bat, like most mammals, maintains a high body temperature primarily through heat produced by its metabolism. Like many bat species inhabiting temperate regions, Townsend's big-eared bat uses torpor as a physiological and behavioral strategy in winter to deal with diminished food resources and cool or cold ambient temperatures, which make it energetically costly to maintain normal high body temperature. Townsend's big-eared bat hibernation sites are generally caves or mines (Pearson et al. 1952, Barbour and Davis 1969), although animals are occasionally found in buildings (Dalquest 1947). In areas with prolonged periods of non-freezing temperatures, Townsend's big-eared bat tends to form relatively small hibernating aggregations of single to several dozen individuals, and may be active during the winter to take advantage of warm weather and prey availability. Larger aggregations (75-460 individuals) are confined to areas that experience prolonged periods of freezing temperatures (Pierson and Rainey 1998).

Habitat associations for Townsend's big-eared bat in California include the inland deserts (Colorado, Mojave, Great Basin); cool, moist coastal redwood forests; oak woodlands of the Sierra Nevada foothills and coastal mountains; and lower to mid-elevation mixed coniferous-deciduous forests. Townsend's big-eared bat has also been observed hibernating in the bristlecone-limber pine habitat of the White Mountains (Inyo County).

Townsend's big-eared bat prefers open surfaces of caves or cave-like structures, such as mine adits and shafts. It has also has been reported in such structures as buildings, bridges, and water diversion tunnels that offer a cave-like environment. It has been found in rock crevices and, like a number of bat species, in large hollow trees. Foraging associations include edge habitats along streams and areas adjacent to and within a variety of wooded habitats. CDFW considers any structure, or set of structures, used by Townsend's big-eared bat as a maternity or hibernation roost to be habitat essential for the continued existence of the species. The essential characteristics of these suitable roost sites extend to the nearby foraging, commuting, and night-roosting habitat and therefore these adjacent habitats are also considered essential.

Status. The two western subspecies of Townsend's big-eared bat are not currently listed as endangered or threatened nor are they candidates for listing under the federal Endangered Species Act (ESA). Two eastern subspecies are listed as Threatened under the ESA.

NatureServe, a non-profit conservation organization whose mission is to provide the scientific basis for effective conservation action through its network of natural heritage programs, ranks Townsend's big-eared bat as a whole and each of the two non-listed subspecies (*C. t. pallescens* and *C. t. townsendii*) as "G3G4/T3T4" throughout their respective geographic ranges. This designation indicates uncertainty regarding conservation status, which may be characterized as either Apparently Secure (G4/T4) or Vulnerable (G3/T3). NatureServe defines "Vulnerable" as "at moderate risk of extinction or elimination due to a restricted range, relatively few populations, recent and widespread declines, or other factors"

and “Apparently Secure” as “Uncommon but not rare; some cause for long-term concern due to declines or other factors.” (http://explorer.natureserve.org/granks.htm).

The current version of the International Union for the Conservation of Nature Red List designates Townsend’s big-eared bat as a ‘Least Concern’ species based on the latest assessment of the species range-wide. The IUCN had previously designated the species in 1996 as ‘Vulnerable.’ The Least Concern designation is based on “its wide distribution, presumed large population, occurrence in a number of protected areas and because it is unlikely to be declining at nearly the rate required to qualify for listing in a threatened category.”

Despite the long-standing designation of Townsend’s big-eared bat as a Species of Special Concern in California (Williams 1986), there has not been a statewide effort to assess the conservation status of the species since Pierson and Rainey’s work in the late 1980s and early 1990s (Pierson and Rainey 1998). To describe Townsend’s big-eared bat population trend in California, the Petition relied heavily on the 1998 report prepared for the Department of Fish and Game (now CDFW). Pierson and Rainey conducted surveys of Townsend’s big-eared bat maternity colonies and hibernacula throughout much of the species’ range in California during the period 1987 to 1991, and compared results to the original site reports during the period 1918 to 1974. Their surveys focused primarily on maternity colonies to assess population status and reproductive capacity. Eighteen historically known maternity colonies with estimates of colony sizes were assessed as part of the study. Six of the colonies were inferred to have been extirpated, five had declined in number of females by more than 20%, four had remained relatively constant in numbers, and three colonies had increased by more than 20%. The authors lumped all 18 colonies’ original population counts to get a historical-period population estimate of 3,004 adult females. Based on their counts during the 1987-1991 surveys, they estimated these colonies had declined by 55% to a total of 1,365 adult females.

The authors also found a decline in the total number of colonies known from the historical period to the resurveys. Of 46 historically-known maternity colonies (many without counts), the authors could not find 24 (either at the original site or within 15 km (9.3 mi) of the original site), which represented a 52% decrease in the number of historically-known colonies.

These comparisons between historical and recent colony numbers and colony size, which were extrapolated to infer changes in total population sizes, suggested that, as of the early 1990s, there had been a decline in the total numbers of Townsend’s big-eared bat in California since the early 20th Century. In combination with other aspects of the species’ biology and observations of human disturbance at Townsend’s big-eared bat roost sites, the trend information collated by Pierson and Rainey (1998) led to their inference that the California Townsend’s big-eared bat population had declined over the several decades before their study.

Based on location and date information gathered by CDFW from researchers and the state’s database in June 2014 for this review (Figure 3), Townsend’s big-eared bat appears to be fairly well distributed throughout much of its historic range in California. This database is comprised of more than 800

occurrence records. There is no evidence of a range contraction with the possible exception of highly populated areas near the coast.

CDFW is currently implementing a State Wildlife Grant-funded project to assess the current conservation status of Townsend's big-eared bat in California. The new statewide survey effort is being conducted over a two-year period and is targeting known and highly-suitable locations for maternity and hibernation roosts. This project has been contracted to researchers from Humboldt State University and Texas A&M University (Joe Szewczak and Michael Morrison) and should provide an updated snapshot of the species' distribution as of 2015-2017. However, the results are not yet available.

For purposes of this status review, CDFW has compiled information from a number of maternity and hibernation roosts from around California where monitoring is conducted (six case studies, Figure 4) in order to assess trends in colony size at specific sites where management is in place. Of the six studies, five concluded that the site specific populations are stable or increasing, while the sixth is stable to decreasing. While this does not result in a statistically valid estimate of the Townsend's big-eared bat population size or trend statewide, it does illustrate how colony sizes and threats vary around the state, as well as how management of roosts directly affects the local assemblages of Townsend's big-eared bats in these areas.

Threats. CDFW has identified the following factors as potential threats to the continued existence of Townsend's big-eared bat in California: loss, degradation, and sustained disturbance of roost sites; loss and degradation of foraging habitat; disease; mining and associated abandoned mine closures; environmental contaminants; climate change and drought; and overexploitation.

The availability of suitable roosting habitat is often considered as a limiting factor for western bat populations. Impacts to roost sites are an important threat to Townsend's big-eared bat. Such impacts include both physical loss/modification of the roost site as well as disturbance of bats at the roost site.

Within the North Coast region of California, the loss of old-growth conifers with large, cavernous basal hollows during late 19th Century and early to mid-20th Century industrial-scale logging is presented as a likely explanation for the apparent decline of Townsend's big-eared bat colonies in the coastal forest of northern and central California (Pierson and Rainey 1998). New and renewed mining operations have the potential to impact Townsend's big-eared bat roosting in abandoned mines, either through disturbance of roosting bats or by destroying the old mine by conversion to open pit-style mining, or through collapse of abandoned mines. Dam construction or modification can result in the inundation of Townsend's big-eared bat roost sites. Although generally considered a cave/mine roosting bat, Townsend's big-eared bat also roosts in large spaces in old buildings and in cavernous spaces in bridges and dams. Bats in such sites are subject to disturbance when humans enter for inspections or other activities. The roosts themselves are subject to eventual deterioration or demolition.

Pearson et al. (1952) documented temporary abandonment of maternity roosts in California as a direct result of his research team entering the roost site to band young. Fellers and Halstead (2015) showed a strong negative relationship between attempted unlawful entries into the Randall House Townsend's

big-eared bat maternity roost (coastal Marin County) and overall colony reproductive success on an annual basis. There are many other reports of abandonment of maternity roosts and even dependent young resulting in their death following roost disturbance.

Disturbance, degradation, and loss of suitable roost sites are recognized threats to Townsend's big-eared bat populations, both in natural roost sites such as large, old trees and caves, as well as in human-made roosts such as old buildings and mines. Although roost sites are now generally managed and protected better than in historical periods, lacking the protections of CESA it is possible the species could be impacted at multiple roost sites in the future, which could lead to population-level impacts.

However, there is no current indication disturbance of roost sites is a significant state-wide threat to the species. Additionally, although impacts to foraging habitat could also affect the species, there is no indication that current impacts to foraging habitat pose a significant threat at this time. Therefore, CDFW does not consider modification and destruction of foraging habitat to be a significant threat to the continued existence of the Townsend's big-eared bat in California. Loss of suitable foraging habitat in the vicinity of roosts has previously been identified as a threat to Townsend's big-eared bat (Pierson and Rainey 1998, Pierson and Fellers 1998, Brown and Berry 2003).

CDFW does not consider overexploitation, predation, or competition to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

White Nose Syndrome (WNS) is a disease that has killed more than 6 million bats in eastern North America (USFWS 2012). It is caused by *Pseudogymnoascus destructans* (Pd), a cold-loving fungus that is thought to have been introduced into northeastern North America from Europe sometime in the early 2000s. The fungus grows in the skin and other tissues of hibernating bats and may affect multiple physiological systems of the bats during the winter period. The most obvious effect on hibernating bats is that infected individuals arouse from deep torpor much more frequently and for longer periods than non-infected bats, which drastically reduces the fat reserves needed to sustain the bats until insect prey is available in the spring. Most affected bats die of starvation, with mortality rates for some species (e.g., *Myotis lucifugus*, the little brown bat) approaching 100% in some eastern hibernacula.

CDFW considers WNS an important potential threat to California populations of Townsend's big-eared bat, but the disease has not yet been detected in California and is not currently impacting Townsend's big-eared bat in California. Therefore, CDFW does not consider disease to be a significant threat to the continued existence of the Townsend's big-eared bat in California at this time. CDFW does not consider other diseases such as rabies to be a threat to the Townsend's big-eared bat in California.

Human-produced toxins may be released or applied to the environment in many forms. Of greatest potential impact to Townsend's big-eared bat are toxins used for control of agricultural and other pests (pesticides), byproducts of mining and ore processing, and air quality contaminants.

Climate change, especially more frequent and severe drought, has the potential to impact Townsend's big-eared bat in California. Based on MaxEnt modeling using climatic variables to model the current and possible future distribution of the species under four different future climate change projections for the

period 2070 to the end of the 21st Century, Townsend's big-eared bat is projected to fare reasonably well, in terms of availability of climatically suitable habitat in California (see Figure 11). At this time CDFW has determined that climate change does not pose a significant threat to the species. Continued and increased monitoring of the species' abundance and distribution should help determine the actual impact of these threats to the species.

A number of recommended management actions are listed in the body of the report. This list includes recommendations for actions that could be undertaken by CDFW as well as by other public agencies, non-governmental organizations, and private landowners. Mining (including renewed mining), agricultural development and pesticide use, restoration or demolition of old buildings and other anthropogenic structures used as roosts, forest management, and recreational caving and mine exploration all have the potential to impact Townsend's big-eared bat populations. State and federal environmental review programs typically include assessment and disclosure of potential impacts to the species in the CEQA/NEPA process. Adequate environmental review should prevent such activities from affecting Townsend's big-eared bat at the population or statewide level.

Recommendation. CDFW includes and makes its recommendation in its status report as submitted to the Commission in an advisory capacity based on the best available science. In consideration of the scientific information contained herein, CDFW has determined that the petitioned action is not warranted at this time.

INTRODUCTION

Petition Evaluation Process

On November 1, 2012, the California Fish and Game Commission (Commission) received the "Petition to List the Townsend's big-eared bat *(Corynorhinus townsendii*) as endangered under the California Endangered Species Act" (dated October 18, 2012; hereafter, the Petition), as submitted by the Center for Biological Diversity. Commission staff transmitted the Petition to the Department of Fish and Wildlife (CDFW) pursuant to Fish and Game Code section 2073 on November 9, 2012, and the Commission published formal notice of receipt of the Petition on November 30, 2012 (Cal. Reg. Notice Register 2012, No. 48-Z, p. 1747). After evaluating the Petition and other relevant information CDFW possessed or received, CDFW provided the Commission with the a report "Evaluation of the Petition from the Center for Biological Diversity to List Townsend's Big-Eared Bat (*Corynorhinus townsendii*) as Threatened or Endangered Under the California Endangered Species Act" (Evaluation). CDFW determined, pursuant to Fish and Game Code section 2073.5, subdivision (a), that sufficient scientific information exists to indicate that the petitioned action may be warranted and recommended the Commission accept the Petition (CDFW 2013). At its scheduled public meeting on June 26, 2013 in Sacramento, California, the Commission considered the Petition, CDFW's Evaluation and recommendation, and comments received. The Commission found that sufficient information existed to indicate the petitioned action may be warranted and accepted the Petition for Consideration. Upon publication of the Commission's notice of its findings, Townsend's big-eared bat was designated a candidate species on November 14, 2013 (Cal. Reg. Notice Register 2013, No. 52-Z, p. 2092).

Department Status Review

Following the Commission's action designating the Townsend's big-eared bat as a candidate species, and pursuant to Fish and Game Code section 2074.4, CDFW solicited information from agencies, educational institutions, tribes, and the public to inform the review of the species' status using the best scientific information available. At its scheduled public meeting on December 3, 2014 in Van Nuys, California, the Commission granted CDFW a six-month extension to facilitate external peer review. This report contains the results of CDFW's status review, including independent peer review of the draft report by scientists with expertise relevant to the Townsend's big-eared bat. The purpose of this status review is to fulfill the mandate as required by Fish and Game Code section 2074.6 and to provide the Commission with the most current, scientifically-based information available on the status of Townsend's big-eared bat in California, and to serve as the basis for CDFW's recommendation to the Commission.

BIOLOGY AND ECOLOGY[1]

Species Description

Townsend's big-eared bat is a medium sized (10-12 g) bat with an adult forearm length of 39-48 mm and ear length of 30-39 mm. Townsend's big-eared bat generally has buffy brown dorsal fur with somewhat paler underparts (Barbour and Davis 1969, Kunz and Martin 1982). Among western North American bats, Townsend's big-eared bat is unique with its combination of a two-pronged, horseshoe-shaped lump on the muzzle and large, long ears. Although other California bats have long ears, no other has both large ears and the two-pronged nose lump. The other large-eared bat species have other characteristics that readily distinguish them from Townsend's big-eared bat.

Townsend's big-eared bat has relatively broad and short wings, which provides a low body mass-to-wing area ratio (wing load) (Norberg and Rayner 1987). Low wing loading confers high maneuverability and good economy of power, and take-off at low speeds. It may also allow the species to take advantage of pulses in prey availability by ingesting a large mass of insects when they are available (Norberg and Rayner 1987).

Systematics

Townsend's big-eared bat (Class Mammalia, Order Chiroptera) is in the Microchiropteran family Vespertilionidae, which contains the most species of the four bat families in the United States. There are two other species of *Corynorhinus*: *Corynorhinus rafinesquii,* Rafinesque's big-eared bat, and *Corynorhinus mexicanus,* the Mexican big-eared bat. The North American genus of big-eared bats now known as *Corynorhinus* was for several decades known as *Plecotus*, and much of the older scientific literature used that name.

There are five currently recognized subspecies of Townsend's big-eared bat in the United States (Handley 1959, Piaggio and Perkins 2005)(see Figure 1). Two of the subspecies (*C. t. townsendii* and *C. t. pallescens*) occur throughout much of western North America (including California), two (the Ozark big-eared bat, *C. t. ingens,* and the Virginia big-eared bat, *C. t. virginianus*) occur in the eastern United States, and one (*C. t. australis*) is distributed primarily in Mexico but also extends into Texas. Both of the eastern subspecies of Townsend's big-eared bat (the Ozark and Virginia big-eared bats) are listed by the U.S. Fish and Wildlife Service as Endangered.

[1] Much of the information presented here on the biology of Townsend's big-eared bat has been adapted from the draft species account prepared by E.D Pierson, W.E. Rainey, and L. Angerer for the California Bat Conservation Plan (CDFW in prep.). Personal communications and personal observations cited without a year reference are from the draft species account. All other personal communications were between the referenced person and Scott Osborn, CDFW Senior Environmental Scientist with the Wildlife Branch, Nongame Wildlife Program.

This classification scheme follows the presumed evolutionary history of Townsend's big-eared bat and related bat species. Tumlison and Douglas (1992) used cladistic analysis of shared acquired characteristics to determine that the New World *Corynorhinus* species comprise a distinct lineage from both the Old World *Plecotus* species (which they had formerly been grouped with under the genus name *Plecotus*) and two other big-eared bat genera (*Idionycteris* and *Euderma*).

Piaggio and Perkins (2005) examined the evolutionary relationships within *Corynorhinus* using both mitochondrial and nuclear DNA. Their results confirmed the status of the five Townsend's big-eared bat subspecies, suggested that *C.townsendii* and *C. mexicanus* are more closely related to each other than to *C. rafinesquii*, and that levels of genetic divergence among the Townsend's big-eared bat subspecies are relatively high (Piaggio and Perkins 2005).

Within Townsend's big-eared bat itself, DNA analysis has shown the western-most subspecies, *C. townsendii townsendii*, may have diverged from the other Townsend's big-eared bat subspecies between 41,000 and 64,000 years ago, while *C. townsendii pallescens* diverged 12,000 to 23,000 years ago, and *C. townsendii australis* diverged between 6,000 and 20,000 years ago (Smith et al. 2008). The timings of divergence and geographic pattern of the subspecies' ranges today suggested to the authors that the subspecies developed during periods of extensive glaciation in western North America when Townsend's big-eared bat populations were isolated from each other. Other mitochondrial DNA evidence suggests an earlier divergence of the five Townsend's big-eared bat subspecies (possibly as early as 1 million years ago), with subsequent effects on distribution during the Pleistocene (Lack and Van Den Bussche 2009).

Geographic Range and Distribution

Townsend's big-eared bat ranges throughout much of the western United States and Canada (Figure 1). In California, its geographic range is generally considered to encompass the entire state, except for the highest elevations of the Sierra Nevada (Figure 2). Within the general range, there are areas of greater and lesser probability of occupancy by Townsend's big-eared bat, with greatest concentrations in areas offering caves (commonly limestone or basaltic lava) or mines as roosting habitat.

Conversely, a general lack of Townsend's big-eared bat records in the Central Valley and Imperial Valley (Figure 2), along with a paucity of suitable roost structures, suggests these areas are unlikely to include day roosts of large numbers of resident Townsend's big-eared bat.

Individuals have been found from sea level along the coast to 1,820 m (6,000 ft) in the Sierra Nevada (Dalquest 1947, Pearson et al. 1952, Pierson and Rainey 1998). In the White Mountains, summer records for males extend up to 2,410 m (7,900 ft), and hibernating groups have been found in mines as high as 3,188 m (10,460 ft) (Szewczak et al. 1998). Maternity colonies are more frequently found below 2,000 m (6,560 ft) (Pierson and Fellers 1998, Szewczak et al. 1998). Outside California, Townsend's big-eared bat has been found to 2,400 m (7,900 ft) (Jones 1965, Jones and Suttkus 1971) and 2,900 m (9,500 ft) (Findley and Negus 1953).

As for the two Townsend's big-eared bat subspecies that occur in California, *C. t. townsendii* occurs primarily in the western-most portion of the species' range in California, Oregon, Washington, Nevada, Idaho, and possibly southwestern Montana and northwestern Utah. *C. t. pallescens* occurs in all the same states as *C. t. townsendii*, plus in more interior portions of the continent in Arizona, Colorado, New Mexico, Texas, and Wyoming (Handley 1959, Piaggio and Perkins 2005). Throughout much of their range in California, Idaho, Nevada, Oregon and Washington there are extensive zones of intergradation where it is difficult to assign individuals to one subspecies or the other based on external characteristics.

Population Genetics

Genetic studies can inform our understanding of animal populations, including the amount of mixing between subpopulations and level of genetic variability among and between individuals or subpopulations. Smith (2001) demonstrated the Townsend's big-eared bats in Oklahoma show high movement (high gene flow) of males across her study area (nuclear microsatellite DNA results) but finer scale movements of females (mitochondrial DNA results). This suggests higher local fidelity of females often remaining near natal roosts relative to males. While individual maternity colonies were highly differentiated from each other, they also included high levels of within-colony variation, indicating some movement of females among maternity colonies.

Miller's (2007) study of Townsend's big-eared bat genetics in southeastern Idaho used nuclear DNA and revealed that most individuals within a small number of hibernacula were not closely related to each other, contrary to an earlier suggestion based on a study in California by Pearson et al. (1952) that Townsend's big-eared bats within a hibernaculum should be closely related, since Townsend's big-eared bats mate at their hibernacula and have high fidelity to these sites. Miller (2007) suggested that "juveniles may disperse from natal colonies before settling and becoming philopatric to a single [hibernation] site, which could create these communities of unrelated individuals." Alternatively, it is possible that Townsend's big-eared bats in her study area are either not loyal to a single hibernaculum or do not mate at the hibernacula in which they over winter. She also found that adult females in maternity colonies are more closely related to each other than are juveniles, which is consistent with males dispersing longer distances than females.

The study by Piaggio and others (2009) of genetic structure, diversity, and dispersal among three subspecies of Townsend's big-eared bat in the Rocky Mountains region (*C. t. townsendii*, *C. t. pallescens*), and in the southeastern U.S. (the endangered *C. t. virginianus* subspecies) used both nuclear and mitochondrial DNA analyses. Their study revealed significantly lower genetic diversity in *C. t. virginianus*, compared to the other two subspecies, which is likely due to the lower number of individuals and their extended physical isolation from other groups of *C. townsendii* which has historically precluded input of novel haplotypes through gene flow. Their study also indicated relatively low levels of gene flow between *C. t. townsendii* and *C. t. pallescens* subspecies. On the other hand, some gene flow can occur at distances of 310 km (192 mi) (Piaggio et al. 2009) between roosts, which (with other recent data from movement studies) suggests that some individuals do move greater distances than has been historically hypothesized. These genetic results are consistent with the

observation that a simple geographic demarcation between the *C.t. pallescens* and *C.t. townsendii* subspecies is not sufficient to identify the subspecies of individuals.

Reproduction and Development

Townsend's big-eared bat is a colonial species. Maternity colonies form between March and June, with the timing varying based on local climate, elevation, and latitude. Colonies typically range from a few dozen to several hundred individuals, although colonies of over 1,000 have been documented. Mating generally takes place in both migratory sites and hibernacula between September or October and February. "Swarming" – a behavior where both sexes mix in autumn prior to moving to hibernacula – has been observed during the latter half of September in the Mojave Desert (P. Brown pers. comm.). Females are generally reproductive in their first year, whereas males typically do not reach sexual maturity until their second year. Gestation length varies with climatic conditions, but generally lasts from 56 to 100 days (Pearson et al. 1952). Studies indicate maternity colonies may move between multiple roost sites during the maternity season (e.g., Sherwin et al. 2000). In large complex mines, colonies may move to different areas within the same mine in response to different roost temperatures (P. Brown 2016 pers. comm.). Whether such movements are in response to habitat requirements for specific stages of reproduction (pregnancy, birthing, and rearing) or the result of other factors is unknown. Movement tends to be more frequent for small colonies and colonies roosting in smaller subterranean features (Sherwin et al. 2003).

A single pup is born between May and July (Easterla 1973, Pearson et al. 1952, Twente 1955). Townsend's big-eared bat pups average 2.4 g at birth, nearly 25% of the mother's postpartum mass (Kunz and Martin 1982). While adult males are typically solitary during the maternity season, adult females and their pups cluster together in colonial roosts (Pearson et al. 1952). Aggregations in maternity roosts have typical densities of between 100 and 150 adults and young per square foot of roost surface area occupied. Such clustering minimizes heat loss and allows more energy to be used for gestation, milk production (adults) and growth (pups). Young bats are capable of flight at 2.5 to 3 weeks of age and are gradually weaned by 2 months (Pearson et al. 1952). Nursery colonies typically begin to disperse in August about the time the young are weaned and break up altogether in September and October (Pearson et al. 1952, Tipton 1983).

Vital Rates (Reproduction, Survival)

Maximum fecundity per adult female is one pup per year. Pearson et al. (1952) estimated an average fecundity for the colonies in their study to be about 0.45 female pups per adult female per year. Examining exit count data from an undisturbed colony where counts were made both before and after young Townsend's big-eared bat became volant, it appears that the number of bats may increase by a factor of 1.5 to 2 (unpublished CDFW analysis of Kentucky Mine counts in 2005 and 2006). Assuming a 50:50 sex ratio of young, this would be equivalent to annual recruitment rates of 0.25 to 0.5 female young per adult female.

Pearson et al. (1952) estimated annual survival at about 50% for the first year of life and about 80% for adults. The authors determined these survival rates, combined with their estimates of fecundity, were

"just sufficient" to maintain a stable population during the years these colonies were studied (Pearson et al. 1952). Ellison (2010) estimated winter survival in a Washington Townsend's big-eared bat colony to range between 54% and 76%, with higher survival for females than for males. Band recoveries have yielded individual longevity records of 16 years, 5 months (Paradiso and Greenhall 1967) and 21 years, 2 months (Perkins 1994).

Behavior

Townsend's big-eared bat's perceived susceptibility to human disturbance at roost sites is usually cited as a key behavioral characteristic putting the species at conservation risk (Twente 1955, Barbour and Davis 1969, Humphrey 1969, Humphrey and Kunz 1976). As summarized by Pierson et al. (1991):

> Townsend's big-eared bats are so sensitive to human disturbance that simple entry into a nursery roost can be enough to induce the colony to abandon a site (Mohr 1972, Humphrey and Kunz 1976) … Activities as apparently harmless as recreational caving have been shown to have negative impacts … and have driven Townsend's big-eared bat from a number of their traditional roost sites in California (Graham 1966, Pierson unpubl. data).

Pearson et al. (1952) documented temporary abandonment of maternity roosts in California as a direct result of his research team entering the roost site to band young. Fellers and Halstead (2015) showed a strong negative relationship between attempted unlawful entries into the Randall House Townsend's big-eared bat maternity roost (coastal Marin County) and overall colony reproductive success on an annual basis.

Contrary to the general pattern of susceptibility to disturbance, one Townsend's big-eared bat maternity colony in California has demonstrated some tolerance to disturbance (Freeman 2012). The Kentucky Mine colony in Sierra County has persisted despite daily tours in the historic stamp mill building where the bats typically roost, though some impacts to the colony and changes in behavior (including temporary roost abandonment) have occurred there over the years (M. Tierney pers. comm. 2015). It should be noted the Kentucky Mine roost site is managed under guidance that emphasizes quiet, predictable disturbance events (tours) and minimizes other, novel types of disturbance. Clark et al. (1996, 1997) also noted one of the eastern Townsend's big-eared bat subspecies, the Ozark big-eared bat (*C. townsendii ingens* did not abandon roosts or caves despite some human entry and surmised this subspecies may tolerate more human activity than the western subspecies.

Once a roost site has been successfully colonized by Townsend's big-eared bat (whether for the warm or hibernation season), it is likely to be used in subsequent years, so long as it remains suitable (Humphrey and Kunz 1976). However, it is not unusual for individuals to move among multiple maternity colonies and even for entire maternity colonies to switch roosts during the course of the season, with some roosts only used for short periods or during occasional years (Fellers and Pierson 2002, Sherwin et al. 2000, 2003). It is possible that these patterns of roost switching have historically been interpreted as roost abandonment rather than normal behavioral patterns. While human disturbance can certainly negatively impact colonies of Townsend's big-eared bats, the intensity, duration, and type of

disturbance must be evaluated before concluding that human disturbance is the driving force behind dynamics of roost use (Sherwin et al. 2003, 2009).

As an example, maternity colonies of *C. townsendii* studied in Utah, Nevada, and California exhibit high levels of resiliency to disturbance with colonies maintaining occupancy of highly disturbed sites for many years prior to the protection of these roosts with bat gates (for example, at Logan Cave in Utah (R. Sherwin pers. comm. 2016)). This is an element of Townsend's big-eared bat biology requiring investigation. The anecdotal reports of movements perceived to result from human disturbance are available because humans were there to see it and report it. It is difficult to know how much movement would occur in the absence of human observation. In cases where maternity roosts are reclaimed (often as a result of renewed mining or for emergency closures), it has proven extremely difficult to exclude females from these roosts – often requiring several weeks of intensive effort. This is in spite of the fact that these exclusions are conducted outside of the active maternity season (typically in the fall) (Sherwin et al. 2003, 2009). Clearly, colonies do not benefit from human disturbance and in many cases, colony sizes, and patterns of roost use (such as location of roosting areas, exiting behaviors) do change following protection. But there is little compelling evidence to support anecdotal accounts of colony collapse resulting from the typical levels of human disturbance realized at most roosts (Brigida 2014, Sherwin et al. 2003).

Night roosts are used opportunistically during breaks from foraging. Such roosts allow the bats to rest and digest meals, socialize, and hydrate while minimizing predation risk, and remain at the foraging area between foraging bouts if the foraging area requires a commuting flight from the day roost. Use of night roosts has been understudied. While there are some data to suggest that individual Townsend's big-eared bats roosting in basal tree hollows do not show particularly high fidelity to night roosts (Fellers and Pierson 2002), caves and abandoned mines are often used predictably as night roosts by this species. Night roosts of Townsend's big-eared bats are often occupied by many individuals and are often shared with other species. During early-evening foraging bouts of six light-tagged Townsend's big-eared bat in Oklahoma, Caire et al. (1984) documented their study animals rested between bouts of foraging about 17% of the time under observation. It is likely the overall resting time between foraging bouts in a given night is greater.

Diet

Diet of Townsend's big-eared bat has not been examined in detail in California, however it is likely that as elsewhere, they are lepidopteran specialists, feeding primarily on medium-sized moths, supplemented with occasional captures of other insects, including flies, beetles, and aquatic insects (Ross 1967, Whitaker et al. 1977, 1981, Dalton et al. 1986, Sample and Whitmore 1993, Burford and Lacki 1998, Dodd and Lacki 2007). According to Szewczak (pers. comm. 2016), the echolocation behavior of Townsend's big-eared bat strongly supports its natural selection as a lepidopteran specialist, particularly on tympanic moths.

Vocalizations

Townsend's big-eared bat produces ultrasonic calls that are used for navigating in the dark, and for locating and capturing prey. They also use both ultrasonic and mid frequency ranges for social communication. While cruising or searching for prey, a semi-regular pattern of calls is emitted at 10 to 20 calls per second (Kunz and Martin 1982). Search and cruising calls are usually simple downward sweeps in frequency, typically starting at about 40 to 45 kHz and ending at about 19 to 23 kHz, with the maximum power (volume) produced at about 21 to 26 KHz (Szewczak et al. 2011). Calls may include sounds produced at the harmonic frequencies at two and three times the fundamental call frequencies – sometimes with more power applied to a harmonic than to the fundamental call. Townsend's big-eared bat is commonly known as a "whispering" bat, because of the relatively low power of its calls – typically about 40 to 50 dB quieter than those of *Myotis lucifugus* (Kunz and Martin 1982). The relatively low intensity of its echolocation calls makes Townsend's big-eared bat difficult to detect acoustically.

Predation

Pearson et al. (1952) discounted predation as a factor limiting Townsend's big-eared bat populations, but individuals may be preyed upon by a variety of native and non-native predators, as has been documented for other bats. The recovery plan for the endangered Ozark big-eared bat (*C. townsendii virginianus*) (USFWS 1995) listed several potential predators of Townsend's big-eared bat, including raccoons (*Procyon lotor*), bobcats (*Lynx rufus*), house cats (*Felis catus*), skunks (*Mephitis*, *Spilogale*), and snakes. These and other generalist predators, such as ringtails (*Bassariscus astutus*) likely take Townsend's big-eared bat opportunistically in California.

Fellers and Halstead (2015) stated several owl species known to prey on bats may have influenced Townsend's big-eared bat emergence times at the Randall House maternity roost. These included great horned owls (*Bubo virginianus*), barn owls (*Tyto alba*), and spotted owls (*Strix occidentalis*). Townsend's big-eared bat's tendency to avoid foraging in open grassland and other areas of low vegetation cover has been hypothesized to be a mechanism for avoiding aerial predators such as owls (Pierson and Fellers 1998); however, this behavior may also be driven by the distribution of the bat's prey as reproductively active female Townsend's big-eared bats in Nevada routinely travel more than 30 km (18 miles) over a barren alkali flat traveling from their maternity roosts to foraging areas (Ives et al. in prep.).

Fellers (2000) also reported that non-native black rats (*Rattus rattus*) preyed upon young Townsend's big-eared bats at the Randall House roost before measures were taken to eliminate rats from the roost site.

Movements

Migration. Townsend's big-eared bat is considered a relatively sedentary species, for which no long-distance migrations have been reported (Barbour and Davis 1969, Humphrey and Kunz 1976, Pearson et al. 1952). The longest movement known for this species in California is 40 km (32 mi) (Morrison and Szewczak, unpublished data). There is some evidence of local migration, perhaps along an elevation gradient.

Townsend's big-eared bats in Oregon appear to move from their hibernacula to active season (maternity) roosts over a period of several nights, using interim roosts before settling into the maternity roost (Dobkin et al. 1995). This study recorded a maximum distance between hibernation site and foraging areas of 24 km (15 mi). Recent data from Nevada indicates movements of over 150 km (93 miles) between maternity roosts and hibernation sites, and even nightly foraging distances in excess of 50 km (31 miles), indicating that individuals are capable of far greater movements than has been previously appreciated. The assumption that individuals are relatively sedentary has led to a general perception that maternity colonies represent discrete populations and that any changes in numbers of bats, or patterns of roost use at the local scale are biologically meaningful and have conservation implications. However, the fact that individuals are capable of moving large distances within and among seasons means that meaningful trend data must be collected at larger spatial scales and that the accumulation of local anecdotes may be misleading (Brigida 2014, Ives 2015, Ives et al. in prep, Sherwin et al. 2000; 2003, 2009).

Feeding. Despite its reputation as a sedentary species, Townsend's big-eared bat may cover a lot of ground while foraging each night. As mentioned above, these bats often travel large distances while foraging, including movements of over 150 kilometers during a single evening (R. Sherwin pers. comm.). Evidence of large foraging distances and large home ranges has also been documented in California (E.D. Pierson pers. comm.).

Thermoregulation and Hibernation

Townsend's big-eared bat, like most mammals, maintains a high body temperature primarily through heat produced by its metabolism. High metabolic rate and elevated (and typically constant) body temperature allow mammals to maintain high aerobic activity levels, which in turn has allowed them to occupy ecological niches only available to highly energetic animals. Like many bat species inhabiting temperate regions, Townsend's big-eared bat uses torpor[2] as a physiological and behavioral strategy in winter to deal with diminished food resources and cool or cold ambient temperatures, which make it energetically costly to maintain normal high body temperature. By allowing core body temperature to cool to near ambient, bats in torpor reduce their energy expenditure to a small fraction of what would be used to keep body temperature elevated (Szewczak and Jackson 1992, Szewczak 1997). Despite the energy savings conferred by torpor, hibernating bats may lose more than 50% of their body mass during the hibernation season (Humphrey and Kunz 1976). Townsend's big-eared bat and other bats that use torpor have a suite of physiological adaptations to allow them to remain healthy during torpor and to

[2] "Torpor" is a general term for reduced metabolic rate and body temperature. For animals adapted to use torpor as described, it can range from "shallow torpor" which occurs when winter temperatures are relatively mild and where the animal may only drop its body temperature a few degrees, to deep hibernation, which occurs in more extreme cold. In hibernation, ambient temperatures may be near or below freezing and the torpid animal may maintain its temperature just above freezing. Bats in hibernation may appear almost completely inanimate with no visible sign of breathing. Arousal from deep torpor may take many minutes to over an hour. Bats in shallow torpor may respond to handling or other stimuli by slowly moving and visibly breathing, and will often arouse in several minutes.

arouse at appropriate times (Szewczak and Jackson 1992, Szewczak 1997) throughout the winter to feed and move within and among roosts.

An important behavioral trait of hibernators is the selection of suitable sites for the inactive period. Townsend's big-eared bat hibernation sites are generally caves or mines (Pearson et al. 1952, Barbour and Davis 1969), although animals are occasionally found in buildings (Dalquest 1947). Deep mine adits and shafts, known to provide significant hibernating sites in New Mexico (Altenbach and Milford 1991), may also be important in California. Winter roosting is typically composed of mixed-sex groups from a single individual to several hundred or several thousand individuals in eastern subspecies; however, behavior varies with latitude. In areas with prolonged periods of non-freezing temperatures, Townsend's big-eared bat tends to form relatively small hibernating aggregations of single to several dozen individuals (Barbour and Davis 1969, Pierson et al. 1991, Pierson and Rainey 1998). Larger aggregations (75-460) are confined to areas that experience prolonged periods of freezing temperatures (Pierson and Rainey 1998).

Studies in the western U.S. have shown that Townsend's big-eared bat selects winter roosts with stable, cold temperatures, and moderate air flow (Humphrey and Kunz 1976, Kunz and Martin 1982). Individuals roost on walls or ceilings, often near entrances (Humphrey and Kunz 1976, Twente 1955). If undisturbed, individuals will frequently roost less than 1 m (3ft) off the ground (Perkins et al. 1994, Brown 2016 pers. obs.), and have been found in air pockets under boulders on cave floors (E. Pierson pers. obs.). Temperature appears to be a limiting factor in roost selection. Recorded temperatures in Townsend's big-eared bat hibernacula range from -2.0°C to 13.0°C (28°F to 55°F) (Humphrey and Kunz 1976, Genter 1986, Pearson et al. 1952, Pierson et al. 1991, Twente 1955), with temperatures below 10°C (50°F) being most common (Perkins et al. 1994, Pierson and Rainey 1998). Within a hibernaculum, Townsend's big-eared bat most frequently hibernates singly, but pairs and clusters ranging from a few to several hundred torpid individuals have been observed. In the White and Inyo mountains, larger groups were observed in sites where air temperature was around 5°C (41°F) while smaller groups occurred at locations with air temperatures that were colder (Szewczak et al. 1998). In the Mojave Desert in the winter, hibernating Townsend's big-eared bat have been found at temperatures of 15.5°C (60°F) as these might be the coolest temperatures available (P. Brown pers. obs.). Hibernating Townsend's big-eared bats in Death Valley, California were found to seek very specific microclimates within roosts that were typically 1-3°C (34-37 °F) cooler than areas immediately surrounding each bat and 5°C (41 °F) cooler than the average conditions found throughout the mine. These data were collected using thermal imaging cameras and reveal the selection of roosting areas within hibernacula is highly regulated. As such, average roost climates or more coarse measurements may be quite misleading for understanding the thermal needs of hibernating Townsend's big-eared bats (Sherwin and Gordon in prep.).

The period of hibernation is shorter at lower elevations and latitudes. Coastal populations of Townsend's big-eared bat, which experience particularly mild winters, may use shallow torpor on a daily basis and are often active during the winter as they take advantage of warm weather and prey availability (Pearson et al. 1952).

Thermoregulation is also an important aspect of the active season for Townsend's big-eared bat, especially for the energetically-demanding processes of pregnancy and lactation. Adult females require warm microclimates to facilitate the rearing of their young as warm temperatures minimize the energy lost as heat during pregnancy and help newborn and young pups conserve energy for growth. Clustering behavior of females and their young further enhances energy conservation and cluster size has been observed to increase and decrease based on the ambient temperature of the roost site (Betts 2010). Clustering also serves to modify the temperature of the colony as combined metabolic heat from the mothers and pups has been documented to raise the temperature of the roosting area by as much as 10°C. This allows females to use a wider variety of roost sites for maternity use as they are not dependent upon abiotic factors of the roosts itself to produce suitable roosting conditions (Sherwin et al. 2009).

Habitat Utilization

Habitat associations for Townsend's big-eared bat in California include the inland deserts (Colorado, Mojave, Great Basin); cool, moist coastal redwood forests; oak woodlands of the coastal ranges and Sierra Nevada foothills; and lower to mid-elevation mixed coniferous-deciduous forests. Townsend's big-eared bat has also been observed hibernating in the bristlecone-limber pine habitat (Szewczak et al. 1998) of the White Mountains (Inyo County). Distribution is patchy throughout the range and is strongly correlated with the availability of caves and cave-like roosting habitat, with highest concentrations often occurring in areas dominated by exposed, cavity forming rock and/or historic mining districts (Genter 1986, Graham 1966, Humphrey and Kunz 1976, Kunz and Martin 1982, Perkins et al. 1994, Pierson and Rainey 1998). The species' habit of roosting on open surfaces within roosts makes it readily detectable and it is often the species most frequently observed (typically in low numbers) in caves and abandoned mines throughout its range.

Roosting Habitat. Townsend's big-eared bat prefers open surfaces of caves or cave-like structures, such as mine adits and shafts (Barbour and Davis 1969, Graham 1966, Humphrey and Kunz 1976). It has also has been reported in such structures as buildings, bridges, and water diversion tunnels that offer a cave-like environment (Barbour and Davis 1969, Dalquest 1947, Howell 1920, Kunz and Martin 1982, Pearson et al. 1952, Perkins and Levesque 1987, Brown et al. 1994, Pierson and Rainey 1998). It has been found in rock crevices and, like a number of bat species (Gellman and Zielinski 1996), in large hollow trees (Fellers and Pierson 2002, Mazurek 2004). Roosting structures often contain multiple openings. While they can often be found in large, complicated cave and mine systems, they are equally common in more simple caves and mines with single openings.

Seasonal use is not limited by roost structure. Maternity colonies, large hibernation colonies, and swarming sites have all been documented in horizontal and vertical structures with less than 10 feet of underground workings. Specific roosts may be used at only one time of year or may serve different functions throughout the year, such as for maternity roosts, hibernation, or other uses (Sherwin et al. 2000, 2003). Roosting surfaces often occur in locations with partial light during the day; however, many roosting areas have been found very deep inside caves or mines, including at deep levels of shafts

(Sherwin et al. 2003, 2009). Of 54 maternity roost sites tabulated by Pierson and Fellers (1998), 43% were in caves, 39% were in mines, and 18% were in buildings.

Townsend's big-eared bat has often been assumed to have fairly restrictive roost requirements (Humphrey and Kunz 1976, Perkins et al. 1994, Pierson et al. 1991). However, while the internal roost temperatures are often critical (Lacki et al. 1994, Pearson et al. 1952, Pierson and Rainey 1998), it only takes a small area within a feature, supporting adequate thermal specifications, to make a seemingly unusable roost opportune (Sherwin et al. 2003). Temperatures vary in maternity roosts throughout California from 19°C (66°F) in cooler regions to 30°C (86°F) in warmer southern regions (Pierson et al. 1991). Some colonies are known to change roosts during the maternity season, using cooler roosts earlier in the year when only pregnant females are present (Pierson et al. 1991, P. Brown pers. comm., V. Dalton pers. comm., Sherwin et al. 2003) and using warmer roosts while pup-rearing. Roost dimensions may also be important; however, this may be an artifact of data recording and scale of data collection. For example, the majority of the roosts examined in California by Pierson and others (Pierson et al. 1991) were described as fairly spacious, being at least 30 m (100 ft) in length, with the roosting surface located at least 2 m (6.5 ft) above the ground, and roost opening at least 15 cm by 62 cm (6 inches by 24 inches). However, local geology typically determines how large caves and mines in a particular location are, so historical mining districts that produced little ore tend to be dominated by many small prospects. Townsend's big-eared bats are just as likely to use these smaller workings during all periods. However, they may be more apt to move among multiple roosts to satisfy their roosting needs in such small roost sites than colonies located in large roosts (Sherwin et al. 2000, 2003, 2009). Night roosts include caves, rock shelters, open buildings, mines and bridges. They can be of any shape and size, and are often located within day roosts. Many of these roosts will host multiple species and often include large numbers of Townsend's big-eared bats.

Foraging Habitat. Foraging associations include edge habitats along streams and areas adjacent to and within a variety of wooded habitats (Brown et al. 1994, Fellers and Pierson 2002, Pierson et al. 2002). Radiotracking and light-tagging studies have found Townsend's big-eared bat foraging in a variety of habitats, including within collapsed lava tubes and trenches (Pierson and Fellers 1998). Brown et al. (1994) showed that on Santa Cruz Island in California, Townsend's big-eared bat avoided the lush introduced vegetation near their day roost, and traveled up to 5 km (3 mi) to feed in native oak and ironwood forest. P. Brown (pers. comm.) also documented Townsend's big-eared bat foraging in desert canyons with water and riparian vegetation on the west slopes of the Panamint Mountains (Inyo County). In these areas the water is usually covered by vegetation and not available for drinking. Radiotracking in Nevada revealed adaptive foraging throughout the year with individuals (reproductive males and females) routinely adjusting foraging patterns and habitat associations in response to resource availability. For example, individuals foraged heavily over an ephemeral pond for a 2 week period. Once the pond dried, individuals shifted their nightly activity to a variety of local habitats including sage-brush, juniper woodlands, riparian areas, cliff faces and alkali flats. Individual use of these areas was predictable as each bat appeared to have a preferred foraging area (Ives 2015; Ives and Sherwin in prep.).

Radiotracking and light-tagging studies in northern California have found Townsend's big-eared bat foraging within forested habitat, within the canopy of oaks (Pierson and Rainey unpubl. data), and along heavily vegetated stream corridors, avoiding open, grazed pasture land (Fellers and Pierson 2002). In Oklahoma, *C. townsendii ingens* more frequently used edge habitats (along intermittent streams) and open areas (pastures, agricultural fields, native grass) compared to wooded habitat (Clark et al. 1993), but also tended to focus foraging along canyon walls (Caire et al. 1984).

Light-tagging studies in West Virginia (V. Dalton pers. comm.) showed a bimodal foraging pattern for *C. t. virginianus*, with animals foraging over hayfields during the first part of the night, and within the forest later in the night, traveling up to 13 km (8 mi) from the day roost. They foraged as long as weather permitted in the fall, and were periodically active in winter (Pierson et al. 1991). Townsend's big-eared bats have also been observed flying in snowstorms (G. Tatarian pers. comm.), in some cases seemingly taking advantage of winter insect hatches (Sherwin 2016 pers. comm.).

CONSERVATION STATUS

Despite the long-standing designation of Townsend's big-eared bat as a Species of Special Concern in California (Williams 1986), there has not been a statewide effort to assess the conservation status of the species since Pierson and Rainey's work in the late 1980s and early 1990s (Pierson and Rainey 1998). CDFW is working with a contract team from Humboldt State University and Texas A & M University to survey maternity roosts and hibernacula over the next two years. This effort will provide the first state-wide assessment of Townsend's big-eared bat status in California since the Pierson and Rainey effort, but the results of this new project will not be available until 2017.

In the meantime, and in the interest of informing the Commission's decision on whether to list Townsend's big-eared bat according to the statutory schedule required by CESA, CDFW offers the following summary of the conservation status of the species. This summary is based on a variety of recent and on-going efforts to study and monitor Townsend's big-eared bat in California and elsewhere.

Regulatory Status

State, federal and non-governmental organizations designate "at risk" species (e.g., threatened and endangered species, Species of Special Concern, Species of Greatest Conservation Need, etc.) and assess and rank their conservation needs. Status designations for Townsend's big-eared bat are summarized below by jurisdiction or organization:

State of California Status. The Fish and Game Commission designated Townsend's big-eared bat a "candidate" for listing as endangered or threatened under CESA, effective December 27, 2013. With the notice of its candidacy for listing, the CESA prohibition against unauthorized "take" of Townsend's big-eared bat is currently in effect. (Fish & G. Code, §§ 2080, 2085). "Take" is defined in the Fish and Game Code as to hunt, pursue, catch, capture, or kill, or to attempt to engage in any of these activities. (*Id.*, § 86.) Take of species protected by CESA, including Townsend's big-eared bat, may be authorized under certain circumstances.

"Species of Special Concern" (SSC) is a Department administrative designation intended to alert biologists, land managers, and others to a species' declining status and to encourage additional management considerations for these species to ensure population viability and to preclude the need for listing. SSCs are defined as species, subspecies, or distinct populations of an animal native to California that currently satisfies one or more of the following (not necessarily mutually exclusive) criteria: extirpated from the State or, in the case of birds, in its primary seasonal or breeding role; listed under the federal Endangered Species Act (but not CESA) as threatened or endangered; meets the State definition of threatened or endangered but has not been formally listed; is experiencing, or formerly experienced, serious (noncyclical) population declines or range retractions (that have not been reversed) that, if continued or resumed, could qualify it for State threatened or endangered status; has naturally small populations exhibiting high susceptibility to risk from any factor(s), that if realized, could lead to declines that would qualify it for State threatened or endangered status (Comrack et al. 2008). As an SSC, Townsend' big-eared bat is also considered a "Species of Greatest Conservation Need" in the 2015 update of California's State Wildlife Action Plan by definition (CDFW 2015).

Townsend's big-eared bat has been designated as a Mammal Species of Special Concern (MSSC) since the list was established in 1986 (Williams 1986). The MSSC list is now undergoing a formal update and revision using an objective, criterion-based method developed by CDFW (see Shuford and Gardali 2008 for a recent published example of the current method). As part of the update process, Townsend's big-eared bat has been evaluated, scored, and ranked using eight criteria along with all other terrestrial mammal taxa naturally occurring in California. Based on current information, it is likely Townsend's big-eared bat will be on the updated MSSC list (assuming it is not CESA-listed as threatened or endangered first).

Projects carried out on state and private lands that are funded or authorized by public agencies (such as highway construction, residential and commercial development, and energy development projects) are subject to the provisions of California Environmental Quality Act (California Public Resources Code, Division 13, section 21000 *et seq*. with related Guidelines published under the California Code of Regulations, Title 14, section 150000 *et seq*.). CEQA requires that actions that may substantially reduce the habitat, decrease the number, or restrict the range of any species that can be considered rare, threatened, or endangered (regardless of status under state or federal law) must be identified, disclosed, considered, and mitigated or justified. (Cal. Code Regs., tit. 14, §§ 15065(1), 15380.) Impacts to species identified as SSCs should be carefully evaluated in CEQA planning documents.

In summary, as a Candidate for CESA listing, Townsend's big-eared bat enjoys a high-level of assessment and disclosure of potential impacts of proposed CEQA projects. The standard "no-take" requirement for projects helps ensure that population-level impacts do not occur when a project is implemented. Should the species not be listed, then the SSC designation should still ensure that proposed projects include assessment and disclosure of potential impacts, but protection from impacts is less certain and take of individuals may occur.

Federal Status. The two western subspecies of Townsend's big-eared bat are not currently listed as endangered or threatened nor are they candidates for listing under the federal Endangered Species Act. Two eastern subspecies are listed as Threatened under the ESA. Several federal land management agencies (e.g., U.S .Forest Service, Bureau of Land Management) have special management designations for the species. See the EXISTING MANAGEMENT, MONITORING, AND RESEARCH ACTIVITIES section below for additional information on federal agency management of Townsend's big-eared bat.

Status in Surrounding States.

Oregon – The Oregon Department of Fish and Wildlife (ODFW) designates Townsend's big-eared bat as a Sensitive/Critical species.[3] Sensitive species are "naturally-reproducing fish and wildlife species, subspecies, or populations which are facing one or more threats to their populations and/or habitats. Implementation of appropriate conservation measures to address the threats may prevent them from declining to the point of qualifying for threatened or endangered status." The Critical designation indicates ODFW has determined that Townsend's big-eared bat is a species "imperiled with extirpation

[3] http://www.dfw.state.or.us/wildlife/diversity/species/sensitive_species.asp

from a specific geographic area of the state because of small population sizes, habitat loss or degradation, and/or immediate threats. Critical species may decline to point of qualifying for threatened or endangered status if conservation actions are not taken."

Nevada – The Nevada Department of Wildlife (NDOW) does not have a special status designation for Townsend's big-eared bat. However, the Nevada Bat Conservation Plan (Bradley et al. 2006), which was adopted by a variety of state agencies and federal agency offices in Nevada, including NDOW, designates the species as "Sensitive." The Nevada Bat Conservation Plan designates the conservation risk to Townsend's big-eared bat as "High" (Bradley et al. 2006). According to the plan, "A far more broad-scaled and complete monitoring effort is needed in Nevada to truly discern the status and trend of this species."

Arizona – The Arizona Game and Fish Department (AGFD) published the Arizona Bat Conservation Strategic Plan (AGFD 2003). The plan outlines the current status of all 28 bat species occurring in Arizona. For Townsend's big-eared bat, the plan states that population trends and conservation status of the species is unclear, though some losses of maternity roost sites are known to have occurred. AGFD published an update to its State Wildlife Action Plan (SWAP) in 2012 (AGFD 2012), in which it designates Townsend's big-eared bat as a Tier 1B Species of Greatest Conservation Need. That status is based primarily on AGFD's determination that the species is in a "demographically poor situation: Unusually low birth rates or high death rates combined with small or declining population size. Demographic rates are affected by known stressors likely causing a worsening situation in parts of Arizona." The Arizona SWAP also notes the species' vulnerability due to its concentration at certain points in its life cycle (colonial roosting habits) and an unknown population trend in the state.

Non-governmental Organization Designations.

NatureServe, a non-profit conservation organization whose mission is to provide the scientific basis for effective conservation action through its network of natural heritage programs, ranks Townsend's big-eared bat as a whole and each of the two non-listed subspecies (*C. t. pallescens* and *C. t. townsendii*) as "G3G4/T3T4" throughout their respective geographic ranges. This designation indicates uncertainty regarding conservation status, which may be characterized as either Apparently Secure (G4/T4) or Vulnerable (G3/T3).

NatureServe defines "Vulnerable" as "at moderate risk of extinction or elimination due to a restricted range, relatively few populations, recent and widespread declines, or other factors" and "Apparently Secure" as "Uncommon but not rare; some cause for long-term concern due to declines or other factors." (http://explorer.natureserve.org/granks.htm).

International Union for the Conservation of Nature (IUCN). The current version of the IUCN Red List (http://www.iucnredlist.org/details/17598/0) designates Townsend's big-eared bat as a 'Least Concern' species based on the latest assessment of the species range-wide. The IUCN had previously designated the species in 1996 as 'Vulnerable.' The Least Concern designation is based on "its wide distribution, presumed large population, occurrence in a number of protected areas and because it is unlikely to be declining at nearly the rate required to qualify for listing in a threatened category."

The Western Bat Working Group (WBWG) is a consortium of agency biologists, consultants, academic researchers, and other interested persons throughout the western states and Canada working to ensure a coordinated approach to bat conservation in western North America (http://wbwg.org/). Based on its initial assessment of the conservation status of western bat species in 1998, WBWG rated Townsend's big-eared bat as "high" priority (the highest conservation concern designation). According to the WBWG website, this designation "represents those species considered the highest priority for funding, planning, and conservation actions. Information about status and threats to most species could result in effective conservation actions being implemented should a commitment to management exist. These species are imperiled or are at high risk of imperilment." It is important to note however, that these designations and assessments have been the result of expert opinion rather than analysis of robust data sets.

Bat Conservation International (BCI) is a not-for-profit organization dedicated to the conservation of "the world's bats and their ecosystems to ensure a healthy planet." BCI does not have an assessment of the conservation status of Townsend's big-eared bat on its website, but has published articles related to the importance of proper mine and cave management to ensure successful roosting of this and other cave/mine-dwelling bat species.

Current Distribution

Townsend's big-eared bat appears to be fairly well distributed throughout much of its historic range in California. Figure 3 displays Townsend's big-eared bat observations in California symbolized by time period of observation. The observations are from a number of sources, including museum specimens, observations submitted to the California Natural Diversity Database (CNDDB), and capture and acoustic records from biologists permitted by CDFW to study Townsend's big-eared bat. Although the total number of records, as well as the records in each of the time periods displayed is relatively small, no obvious pattern of a reduction in distribution is apparent in Figure 3. It is likely that occurrences are now rarer in the South Coast and Bay Area than before urbanization.

Population Trends

Summary of Pierson and Rainey (1998) Statewide Assessment and Other Information Cited in the Petition

To describe Townsend's big-eared bat population trend in California, the Petition relied heavily on the work conducted by Pierson and Rainey (1998) for the Department of Fish and Game. Pierson and Rainey conducted surveys of known Townsend's big-eared bat maternity colonies and hibernacula throughout much of the species' range in California during the period 1987 to 1991. Their surveys focused primarily on maternity colonies to assess population status and reproductive capacity.[4] In addition to visiting and counting the numbers of bats at all known large (> 30 females) Townsend's big-eared bat maternity colony roost sites in California, the authors also searched for additional or alternate roost sites within 15

[4] However, as noted by Sherwin (pers. comm. 2016), maternity colonies are not equivalent to populations and may not provide a reliable index of population status unless concurrent data are collected from a broad geographic area at all possible maternity roost sites.

km (9.3 mi) of the known sites.[5] The authors also visited five known Townsend's big-eared bat hibernation sites in California and described the observations of other researchers at several other hibernation sites. The authors developed several measures of population status and trend in their study, including total estimated number of adult females at maternity colonies in the state, total number of colonies, average size of maternity colonies, and average and total size of hibernation colonies.

The work by Pierson and Rainey (1998) suggests a decline in the numbers of Townsend's big-eared bats roosting in historical sites over the period between the original surveys of the maternity colony roost sites and the re-surveys conducted by the authors. Eighteen historically known maternity colonies with estimates of colony sizes were assessed in the study using either exit count with night-vision equipment, direct count of roosting individuals, or estimates of numbers based on area of roost ceiling occupied. The original dates of detection ranged from 1918 to 1974, with most of the original surveys conducted in the 1930s through 1960s. Six of the colonies were inferred to have been extirpated, five had declined in number of females by more than 20%, four had remained relatively constant in numbers, and three colonies had increased by more than 20%.[6] The authors lumped all 18 colonies' original population counts to get a historical-period population estimate of 3,004 adult females. Based on their counts during the 1987-1991 surveys, they estimated these colonies had declined by 55% to a total of 1,365 adult females.

The authors also found a decline in the total number of colonies known from the historical period to the resurveys. Of 46 historically-known maternity colonies (many without counts), the authors could not find 24 (either at the original site or within 15 km (9.3 mi) of the original site), which represented a 52% decrease in the number of historically-known colonies.

Additional maternity colonies were located in the period after 1980, either by the authors or reliably reported to the authors by other researchers. These colonies were sufficiently distant from historically-known colonies for the authors to conclude they were not part of the historical set. Although no conclusion about population trend could be made based on the inclusion of the additional colonies, Pierson and Rainey's (1998) point estimate for the total known adult female Townsend's big-eared bat population size in California was 4,252 individuals, distributed among 39 maternity colonies. The authors cited reliable reports of four other colonies of unknown size. The Petition cites reports and personal communications of an additional four maternity colonies known as of 2003, as well as observations of lactating females in areas without known colonies, suggesting there are additional maternity colonies not yet discovered.

Pierson and Rainey (1998) also compared the average size of the 18 historically-known maternity colonies to the 38 colonies with estimates known at the time of their surveys. They found average

[5] Based on the Pierson and Rainey (1998) report, it is unclear whether a single or multiple survey visits were made to each site. However, because the report provides a single number of individuals at each roost site, with no sample size or estimate of variation around that number, it is likely this extensive survey effort was considered complete at each site once a count was made. Information on the historical survey methods are lacking.

[6] Direct comparisons between historical colony size and current size are difficult, given the uncertainty in historical survey methods.

number of adult females in the historical colonies to be 164, while the currently-known colonies averaged 112 females. Thus, the recent colony size was 32% smaller than the historical colony size.[7]

Pierson and Rainey (1998) also assessed the size of five historically-known hibernation colonies in California. One of the colonies (at Lava Beds National Monument) had remained stable at approximately 30 individuals. The other four, which had original counts of between 55 and 177 bats, showed dramatic declines of between 70% and 94%. These sites were in Shasta, Lake, and Napa counties.

The Petition also cited observations by Williams (1986), who was an active researcher of the conservation status of mammals in California in the latter half of the 20th century. As mentioned in the Petition, Williams (1986) stated his impression that Townsend's big-eared bat had been common in central California through the 1960s, but had dramatically declined by the early 1970s. Williams (1986) mentioned that he had only captured one individual Townsend's big-eared bat during his 14 years of work in central California in the 1970s and 1980s.[8] Townsend's big-eared bat has been recently observed in the central coast area of California, on Department lands and Vandenberg Air Force Base (R. Stafford 2014, 2015 pers. comm.; R. Evans 2014 pers. comm.). These observations, which included a maternity roost site for both of the jurisdictions, as well as a large (>400 total individuals) maternity colony at Hearst San Simeon State Historical Monument, indicate the species continues to occur in the region, although no information on population or range trends is available for this area.

Other published observations of declines in Townsend's big-eared bat colonies in the Sierra Nevada and lower Colorado River area (Graham 1966, Stager 1939) were mentioned in the Petition. Townsend's big-eared bats were discovered roosting in the Old Senator Mine (near the Colorado River) and Steece Copper Mine (Riverside Mountains) in the early 20th century (Grinnell 1914, Howell 1920). At that time, Howell counted about 100 adult females in the Old Senator Mine maternity colony. Neither the Senator nor the Steece Mine currently has Townsend's big-eared bat colonies (Brown and Berry 2003).

Stager (pers. comm. to P. Brown) described a cluster of Townsend's big-eared bats that occurred in the 1930s in the main level of the Alice Mine (Riverside Mountains). Based on the areal extent of the cluster and standard density estimates, the colony in the Alice Mine at that time would have been over 3000 bats. The last specimen collected from the Alice was in April 1954. When P. Brown first visited the Alice Mine in August 1968, piles of old guano remained, but these have now been trampled to dust (Brown pers. comm. 2016).

The Mountaineer Mine in the Riverside Mountains is the only mine along the main lower Colorado River currently known to shelter a Townsend's big-eared bat maternity colony (Brown and Berry 2003). The dense native vegetation documented by Stager (1939) has been removed along the lower Colorado River over the past 50 years and replaced with agricultural fields that are subjected to extensive

[7] From Pierson and Rainey (1998): "A comparison of colony size for historically and currently known colonies indicates mean colony size has decreased by 31.9%, from 164.4 (n = 18) to 111.9 (n = 38). The 38 colonies for which population estimates could be obtained totaled approximately 4,250 adult females (Appendix I)."

[8] However, it should be noted that the impression of rarity may be partly based on difficulty of capture (Sherwin 2016 pers. comm.).

pesticide spraying. In forested areas, spraying for lepidopteran species may alter the prey base for big-eared bats (Brown et al. 1994). The loss of foraging habitat, pesticide spraying, and human intrusion in the roosts may all be factors impacting Townsend's big-eared bat populations (P. Brown 2016 pers. comm.) in this area.

In summary, the Petition relies heavily on the information regarding perceived changes in maternity colonies at a subset of historical roosts cited in Pierson and Rainey's (1998) statewide assessment. Pierson and Rainey summarized their results as follows: of 18 historically-known maternity roosts with colony counts, six of the colonies were not occupied during surveys conducted by the authors. Another six colonies showed a decline in the number of adult female Townsend's big-eared bats present at the time of survey. Although five colonies had increased in size (and one remained stable at 50 females), the overall decline in numbers from the historical period appeared to be substantial.[9]

These comparisons between historical and recent colony numbers, colony size, and then extrapolated to suggest changes in total population sizes suggest that, as of the early 1990s, there had been a decline in the total numbers of Townsend's big-eared bat in California since the early 20th century. In combination with other aspects of the species' biology and observations of human disturbance at Townsend's big-eared bat roost sites, the trend information collated by Pierson and Rainey (1998) led to their inference that the California Townsend's big-eared bat population had declined over the several decades before their study. However, these data were interpreted based on assumptions such as static use of roosts and populations delineated at local scales around known roosts. It is possible that declines may have been substantial in some areas, but recent data suggest colonies throughout the western United States and parts of California are currently widespread and abundant as a result of revised approaches to abandoned mine reclamation that mitigate mine closure impacts to bats and other wildlife (Sherwin 2016 pers. comm.).

CDFW is aware of ongoing efforts to monitor or revisit several important Townsend's big-eared bat maternity and hibernation roosts in California. These efforts include monitoring at both hibernation and maternity colonies at Lava Beds National Monument (S. Thomas 2013 pers. comm.), revisiting known Townsend's big-eared bat hibernacula in the White and Inyo mountains (Szewczak et al. 1998, M. Morrison 2013 pers. comm.), long-term annual counts of maternity colonies in historical buildings in Marin and Sierra counties (Fellers and Halstead 2015, W. Copren 2013 pers. comm.), as well as at other sites. The following section summarizes recent results from these ongoing monitoring efforts.

Townsend's Big-Eared Bat Roost Site Monitoring Case Studies

To assess Townsend's big-eared bat population trends since Pierson and Rainey's (1998) work, CDFW has compiled information from a number of maternity and hibernation roosts from around California.

[9] However, such data may be less conclusive than suggested by the authors. Sherwin (2016 pers. comm.) states: "Without very intense historical and recent surveys including concurrent sampling of all potential roosts, and even radio telemetry, this statement cannot be supported by these data. I have studied many roosts that are used intensively for very short periods of time, but are usually vacant, and there are no biological residues of past use. Without understanding patterns of roost use at the landscape scale these data could easily be interpreted as catastrophic loss, when the local numbers have remained stable for decades."

The following is a summary of studies that assess trends in colony size at specific sites. While this summary does not comprise a statistically valid estimate of the Townsend's big-eared bat population size or trend statewide, it does illustrate how colony sizes and threats vary around the state, as well as how management of roosts directly affects the local assemblages of Townsend's big-eared bats in these areas. Locations referenced here are depicted in Figure 4.

Randall House Maternity Roost (Marin County). Fellers and Halstead (2015) reported results from 25 years of monitoring the Randall House maternity roost site in Marin County. The Randall House is a two-story late 19th Century ranch house situated in a valley at Point Reyes National Seashore. It was last occupied by humans in the 1970s and in 1987 was discovered to be the roost of a Townsend's big-eared bat maternity colony. At that time, the colony numbered 95 adult females. The site had been subject to repeated break-ins by local teenagers prior to 1987, but upon discovery of the Townsend's big-eared bat colony, the NPS fortified the house against unauthorized entry and has since maintained the house for use by the bats.

Using night-vision equipment, Fellers and his collaborators conducted 178 exit counts of Townsend's big-eared bat during the maternity season between 1988 and 2012. In addition to information on the number of adult females and young present at the site, this long-term monitoring study also yielded important information on the effects of human disturbance on colony status, effects of season and environmental factors on emergence time from the roost, and other natural history aspects of the species.

Over the course of the 25-year study, the Randall House Townsend's big-eared bat maternity colony increased in size (see Figure 5B). Adult female maximum number recorded increased from 95 in 1988 to 395 in 2012. The maximum recorded number of adult females plus volant young increased from 176 to 512. The annual rate of increase was estimated to be 8.7% for adult females and 5.3% for volant young.

Attempted and successful break-ins to the roost building occurred occasionally during the study period, despite increased security at the site. These disturbance events were documented by Fellers and Halstead (2015), who found a significant negative correlation between disturbance events and subsequent numbers of adult females and volant young (compare Figures 5A and 5B). In other words, there were fewer Townsend's big-eared bat adults and young at the roost site in years with human disturbance events.[10]

The authors note the Randall House is one of the most important remaining Townsend's big-eared bat maternity roost sites in coastal California. Because of the NPS commitment to maintaining the Randall House for Townsend's big-eared bat use, it is one of the few maternity roosts classified by Pierson and Rainey (1998) as "secure." Prior to its discovery in 1987, two other nearby historical roosts (the Olema Inn and an old barn near Inverness) had already been lost. Fellers and Halstead (2015) note that only

[10] The rebound in numbers at the site after years with disturbance events suggests there is some resiliency of the species to disturbance events. Sherwin (2016 pers. comm.): "these bats did not die… they relocated to alternate roosts until the threat had subsided and then returned. Certainly disturbance can be a factor, but these animals are fully capable of mitigating impacts through temporary relocation as needed."

one other Townsend's big-eared bat maternity roost is known in the area and, although also located on NPS land, it is structurally dilapidated and its long-term suitability for Townsend's big-eared bat use is questionable. Like other old wooden buildings used by Townsend's big-eared bat around the state, these structures are vulnerable to degradation and loss over time. Replacement structures tend to be made of materials and from designs less suitable for bats.

Nevertheless, the Randall House is an example of how management of a roost structure may allow Townsend's big-eared bat to continue to occupy an area.

Kentucky Mine Maternity Roost (Sierra County). The Kentucky Mine Historic Park and Museum is located in Sierra City, Sierra County, at an elevation of 1340 m (4400 ft). The Kentucky Mine Townsend's big-eared bat maternity colony was not known at the time of Pierson and Rainey's 1980s and early 1990s statewide assessment. The colony primarily roosts in a historical mine building (a stamp mill used to crush ore excavated from the nearby mine), but the bats appear to also use the nearby mine itself as an alternate roost site (M. Tierney 2015 pers. comm.).

As described by Freeman (2012), unlike most Townsend's big-eared bat maternity colonies, "this colony has acclimated to a level of disturbance typically considered intolerable for *C. townsendii*. The Sierra County Historical Society leads tours twice a day through the stamp mill throughout the maternity period. During these tours, guides wind up a massive iron stamp and let it pound down to demonstrate how it crushes rocks to remove the gold. This noisy activity frequently occurs directly beneath the roosting bats and causes the entire building to quiver. The grounds surrounding the stamp mill permit daily public use. On weekends, human disturbance continues into the night. An outdoor amphitheater located less than 50 meters from the colony is used for concerts during the nursery season. Although there is no information on colony size between the secession of mining activity and the advent of later recreational use of the site, it is certain this colony persists despite on-going disturbances."

The U.S. Forest Service prepared a management plan for the colony in 2007 (Tierney and Freeman 2007) and the Sierra County Historical Society, which operates the park and museum, cooperates with the U.S. Forest Service to manage the risk of disturbance to the colony by following the recommendations of the plan (W. Copren 2012 pers. comm.; M. Tierney 2015 pers. comm.). Among the plan's guidelines are measures to make the on-going human activities at the roost site consistent and predictable to allow the bats to acclimate to disturbance.

Exit counts from the stamp mill during the maternity season have been conducted by the U.S. Forest Service and others since 1994, along with occasional roost counts within the stamp mill and exit counts from the shafts of the mine itself. Data are available for the period 1994 through 2005 (Tierney, unpublished data). Depending on year, the counts at the stamp mill were conducted at various times during the maternity season (and therefore may include either adult females only or adult females and their young). The counts were sometimes conducted on nights when the colony was apparently roosting at an alternative site. The exit count data at first glance is irregular (Figure 6A).

By removing exit counts at the stamp mill roost with anomalously low numbers suggesting the bats were roosting at an alternative site (counts with fewer than 20 bats in years with other counts of 40 or more bats) and by separating the counts into the pre-volancy and volancy periods of the young (before mid-July and after the third week of July), a clearer pattern develops (Figures 6A and 6B).

Early season counts (consisting of adult females only) at the Kentucky Mine have generally been in the range of 30 to 50 bats since the first count of 66 bats was made in late June 1994. After young achieve flight starting around the last week of July, counts have varied between lows of around 35 in the late 1990s to between 50 and about 100 in the early 2000s (Figure 6A). Exit count data at the mine shaft roost site in late August and early September 2003 totaled 140 and 168 bats, but these very late counts would include adult males as well as females and young of the year (Figure 6B). It is also quite possible that both the mill and mine are concurrently used by individuals of this colony.

CDFW does not have access to more recent exit count data from Kentucky Mill, but the U.S. Forest Service's estimate from data collected subsequent to 2005 is that the colony size has been fairly stable at or near 100 adult females (M. Tierney 2015 pers. comm.; K. Freeman 2015 pers. comm.).

Lava Beds National Monument Maternity Roosts (Siskiyou and Modoc counties). Lava Beds National Monument (LBNM) is located in northeastern California. The monument contains the largest concentration of lava caves in the contiguous United States; LBNM staff had identified more than 750 caves by 2013. The extensive network of caves at Lava Beds National Monument in Siskiyou and Modoc counties has been inferred to be an area of high ecological importance for Townsend's big-eared bats in the region – Pierson and Rainey (1998) estimated that a quarter of the state's known breeding females occurred at LBNM at the time of their work (Pierson and Rainey 1998). These caves have been monitored for Townsend's big-eared bat presence during the maternity season over the past couple of decades, but because of Townsend's big-eared bat's known sensitivity to disturbance, most surveys during the active season have been limited to quick checks for presence or absence of bats (T. Weller 2014 pers. comm.). Counts of bats were infrequently made during these surveys and only rough estimates of bat numbers are available.[11] In accordance with cave resource management guidelines, caves where Townsend's big-eared bats were observed during the active season were then subsequently administratively closed to recreational access.

Efforts to monitor the Townsend's big-eared bat colonies at LBNM during the maternity season are of low intensity in an effort to minimize the risk of disturbance of roosting bats. Three Townsend's big-eared bat maternity colonies are monitored for presence/absence and to collect cave microclimate data (temperature and relative humidity). Depending on staff availability, the monitoring occurs on a variable schedule of between once per week to once per month (Katrina Smith 2015 pers. comm.). Exit counts have also been conducted, but conditions are not conducive to accurate counts (Katrina Smith 2015 pers. comm.).

[11] Visual counts in roosts are more effective than exit counts in the rugged, multiple-opening lava tubes and other caves of the area.

As part of his analysis of recent (1990s and later) Townsend's big-eared bat monitoring data from LBNM, Weller attempted to discern patterns of occupancy by date and location during the active season (T. Weller 2014 pers. comm.). Apart from very general conclusions about the timing of the maternity season, no pattern of occupancy in particular caves at particular dates, nor trend in bat colony size, can be discerned from these data (T. Weller 2014 pers. comm.). Weller concluded the known roost-switching behavior of Townsend's big-eared bat during the maternity season and the opportunistic and infrequent attempts to monitor Townsend's big-eared bat at LBNM during the active season preclude inferences about active season numerical trends using existing data. He advocated instead the use of Townsend's big-eared bat counts at hibernacula, where individual bats may reliably be counted during the inactive season (and without undue disturbance of the bats) as the preferred method to estimate local population size and trend. See below for a summary of results of LBNM hibernaculum monitoring (Weller et al. 2014).

Lava Beds National Monument Hibernacula (Modoc and Siskiyou counties). The Lava Beds area of northern California has been inferred to be home to one of the largest concentrations of Townsend's big-eared bat in California (Pierson and Rainey 1998). The National Park Service at LBNM has monitored winter bat use of the lava tubes and caves for many years (Weller et al. 2014). Townsend's big-eared bat are the most commonly encountered bat species in winter because of their habit of roosting in the open, but Myotis bats (*Myotis* sp.) and big brown bats (*Eptesicus fuscus*) are also occasionally observed (Katrina Smith 2015 pers. comm.).

NPS considers the period from November 15 to March 15 to encompass the Townsend's big-eared bat hibernation season at LBNM. Any bat survey completed in caves during this period is included in the LBNM bat database and is considered hibernacula monitoring data. In recent years, a focused effort to monitor the numbers of hibernating individuals at LBNM has been conducted, with one entire week in mid-winter devoted to completing as many bat hibernacula surveys as possible. NPS staff and collaborators use a stratified random sampling method to select caves for survey based on the number of bats seen there in previous years. This allows collection of annual data on large known hibernacula and also the survey of sites that have never been visited in winter. Using this method, in the past few years NPS has discovered four new hibernation sites with more than 30 bats, plus several sites with smaller numbers of Townsend's big-eared bat.

Winter bat surveys at LBNM use headlamps and other caving gear to enter caves to tally all visually observed hibernating bats. Townsend's big-eared bats typically hibernate singly or in small groups, generally consisting of fewer than 20 individuals, though larger clusters are occasionally observed. Along with counts of bats by species and location within the caves, cave microclimate data (air temperature, ceiling temperature, and relative humidity) are also recorded (Katrina Smith 2015 pers. comm.).

Weller et al. (2014) analyzed the results of NPS Townsend's big-eared bat hibernacula monitoring data from a 22-year period (1991-2012) at LBNM to determine if a trend in the number of Townsend's big-eared bat hibernating could be discerned. Over this period, bats were counted in a total of 52 caves. Although a concerted effort was made by NPS to monitor hibernating bats each year, the number of

caves visited and number of surveys conducted varied based on staff availability. These analyses were also used to design a flexible yet statistically robust monitoring program in future years.

Weller et al. (2014) used regression analysis to model the changes and trend in Townsend's big-eared bat numbers at each cave that had at least four surveys conducted from 1991 and 2012, and for which at least half of the surveys had at least one bat recorded. Using these models, the authors generated predicted numbers of Townsend's big-eared bat for each cave in non-survey years, as well as for 2012. The 2012 predictions were compared to the actual counts for that year. They also estimated the total number of Townsend's big-eared bat hibernating in all the caves each year by combining actual counts and estimated numbers.

Seventeen of the 22 caves monitored during at least four years had a positive trend in the number of hibernating Townsend's big-eared bat during the 22-year study period (Figure 6), and although not all of these were statistically significant, six of the caves with the largest numbers of bats (ranging from a few 10s to a few hundreds of bats) had statistically significant positive slopes. The decreasing trends for the other five caves were not statistically significant, nor did any of these caves ever have more than 10 Townsend's big-eared bat observed in a count.

The authors estimated the number of hibernating bats in the 52 surveyed caves increased from 834 bats in 1991 to 1,427 bats in 2012 (Figure 7). The estimated cumulative annual growth rate for the 52 caves over the period 1991–2012 was about 1.8% (Figure 8). The estimated annual population growth rate for the caves surveyed most often was about 4%. Estimates based on data from 1991 to 2011 generally predicted the 2012 counts well; however, the actual bats counted in most caves exceeded the predicted numbers in 2012. Seven caves had their highest count in 2012 and another three equaled their previous high count.

Although 52 caves among the 97 surveyed during the 22-year study period were observed to have hibernating Townsend's big-eared bats during one or more years, Cave L970 stands out as an especially important site. In 1990, 376 bats were counted there and it has consistently held the majority of bats counted each year (see Table 1 from Weller et al. 2014).

Although the authors list a number of caveats regarding their results, they are "confident that the number of bats in the 52 surveyed caves has increased or, at the least, remained stable." They state "the increasing number of hibernating individuals reaffirms LBNM as a population stronghold for Townsend's big-eared bats in a state (Pierson and Rainey 1998) and region (Pierson et al. 1999) where it is considered imperiled. Potential ecological explanations for the increase in hibernating bats are unclear but could be related to changes in management policy at LBNM. Beginning in 1991, approximately 10 caves were closed during the maternity period to limit disturbance of maternity colonies by visitors. Lava Beds National Monument also closed winter hibernation sites to visitors, starting with a few sites in the 1990s and increasing to nearly 20 caves by 2012."

Pinnacles National Park Maternity and Hibernation Roosts (San Benito County). Pinnacles National Park, located about 65 km (40 mi) east of Monterey, encompasses approximately 9,700 ha (24,000

acres). Pinnacles National Monument (later Park) was established to protect and allow public use of the unique talus cave systems found there, which are formed from the remnants of a 23-million-year-old volcano. The Townsend's big-eared bat maternity colony that occurs in the cave system at Pinnacles National Park was not known at the time of Pierson and Rainey's statewide survey in the 1980s and early 1990s. Following its discovery in 1997, NPS closed the cave to the public for 4 years to allow the bats undisturbed use of the cave and to determine how best to manage the site (NPS 2002). The Pinnacles roost site is used by Townsend's big-eared bats for hibernation and for the maternity season. Portions of the cave are warm enough during the maternity season for gestation and pup-rearing, while other sections are cool enough in the winter to provide a suitable environment for hibernation. After the period of study, NPS adopted a management policy for the site that allows park visitors to seasonally access the portions of the caves not in use by the bats (NPS 2002, Paul Johnson 2015 pers. comm.).

NPS conducts annual monitoring of the Townsend's big-eared bat colony, usually during both the maternity and hibernation seasons, to determine the effectiveness of this management strategy as well as to verify the dates for shifting visitor access. Because of the porous nature of the talus caves at Pinnacles, it is not possible to conduct exit counts at one or a few entrances to the roosts. Instead, NPS staff attempt to conduct visual counts of the maternity colony and hibernating bats within the roosts. Precise counts are not always possible due to limited access by humans to areas used by the bats, as well as the importance of minimizing disturbance to the roosting bats.

Over the period from 1997 to 2014, the total maternity colony size (sometimes including pups) has ranged from about 150 to possibly as high as 1000 individuals; though in most years the total maternity colony size ranges between 200 and 400 individuals (Table 2). The hibernaculum counts are generally lower than the maternity roost counts (possibly due to dispersed winter roosting habits), ranging from about 15 to 400 individuals, with many years having counts of around 200 individuals (Table 2). The annual count data shows an early increase in the total number of Townsend's big-eared bat individuals counted in both the maternity and hibernation seasons. This apparent increase in colony size may be attributed to the public cave closure from 1997 to 2002, followed by the adoption of the current management strategy of seasonal public access to the caves. Additional factors affecting the data are the intensity and frequency of survey effort in a given year. According to the NPS staff familiar with the surveys, the later years reported fewer survey visits to the roost site, which made it less likely that peak numbers would be detected in a given year (Paul Johnson 2015 pers. comm.). Despite the apparent decline in colony size since 2005-2006, NPS considers the Pinnacles Townsend's big-eared bat population to be relatively stable (Paul Johnson 2015 pers. comm.).

Hearst Castle Maternity Roost (San Luis Obispo County). The Townsend's big-eared bat maternity colony at Hearst San Simeon State Historical Monument was not known at the time of Pierson and Rainey's (1998) statewide survey. The Townsend's big-eared bat roost site was discovered during an assessment by California Department of Parks and Recreation (CDPR) of the bats occurring at Hearst Castle in 2000 (K. Miner 2015 pers. comm.). The maternity roost is located in a cavernous space within the reinforced concrete stair and landing structure at the main entrance to the complex of mansions that comprise Hearst Castle. Prior to the survey, the space was regularly inspected for structural

integrity and used for closed-space rescue training by park staff during the maternity season, who reported that bats were disturbed by their presence. Once discovered that it was being used by Townsend's big-eared bats, CDPR limited entry during the maternity season to only necessary safety inspections. Prior to 2003, Townsend's big-eared bats entered and exited the roost space through a narrow space below a screened door, forcing the bats to crawl on the ground. In 2003, the site was modified by adding two openings to the roost at more typical locations above the ground and sized to accommodate flying Townsend's big-eared bats accessing the site (R. Orr 2015 pers. comm.). CDPR also developed management guidance to ensure maintenance and repair activities at the site have minimal impact on roosting bats, including Townsend's big-eared bat (CDPR 2003).

Exit counts conducted by CDPR staff since 2000 suggest the management of the site has enabled the colony to persist and increase in size. Most of the exit counts at the Townsend's big-eared bat roost have been conducted during late August, at which time the counts would likely include both adult females and their volant young and possibly adult males, as well. Late summer exit counts ranged from 60 to 95 total individuals prior to the roost entrance modification work. Since the modification and adoption of the bat protection policy in 2003, total counts of Townsend's big-eared bat during the late summer have increased fairly steadily through the years (Figure 9). Over the period 2012-2014, late summer counts ranged from 413 to 813 total Townsend's big-eared bat individuals (including both adults and young of the year) at the site.

Santa Cruz Island Maternity Colony (Channel Islands National Park). Santa Cruz Island is the largest and most habitat-diverse of California's Channel Islands and it is the only Channel Island known to harbor a large reproductive colony of Townsend's big-eared bat (Brown et al. 1994). A small colony of fewer than 10 bats was discovered in a mine on Santa Catalina Island in 2001 (Brown and Berry 2002). Because of their distance to the mainland, the Santa Cruz and Santa Catalina Island Townsend's big-eared bat populations may be isolated from other Townsend's big-eared bat populations. If so, it is possible the island populations may have unique genetic characteristics within the species. Such uniqueness may be of conservation value in the face of climate change or other threats. The Santa Cruz Island colony was first described in 1939 as roosting in a 2-story ranch house at Prisoners Harbor on the north-central side of the island. At that time, it was estimated to number more than 300 individuals, which were likely both adult females and their volant young (Brown et al. 1994). A total of 246 individuals were taken for scientific collections in 1939 and two subsequent collection trips in 1949 and 1964 (Brown et al. 1994). Pierson and Rainey (1998) cited Museum of Vertebrate Zoology records as stating the colony in 1948 numbered 150 adult females.

At some point between the mid-1960s and 1974, the Prisoners Harbor ranch house was demolished. Despite extensive searches, large colonies of Townsend's big-eared bat were not observed again on the island until 1991, when they were reported to Pat Brown as occurring in the Bakery in an old adobe building at Scorpion Ranch on the northeast end of the island (Brown et al. 1994). It is not clear whether the Scorpion Ranch site was colonized by Townsend's big-eared bat displaced from Prisoners Harbor or if it was already in use prior to the loss of the Prisoners Harbor site. The National Park Service has since

then assumed management of the entire island, including the Scorpion Ranch buildings, as part of the Channel Islands National Park.

NPS and others have conducted regular exit counts at the maternity roost site during the spring (adult females only) and late summer (adult females and their young). Exit count data available to CDFW suggest the number of Townsend's big-eared bats at Scorpion Ranch have never been as high as at the Prisoners Harbor roost site. Spring counts in the early 2000s ranged from about 50 to 105 adult females, while fall counts ranged from about 75 to 165 adult females and their young.

Work was conducted in 2009 to renovate for human reoccupation other portions of the old adobe building. Exit counts by NPS personnel at the bakery roost site continued during maternity season during this time (T. Coonan 2014 pers. comm.). During the 4-year period from 2010 to 2013, the bakery roost site was abandoned, either temporarily (2010 and 2011) or for the remainder of the maternity season (2012 and 2013). The latter abandonment events resulted in the known death of pups at the caves to which the adult females had moved. Early season counts suggest between 60 and 90 adult females arrived at the roost site each year. The cause(s) and exact dates of abandonment are not known, but could include public visitor entry over the half-door into the roost site or other activity in and around the building, including use of other rooms within the building by NPS personnel.

Proposals have been made to increase monitoring activity at the maternity roost site to more closely track human activity and bat numbers (T. Coonan 2014 pers. comm.), as well as to exclude human entrance into the roost site with a bat-friendly gate. These proposals have not been implemented due to lack of funding (T. Coonan 2014 pers. comm.).

In summary, the Santa Cruz Island Townsend's big-eared bat colony has fared relatively poorly since it was first described in 1939. Repeated collections for scientific purposes, demolition or reconfiguration of roost sites, and disturbance have all impacted the bats, which had its highest recorded number (more than 300) reported when it was first counted. Although the failed or reduced recruitment that occurred during 2010 through 2013 may not yet have significantly reduced the colony size of this long-lived species, repeated reproductive failures will impact the age structure of the population. If reproductive failure of this colony continues, it is possible the Santa Cruz Island Townsend's big-eared bat population may become extirpated.

White-Inyo Mountains Hibernacula (Tulare and Mono counties). Szewczak et al. (1998) conducted an extensive survey program for bats in the White and Inyo Mountains from 1990 through 1996. As part of that survey effort, many observations of Townsend's big-eared bat were made, along with counts of Townsend's big-eared bat in individual hibernacula, which typically were in caves and abandoned mines. The authors have revisited many of the hibernation roosts since the original study was completed (M. Morrison 2014 pers. comm.). Some hibernation sites were repeatedly surveyed over multiple years while others were surveyed only once.

Morrison and Szewczak conducted 92 surveys of 47 sites within 28 different mines and caves in the study area from 1991 to 2014 (M. Morrison 2014 pers. comm.). Counts of hibernating Townsend's big-

eared bat ranged from 0 to 80 individuals per site. The median count per site for all Townsend's big-eared bat surveys was 4 individuals. Of the 47 sites, 33 were surveyed more than once. Of these, 62% of the sites had a decrease in the number of hibernating Townsend's big-eared bat, 19% showed an increase in numbers, 16% showed an initial increase but then decreased in recent years, and 3% showed an initial decrease and then increase in recent years. A mean decrease of 3 individuals per site was recorded among the revisited sites.

These data from Townsend's big-eared bat hibernacula in the White and Inyo mountains are preliminary and do not lend themselves to strong conclusions. However, the preliminary data suggest that, unlike the situation at Lava Beds National Monument, the number of Townsend's big-eared bats in the southeastern part of the state may be stable at best, or possibly decreasing.

Summary of Population Monitoring Studies. Table 3 summarizes the results of monitoring of Townsend's big-eared bat hibernation and maternity colonies at the aforementioned sites. Two of the sites (one hibernation and one maternity) had statistically significant increases in total population size over two-plus decades of monitoring. At the other sites, no statistical conclusions could be made about population trend.

Because the total current Townsend's big-eared bat population extent and the status of many roost sites in California are unknown, CDFW applied for and received a State Wildlife Grant from the U.S. Fish and Wildlife Service to conduct a two-year study to address this information need. This study, which is being conducted in collaboration with researchers from Humboldt State University and Texas A&M University, will provide a current snapshot of the distribution and numbers of individuals in surveyed areas throughout the state which can be compared with inferences made by Pierson and Rainey (1998) for the historical period (pre-1980) as well as the estimates made by Pierson and Rainey based on their own survey work in the 1980s and 1990s. It is hoped these surveys will provide CDFW and the Fish and Game Commission a much clearer picture of the species' status in California than do the isolated case studies summarized here. The results of the two-year study are expected to be available by June 2017.

Threats

CDFW has identified the following factors as potential threats to the continued existence of Townsend's big-eared bat in California: loss, degradation, and sustained disturbance of roost sites; loss and degradation of foraging habitat; disease; mining and associated abandoned mine closures; environmental contaminants; climate change and drought; and overexploitation. Each of these topics is addressed below. Competition for resources (such as prey, water, and cover habitat) with other native or introduced species was considered as a potential threat but eliminated from further consideration due to lack of evidence that it may pose a threat to the continued existence of the species.

Roosting Site Loss, Structural Degradation, and Disturbance.

The availability of suitable roosting habitat is often considered as a limiting factor for western bat populations. For example, Pierson (1998) stated "considerable evidence suggests that roosts are limiting for many bat species." Hayes (2003) cites several authors that "hypothesized [roosts] to be the primary factor" limiting bat populations. That roosts may limit bat populations, including Townsend's big-eared

bat, is a reasonable conclusion, given bats may use multiple roost sites with different characteristics during the year; that roost site suitability may be based on a narrow range of suitable temperatures, relative humidity, physical dimensions, and so on; and that such sites may occur in low densities on the landscape.

Impacts to roost sites are an important threat to Townsend's big-eared bat. Such impacts include both physical loss/modification of the roost site as well as disturbance of bats at the roost site.

Within the North Coast region of California, the loss of old-growth conifers with large, cavernous basal hollows during late 19th Century and early to mid-20th Century industrial-scale logging is presented as a likely explanation for the apparent decline of Townsend's big-eared bat colonies in the coastal forest of northern and central California (Pierson and Rainey 1998). The association of Townsend's big-eared bat with large basal hollows has been demonstrated by the work of Pierson and Fellers (1998) and Mazurek (2004) and is hypothesized as the historical roosting habitat of this species prior to the Wisconsin glaciation period (Humphrey and Kunz 1976).

More recent and ongoing forestry practices that could impact Townsend's big-eared bat include harvest of remnant old-growth trees with suitable roosting cavities, as well as disturbance associated with timber operations, increased access to roost sites by human visitors, loss of oak woodlands (which may provide roost sites and certainly provide foraging habitat), conversion of forest to agriculture such as vineyards, and application of chemicals.

New and renewed mining operations have the potential to impact Townsend's big-eared bat roosting in abandoned mines, either through disturbance of roosting bats or by destroying the old mine by conversion to open pit-style mining, or through collapse of abandoned mines. Four examples of the destruction or loss of Townsend's big-eared bat roost sites are described in the Petition.

Dam construction or modification can result in the inundation of Townsend's big-eared bat roost sites. The Petition mentions one large colony that was displaced by construction of the New Melones Dam on the Stanislaus River. As stated in the Petition, much of the dam-building, reconstruction, and license renewal in California occurs at the same elevations in the foothills of the Sierra Nevada and Klamath and Trinity mountains that are optimal for Townsend's big-eared bat roosts.

Although generally considered a cave/mine roosting bat, Townsend's big-eared bat also roosts in large spaces in old buildings and in cavernous spaces in bridges and dams. Bats in such sites are subject to disturbance when humans enter for inspections or other activities. The roosts themselves are subject to eventual deterioration or demolition. Pierson and Rainey (1998) documented the loss of several Townsend's big-eared bat roosts found in buildings.

There is an ongoing interest in caves and abandoned mines among recreational explorers. There is also a collectible market for mining artifacts. Multiple posts on YouTube and websites such as the Mojave Underground document entry into abandoned mines for recreational exploration. These often include videos or notes about bats encountered, which usually are Townsend's big-eared bats (P. Brown 2016 pers. comm.). People entering mines can disturb bats during the critical maternity and hibernation

seasons. Based on observations of movement of Townsend's big-eared bats from roost sites after human entry, it has been hypothesized that the species is particularly susceptible to such disturbance. Recreationists and homeless persons may also enter old buildings used as roosts and, in doing so, disturb bats. A house at the CDFW Chorro Creek Wildlife Area has provided a roost for a Townsend's big-eared bat maternity colony off and on for several years. The site has been repeatedly abandoned by the bats after break-ins followed by subsequent re-occupancy after the house is resealed (R. Stafford 2014 pers. comm.). The same pattern of partial or complete, albeit temporary, abandonment has been observed at the Randall House maternity roost site (Fellers and Halstead 2015) and other sites.

For example, a mine in the Tungsten Hills north of Bishop contained a maternity colony of more than 200 Townsend's big-eared bats in July 2008. In preparation for gating in fall 2011, it was visited by a Bureau of Land Management (BLM) biologist who noted a maternity cluster near the mine portal in July 2011. Since the maternity colonies prefer warm temperatures, it is common for them to roost very close to the surface in the summer in an exposed position that makes them especially vulnerable to disturbance from even casual entry into the mine. Returning a week later, the same biologist discovered dead bats hanging from the ceiling and on the floor. P. Brown collected 46 juveniles that had starved, but much of the mine is inaccessible (raises and winzes) and more bats could have been present or removed by scavengers. The mine was gated in fall 2011 and has been surveyed every summer since then. No bats were present in the summer of 2012. However, 50 Townsend's big-eared bats were observed exiting on June 14, 2014 indicating a portion or remnant of the colony has returned, but not in the numbers observed prior to the disturbance. Based on the mortality of juveniles observed in 2011, the bat colony lost at least a year of reproductive recruitment (P. Brown 2016 pers. comm.).

While it is certainly true that natural roosting habitat for Townsend's big-eared bat has been impacted by humans over the past 150 years, it is important to consider that historical mining and building construction also added to the total available roost habitat in the state in the late 1800s and early 1900s. Assuming the location of roost habitat is a limiting factor for Townsend's big-eared bat, it is possible that the total abundance of the species actually increased throughout the west, or that their distribution shifted as they were free to move away from historical cave roosts into areas from which they were historically precluded due to the lack of subterranean habitat (Sherwin et al. 2009). It is unknown to what degree the hypothesized decreases in colony sizes at natural roost sites of caves and large old trees with basal hollows have been offset by redistribution of individuals throughout the western United States. Many of the old buildings and mines themselves have been subsequently impacted, and in many cases lost, since the historical period. The development of commercial caves for recreational access occurred before surveys for bats were conducted, so the loss of some of these sites as roosting habitat is unknown. Moreover, with the documented loss of approximately 95% of old-growth coastal redwood forest on California's North Coast (Fox 1989), it is likely that this region has suffered a substantial decrease in roost site availability during the historical period.

In summary, CDFW considers loss, degradation, and disturbance at roost sites to be an important threat to Townsend's big-eared bat in California. Given the species' hypothesized susceptibility to disturbance, its reliance on cavernous roost sites, and the colonial nature of the species, especially during the

maternity season, it is possible that population-level or even statewide impacts could occur to the species from the loss or disturbance at relatively few roost sites.[12]

Loss of Foraging Habitat (including water)

Loss of suitable foraging habitat has previously been identified as a threat to Townsend's big-eared bat (Pierson and Rainey 1998, Pierson and Fellers 1998, Brown and Berry 2003). Ideal habitat for foraging likely includes a mix of edge and continuous vegetation cover, though the species may forage in almost all vegetation communities (Sherwin 2016 pers. comm.). Land management practices that create large openings of low shrub or grass cover in forest and woodland areas, such as agricultural development and extensive clear-cutting reduce foraging habitat suitability for the species. Likewise, residential and urban development reduce available foraging habitat. This is especially true in the extensive, highly-developed regions along California's South Coast and Bay Area. Although individual Townsend's big-eared bats may still make forays into these areas, it seems unlikely that breeding populations could be supported in urbanized areas where human presence is ubiquitous.

Mature riparian habitat may be especially favorable for Townsend's big-eared bat, in terms of structure and prey production. It has been estimated that 95% of California's riparian habitat, which is important for foraging Townsend's big-eared bats, has been lost to vegetation clearing or conversion and inundation behind dams (Katibah 1984). Climate change, including the effects of protracted or severe drought, may also negatively affect foraging habitat suitability and insect prey availability, both through vegetation changes and reductions in surface water availability.

In summary, CDFW considers loss of foraging habitat to be a potential threat to Townsend's big-eared bat in California.

White Nose Syndrome and other Disease

White Nose Syndrome (WNS) is a disease that has killed more than 6 million bats in eastern North America (USFWS 2012). It is caused by *Pseudogymnoascus destructans* (Pd), a cold-loving fungus that is thought to have been introduced into northeastern North America from Europe sometime in the early 2000s. The fungus grows in the skin and other tissues of hibernating bats and may affect multiple physiological systems of the bats during the winter period. The most obvious effect on hibernating bats is that infected individuals arouse from deep torpor much more frequently and for longer periods than non-infected bats, which drastically reduces the fat reserves needed to sustain the bats until insect prey is available in the spring. Most affected bats die of starvation, with mortality rates for some species (e.g., *Myotis lucifugus*, the little brown bat) approaching 100% in some eastern hibernacula.[13]

WNS was recently detected in North America in Washington state (previous to 2016 its western-most occurrences were in Minnesota and Nebraska). Surveillance studies to sample for the Pd fungus have yet

[12] On the other hand, as Sherwin (2016 pers. comm.) notes: "The fact that females remain active throughout the maternity period allows them to move from danger immediately upon noting human or animal disturbance. This actually helps them deal with disturbance, but may give the impression of susceptibility to it."

[13] https://www.whitenosesyndrome.org/

to detect it in California (W. Frick 2012 pers. comm.). Pd has been detected from swabs taken from the fur of Townsend's big-eared bats in WNS-affected areas in the eastern United States, but so far WNS (the disease) has not been observed to manifest in the eastern subspecies (A. Ballmann 2015 pers. comm.).

Little is known about the occurrence of other diseases, such as rabies, in Townsend's big-eared bat. Based on recent submissions of bats to state and county public health test labs, there is nothing to suggest Townsend's big-eared bat populations in California have been subject to recent disease outbreaks (Calif. Department of Public Health unpublished data 2015).

CDFW considers WNS an important potential threat to California populations of Townsend's big-eared bat. Based on observations in the eastern U.S., the species' susceptibility to the disease is unclear. Continued monitoring of hibernating bats (as at Lava Beds National Monument), surveillance for the fungal agent of WNS, and incorporation of measures to reduce the risk of introducing or transmitting the fungus to hibernation sites in California are all important measures to reduce the risk of WNS to California populations. CDFW does not consider other diseases such as rabies to be a threat to the Townsend's big-eared bat in California.

Environmental Contaminants

Environmental contaminants include both naturally occurring and human-generated toxins that may affect the health of plants or animals. Naturally occurring toxins, such as heavy metal minerals, sulfur oxides, ammonia, and carbon dioxide, generally do not naturally occur in sufficient concentrations to impact Townsend's big-eared bat populations and will not be addressed here. Human-produced toxins may be released or applied to the environment in many forms. Of greatest potential impact to Townsend's big-eared bat are toxins used for control of agricultural and other pests (pesticides), byproducts of mining and ore processing, and air quality contaminants.

Pesticides. The California Department of Pesticide Regulation publishes an annual Pesticide Use Report for California (available at www.cdpr.gov). These reports provide information on the types, amounts, and general location of pesticides used each year in the state. According to the 2013 annual report (Calif. Department of Pesticide Regulation 2015), a total of about 88 million kg of all types of pesticides were applied in California. Figure 10 (based on data provided in Calif. Department of Pesticide Regulation 2015, Table 1), depicts the 2013 average application (kg/ha) of all pesticides for each county in California. Pesticide use appears to be greatest in the San Joaquin Valley, an area with relatively few recorded observations of Townsend's big-eared bat. However, as noted in the Petition, drift of agricultural pesticides is known to occur – for example, pesticide chemicals applied in the Central Valley have been detected in frogs living in the Sierra Nevada (Sparling et al. 2001).

The most recent Pesticide Use Report (PUR-2013, Calif. Department of Pesticide Regulation 2015), which reports annual pesticide use for many classes of pesticides, states "regression analyses on use from 1996 to 2013 do not indicate a significant trend of either increase or decrease in total pesticide use." However, inspection of the report's figures suggests that total use of certain classes of pesticides has decreased over the period 1995-2013, while others have remained roughly the same or increased. In

particular, the most heavily used classes of pesticides (Fungicide/Insecticide, Insecticide) have shown a fairly marked decrease over the period (see Figure 1 of the PUR-2013). California Department of Pesticide Regulation also tracks use of various pesticide chemical classes, including "reproductive toxicity" chemicals, carcinogens, cholinesterase-inhibiting chemicals (organophosphates and carbamates), groundwater-impacting chemicals, toxic air contaminants, fumigants, and biopesticides (microorganisms and naturally-occurring chemicals used in lieu of synthetic chemicals). Some classes, such as the "reproductive toxic" chemicals, cholinesterase-inhibiting chemicals, and groundwater-impacting chemicals, have clearly decreased in usage (see Figures 6, 7, and 8 of PUR-2013). Others, such as carcinogens (PUR Figure 6), air contaminants (PUR Figure 9), and Fumigants (PUR Figure 10) have varied somewhat over the years but do not show a trend in use. Biopesticides (PUR Figure 12) have shown a steady increase in use over the report period.

The extent pesticide use in California impacts Townsend's big-eared bat populations is unknown; however, it is likely that some Townsend's big-eared bat individuals, at least, are impacted where these toxins are concentrated, either by ingestion of prey (including the potential for bioaccumulation within prey or bat) or water contaminated by pesticides, or by absorption through the skin after contact with pesticides in the air or on surfaces. These impacts may result from both lethal and sub-lethal exposure effects on survival and reproduction. While it is encouraging that use of some of the most environmentally damaging pesticides has decreased over the past two decades, it is unknown what level of threat the current and future levels of application pose to Townsend's big-eared bat populations. Broad-scale use of pesticides may also reduce abundance of prey for Townsend's big-eared bat.

Mine Toxins. Mineral extraction can result in pools of water contaminated with toxic chemicals. Such toxic pools have long been recognized as a threat to wildlife, including bats that may drink from them (Clark and Hothem 1991). The rising price of gold in the 1980s led to the renewal of mining using cyanide leaching as an extraction method in gold fields previously considered depleted. See the section on Mining for more information on renewed mining). The research and publicizing of the threat to wildlife of open cyanide ponds resulted in greater attention to this problem by federal and state regulators (S. Reeves 2015 pers. comm.), as well as industry-led measures to reduce the environmental hazards associated with cyanide leach fields (SME 2014).

The "International Cyanide Management Code for the Manufacture, Transport, and Use of Cyanide in the Production of Gold" is an industry voluntary program for gold mining companies. It is intended to provide for the safe management of cyanide and cyanidation mill tailings and leach solutions. Companies that adopt the code must have their mining operations that use cyanide to recover gold audited by an independent third party to determine the status of code implementation. Those operations that meet the code requirements can be certified. The code was developed by a multi-stakeholder steering committee under the guidance of the United Nations Environmental Program and the International Council on Metals and the Environment (http://www.cyanidecode.org/about-cyanide-code#sthash.4jbDJ744.dpuf).

According to available information, the largest gold mines in California are certified under the code (S. Reeves 2015 pers. comm.). Although toxic leach fields and ponds remain a potential threat to

Townsend's big-eared bat, CDFW believes that oversight of the mining industry by BLM, Regional Water Quality Control Boards, and the California Geological Survey minimize the risks associated with mine toxins to an acceptably low level.

Air Quality. As described in the Petition, poor air quality on a local or regional basis may result from human transportation, wildfires, energy production and manufacturing activities, ground disturbance, and erosion and loss of native vegetation cover. Although it is reasonable to conclude that Townsend's big-eared bat (and bats in general) may be affected by poor air quality due to their high metabolic rate when active, CDFW is not aware of any research indicating an impact of air pollutants in bat populations in California.

Climate Change

As described in CDFW's document outlining the agency's plans to address climate change (CDFG 2011), "a growing body of scientific research indicates California's remarkable diversity of habitats and wildlife is threatened by climate change. Ecological changes, including changes in species' distributions, timing of life cycles, and abundance, have already occurred in California over the past century in concert with increases in average temperature and changes in precipitation patterns (California Natural Resources Agency 2009). Existing stressors such as human population growth and associated land use changes, wildfires and associated habitat modification, water management conflicts, invasive species, and other widespread stressors will be exacerbated by climate change, and could increase negative impacts to ecosystems beyond the effects of individual stressors."

To assess the potential for future climate change to affect the distribution of Townsend's big-eared bat, Stewart (J. Stewart, unpublished data) conducted MaxEnt modeling using climatic variables to model the current and possible future distribution of the species under several projections of future climate during the period 2070 to the end of the 21st Century. This method uses the concept of a "climate envelope," the geographic area with a climate suitable for a species' survival. Such "envelopes" are generally expected to move up in elevation and north in latitude in the future with a warming climate.

The best predictors of Townsend's big-eared bat distribution in California were temperature and snowpack, with average amount of snowpack providing the most parsimonious model – that is, the species is less likely to occur in areas where greater snowpack occurs in the winter (J. Stewart 2015 unpublished results). Under four different future climate change projections (generally described as Warm-Wet and Hot-Dry) and two greenhouse gas emission scenarios (High and Low), Townsend's big-eared bat is projected to fare reasonably well, in terms of availability of climatically suitable habitat in California (see Figure 11). Although under some scenarios the species' suitable range is projected to retract in some areas (red areas in the figure), most of the currently-suitable modeled habitat is projected to remain suitable. Some areas, notably in the northern and higher elevations areas of the state, are projected to increase in suitability in the future. Under the worst-case scenario for Townsend's big-eared bat, 88% of current known locations for the species are projected to remain suitable. Other scenarios indicated 90% to 95% of current locations would remain suitable.

Stewart (2015 pers. comm.) suggests these results are not surprising, given the generally wide distribution of Townsend's big-eared bat in California, as well as its broad distribution in North America, including south through much of Mexico to the edge of the tropics. While such modeling may not accurately or precisely predict future habitat suitability for a species, and additional work is needed to ensure that future climate does not substantially impact Townsend's big-eared bat (for example, through loss of surface water and suitable foraging habitat, or de-coupling of suitable roost site structures from suitable climate areas), at this time CDFW has determined that climate change does not pose a significant threat to the species.

Mining

California has a long history of mining due to its variety of mineral and geological resources and ranks among the states with the highest production of minerals other than fossil fuels. Starting even before the Gold Rush era of the mid-1800s, tens of thousands of mines have been excavated in the state. The Abandoned Mine Lands Unit (AMLU) of the California Department of Conservation (California Department of Conservation 2009) estimates that there are approximately 47,000 abandoned mine sites in California. Although mines exist throughout the state, the majority of these mines are concentrated in the desert regions and western Sierra Nevada foothills (see Figure 12). Approximately two-thirds of abandoned mine sites are on federal land, 31% are on private land, and 2% are on state and local government land.

Mines provide important shelter for Townsend's big-eared bat and other bat species that evolved to roost in natural caves and crevices. Historic underground mining has created habitat for bats and other wildlife. Eighty percent of the mines in the western U.S. show some evidence of bat activity (Tuttle and Taylor 1998). Mines may be used by Townsend's big-eared bat year round for their roosting needs. These include critically important maternity and hibernation seasons. Large, structurally diverse mines may provide both warm roosts for maternity colonies and the cool or cold temperatures required during hibernation (Pierson and Fellers 1998, Pierson and Rainey 1998; Pierson et al. 1991, 1999). More recent work suggests smaller and less complex mines are also commonly used for maternity and hibernation seasons (Sherwin 2016 pers. comm.).

Mines may also offer prey such as moths and other insects and open water for drinking in chambers that intercept ground water. Such water resources are especially important in desert regions where surface water may be uncommon.

Because of the importance of historical and abandoned mines to Townsend's big-eared bats, several management issues related to mines and mining may pose a threat to the species. These include: closure of mines (either due to natural processes or intentional closure for hazard abatement), renewed mining, environmental contamination, and human disturbance at mine roosts. The latter two topics are discussed elsewhere in the Threats section of this report.

Abandoned Mine Lands (AML) programs are tasked with the closure of open mines hazardous to human safety. To determine the appropriate closure method at a mine, it is necessary to determine through surveys what species may be using the mine. Permanent abandoned mine closure methods have

resulted in the destruction of roosting habitat and have also caused direct mortality of bats by trapping them within the closed mine without prior exclusion at the appropriate season (Brown 1995b; Altenbach and Pierson 1995). Bat conservationists have advocated for assessment and planning for the appropriate mine closure method (fences, bat gates, cupolas, large grates) that allow bats to pass through openings too small for humans, while maintaining air flow patterns crucial for internal habitat conditions (Sherwin et al. 2009). Not all mine closure techniques presumed to be bat friendly are accepted by Townsend's big-eared bat (P. Brown 2016 pers. comm.). Recent installation of two corrugated culverts with inserted angle iron bars in the Bishop BLM field office resulted in the abandonment by the maternity colony of Townsend's big-eared bat of one mine and the use of an alternate traditional gated entrance by another (P. Brown 2016 pers. comm.). A similar event of roost abandonment appears to have happened at a maternity colony in the Gem Mine in the Panamint Mountains in Death Valley National Park after culvert installation (P. Brown pers. obs.). Whereas bats will fly through smooth-walled culverts, the corrugation appears to interfere with echolocation (Brown and Simmons 2015, Simmons and Brown 2015). Corrugated culvert closure has often been the closure method of choice for some agencies, especially the U.S. Forest Service (P. Brown 2016 pers. comm.).

California's Department of Conservation has an AML unit that is actively engaged in reducing the hazards associated with open mines. It works with state and private mine owners to ensure that wildlife-compatible closure methods are implemented. It also coordinates with federal land management agencies for closures on BLM and other federal lands. See http://www.conservation.ca.gov/omr/abandoned_mine_lands for more information on AML issues in California.

Modern methods of mineral extraction have allowed mining companies to renew mining in historical areas previously abandoned. For example, the use of chemical extraction methods for gold from open pit mines often occurs directly in areas with abandoned shaft mines. Renewed mining in historical mine districts has the potential to impact Townsend's big-eared bat and other bat species where the modern mine removes the previous underground mine (Pierson et al. 1991). One of the largest maternity colonies in the California desert was removed at the Briggs Mine in Inyo County (P. Brown 2016 pers. comm.), although pre-project gating of other historical mines appears to have mitigated the loss of roosting habitat, as bats have been observed to use the alternate sites (Brigida 2014). In addition, renewed mining may impact native vegetation and water sources used for foraging around the mine, and may introduce chemical contaminants used for mineral extraction. See the section on Environmental Contaminants for more information on this aspect of mining impacts to bats.

In summary, CDFW considers the impacts associated with mine closures and renewed mining to be important potential threats to Townsend's big-eared bats. Active AML programs at the state and federal level should minimize the threat of mine closures to sensitive species. Environmental review of proposed mining projects through CEQA and NEPA should ensure adequate assessment and disclosure of potential impacts to Townsend's big-eared bat from such projects. Provided such programs are adequately funded by state and federal agencies, it is likely that population-level impacts associated with legacy mines and renewed mining may not occur. However, there is less certainty that important

roost sites and Townsend's big-eared bat colonies would be adequately protected in the absence of a listing of the species as threatened or endangered.[14] This is especially true if the price of gold and other minerals increases as it did a decade ago, and more renewed mining in historic districts becomes economically feasible. A population of Townsend's big-eared bat will be impacted by the recently permitted Golden Queen Mine at Soledad Mountain near Mojave, CA. No adequate mitigation is in place that might mitigate for impacts or ensure survival of that population (P. Brown 2016 pers. comm.).

Overexploitation (for Scientific Use)

As a nongame mammal (defined in Fish and Game Code section 4150), Townsend's big-eared bat is not harvested or collected for commercial or personal use. Collection of Townsend's big-eared bat does occur in California on a limited basis for bona fide scientific and educational purposes. Such collection is regulated according to Fish and Game Code (sections 1002 *et seq*.), which is administered by CDFW.

In the past, scientific collections were made on a much greater scale than occurs today. The mammal collections at the Museum of Vertebrate Zoology, Los Angeles County Museum of Natural History, and at many other museums and universities in the western U.S. were established through the lethal taking of representative specimens of California's mammalian fauna. Such collections remain an important resource for scientific investigations of the phylogeny, evolution, taxonomy, diet, morphology, physiology of California's fauna (Pyke and Ehrlich 2010).

For long-lived/low fecundity species such as Townsend's big-eared bat, it is possible that repeated scientific collection may have a population impact. As documented by Brown et al. (1994), the Townsend's big-eared bat maternity colony at Prisoners Harbor (Santa Cruz Island) was subjected to three collecting episodes over a period of 25 years in which a total of 246 individuals were taken. The Santa Cruz Island colony, which apparently numbered "more than" 300 individuals (which probably included both adult females and their young) in 1939, has never recovered to its historical size, though other impacts, including roost loss and disturbance have been contributing factors.

Non-collecting scientific study may also impact Townsend's big-eared bat populations through disturbance of roosts. Before Townsend's big-eared bat's susceptibility to roost site disturbance was well documented, Pearson et al. (1952) conducted investigations of the basic ecology and reproductive biology of Townsend's big-eared bat in California. These studies included occasional entry into maternity and hibernation roosts at multiple sites around California to collect information and to place wing-bands on bats. In one case, the authors banded 75 young Townsend's big-eared bats during the early night while the adult females were foraging. By the next morning, the young had been carried by their mothers to another roost site, presumably in response to the disturbance at the original roost site (Pearson et al. 1952). The authors did not document whether there was an impact in terms of growth or survival of the young from this disturbance event.

[14] On the other hand, even lacking a listing, this species has benefitted from proactive conservation actions designed to mitigate the impacts of human activities in and around mines used for roosting (Brigida 2014, Ives 2015).

Placement of wing bands on bats is a long-standing method used to mark individual bats (Barclay and Bell 1988, Gannon et. al. 2007). Recapture of banded bats can provide information on movements, survival, and population size. Based on available information, it appears Townsend's big-eared bat does not handle wing-banding as well as other bat species (Pierson and Fellers 1994). Ellison (2010) summarized results from her own and others' studies suggesting a relatively high proportion of banded Townsend's big-eared bat suffer from perforated wing membranes, scarring, tissue-swelling, infection, and irritation. Moreover, the banding activity may have disturbed some individuals sufficiently to cause them to move to different roost sites (Ellison 2010).

Because of the concerns related to over-collection, disturbance at roosts, and wing-banding, CDFW carefully controls the activities of scientific researchers working on Townsend's big-eared bat in California. All persons who may take[15] Townsend's big-eared bat for scientific or educational purposes are required to possess a current Scientific Collecting Permit and, while a candidate for listing, a CESA permit or memorandum of understanding issued under the authority of Fish and Game Code section 2081(a). Among the standard conditions used in research permits are: a prohibition on entry into known roost sites (unless specifically authorized for a particular study), immediate departure from sites discovered to be maternity roosts, and measures to minimize the risk of introducing the fungus that causes White Nose Syndrome to hibernacula. Wing-banding is not currently authorized for any researcher working on Townsend's big-eared bat. No collection of Townsend's big-eared bat specimens is currently authorized for any researcher. Prior to Townsend's big-eared bat's designation as a Candidate for listing, Scientific Collecting Permits that authorized work with Townsend's big-eared bat had similar provisions for the protection of Townsend's big-eared bat individuals and populations.

Given the level of control exerted by CDFW on scientific researchers working with bats, overexploitation for scientific purposes is not considered to be a threat to the continued existence of Townsend's big-eared bat in California.

Habitat Essential for Continued Existence of the Species (Fish & G. Code §, 2074.6)

In 1952, after intensive study of Townsend's big-eared bat at several maternity and hibernation roosts at both coastal low elevation sites and interior high-elevation sites, Pearson and his co-authors considered factors that may be limiting Townsend's big-eared bat populations in California. They dismissed predation as a limiting factor, as they had never observed a predation event or evidence of such, nor were they aware of any important natural predators of Townsend's big-eared bat.[16] Disease was likewise discounted in importance due to lack of observation. Pearson et al. (1952) considered the availability of food and water as a possible limiting factor, but could not address this factor given a lack of data on prey availability. Regarding roost site availability, the authors noted that each maternity and

[15] "Take" is defined in Fish and Gamd Code section 86 as "to hunt, pursue, catch, capture, or kill" or to attempt to do so.

[16] But see Fellers's (2000) report of black rats, *Rattus rattus*, preying upon non-volant young Townsend's big-eared bat at the Randall House maternity roost, as well as his description of the possible effect of owl presence on roost departure times of Townsend's big-eared bat at the same site (Fellers 2014).

hibernation roost site in their study seemed large enough to house many more Townsend's big-eared bat individuals than were observed. They reasoned that at the local scale food or water may be limiting, but on a regional scale appropriate roost sites may be limiting the total population size. Appropriate roost sites not only must have suitable size and other structural and microclimate characteristics, but also must be near suitable foraging habitat. Additional habitat benefits are derived from safe and accessible sources of open water for drinking, though some desert populations appear to be able to subsist on water in their prey and metabolic water production.

With these considerations in mind, and with the apparent loss of historical roost sites documented by Pierson and Rainey (1998) and others, and the expected continued degradation and loss of old buildings suitable for use as roost sites (Fellers and Halstead 2015, G. Tatarian 2014 pers. comm.), CDFW considers any structure, or set of structures, used by Townsend's big-eared bat as a maternity or hibernation roost to be habitat essential for the continued existence of the species. The essential characteristics of these suitable roost sites extend to the nearby foraging, commuting, and night-roosting habitat and therefore these adjacent habitats are also considered essential.[17]

It may be possible on a case-specific basis to identify alternative or replacement roost structures, or set of structures (to allow for roost-switching), and adjacent habitat that would serve a local Townsend's big-eared bat colony. The suitability of such alternative or replacement roost sites would need to be demonstrated (through comparable use by the local Townsend's big-eared bats) prior to considering any occupied roost unnecessary for the colony. CDFW is aware of that replacement roost structures have been purpose-built for use by Townsend's big-eared bat on a limited basis, but this is a management action that should be further explored on an experimental basis.

EXISTING MANAGEMENT, MONITORING, AND RESEARCH ACTIVITIES

California Department of Fish and Wildlife

The CDFW is the state trustee agency for fish, wildlife, and botanical resources. In addition to its current status as a Candidate for CESA listing, CDFW designated Townsend's big-eared bat as a Species of Special Concern (Williams 1986). The SSC designation does not confer any legal protection on the species, but rather is intended to ensure management, conservation, and research activities are implemented to prevent future declines and the need for listing under the California Endangered Species Act (Comrack et al. 2008). As an SSC, Townsend's big-eared bat is also designated as a Species of Greatest Conservation Need (SGCN) in California's State Wildlife Action Plan (SWAP, CDFW 2015). This designation provides additional focus on the species by CDFW, as well as funding opportunities for

[17] In particular, as noted by Tatarian (2015 pers. comm.), structures used for roosting by single Townsend's big-eared bats in the vicinity of maternity roosts and hibernacula may be essential to allow population-level behaviors essential to reproduction. These behaviors include socialization between adult females and males in the fall leading to mating at mixed-sex overwintering roost sites, as well as dispersal of young at the end of the maternity season.

research and conservation actions from the State Wildlife Grant program of the U.S. Fish and Wildlife Service.

As part of CDFW's general mission to monitor wildlife resources, known Townsend's big-eared bat roosts on CDFW lands (Wildlife Areas and Ecological Reserves) are monitored. This includes the maternity colony that occurs on the Chorro Creek Ecological Reserve in CDFW's Central Region. Through on-going monitoring, CDFW has documented the impact of human disturbance at this site and has implemented measures to reduce the threat of disturbance to the colony (R. Stafford 2014, 2015 pers. comms.).

Townsend's big-eared bat is currently a Candidate for listing as threatened or endangered under the California Endangered Species Act. As such, the prohibition on "take" of listed and candidate species of CESA applies to Townsend's big-eared bat. Regulatory programs of CDFW now review proposed CEQA, timber harvesting plans, and scientific research applications to ensure that no take of the species would occur, unless authorized by one of the statutory exemptions allowing such take, such as the Incidental Take Permit and Safe Harbor mechanisms of CESA, or through a permit or memorandum of understanding for take for scientific or educational purposes. All such take may only be authorized if it is fully mitigated and would not jeopardize the continued existence of the species in California. As mentioned above, should the species not be listed then it would revert to the Species of Special Concern designation. SSCs typically receive some attention during CEQA review, but protection from take and population-level impacts is less certain. This applies not only to projects for which CDFW is the lead or responsible agency, but for CEQA projects for which other state agencies (such as the California Department of Parks and Recreation and CalFire, see below), counties, or cities are the lead agency.

CDFW is currently implementing three projects relevant to Townsend's big-eared bat that are funded by the State Wildlife Grant program. The California Bat Conservation Plan (CBCP) was initially funded by a State Wildlife Grant in the mid-2000s and, after several years of development is now nearing completion, thanks in part to a new State Wildlife Grant to complete final edits. The CBCP addresses the management and conservation of all bat species occurring in California, including Townsend's big-eared bat, and will provide specific recommendations for the management, policy development, and research for all species, all ecoregions, and all the major conservation issues affecting bats in the state. Included in the CBCP is a relative ranking of the species for conservation concern – Townsend's big-eared bat consistently was rated by the authors as among the greatest concern bat species.

The second State Wildlife Grant-funded project directly addresses the current conservation status of Townsend's big-eared bat in California. Previously, CDFW (at the time the California Department of Fish and Game) funded a statewide survey for Townsend's big-eared bat in the 1980s by Elizabeth Pierson and William Rainey (Pierson and Rainey 1998). The new statewide survey effort is being conducted over a two-year period and is targeting known and highly-suitable locations for maternity and hibernation roosts. This project is being contracted to researchers from Humboldt State University and Texas A&M University (Joe Szewczak and Michael Morrison) and should provide an updated snapshot of the species' distribution as of 2015-2017.

State Wildlife Grant funding was also provided to CDFW and other western states to implement a project to expand bat monitoring according to the North American Bat Monitoring Program (Loeb et al. 2015). In California, this project is initially focused on acoustic monitoring of bat activity around the state, which is not likely to provide a lot of data on Townsend's big-eared bat due to its quiet echolocation calls. However, CDFW plans to increase efforts to monitor important roosts for Townsend's big-eared bat and other species in the future as the program continues to develop.

California Department of Parks and Recreation

The CDPR manages state parks throughout California. As with other land management agencies, CDPR manages sensitive biological resources, such as Townsend's big-eared bat, both through review of proposed project impacts under the environmental review process, as well as through focused monitoring efforts at known roosts (such as at Hearst San Simeon State Historical Monument).

California Department of Forestry and Fire Protection

CalFire is the lead agency in California for timber harvest projects on private and state forest lands. Timber harvest review is a CEQA-equivalent environmental review process and, as such, requires proposed timber management projects to assess and disclose potential impacts on the environment, including to biological resources. Since the designation of Townsend's big-eared bat as a candidate for listing under CESA, CalFire has been proactive in working with timber companies and registered professional foresters to ensure significant impacts to the species, as well as "take," are avoided.

National Park Service

NPS lands in California include several known Townsend's big-eared bat roost sites, including the large number of caves at Lava Beds National Monument, the Randall House maternity colony at Point Reyes National Seashore, the hibernacula and maternity roosts at Pinnacles National Park, and the Scorpion Ranch maternity roost on Santa Cruz Island. In general, the NPS approach to sensitive biological resources, such as Townsend's big-eared bat and its habitat, is to survey, monitor, manage, and to conduct research on the species. However, on Santa Cruz Island, NPS management of the Townsend's big-eared bat at Scorpion Ranch has not been adequate to ensure the conservation of that population.

In addition to the monitoring and management of the aforementioned sites, work by E.D. Pierson and others in Yosemite National Park and Sequoia National Park (Pierson and Heady 1996, Pierson 1997, and Pierson et al. 2006) provided baseline information on bat use of these areas, including use by Townsend's big-eared bat (S. Stock 2014 pers. comm.).

Bureau of Land Management

BLM designates Townsend's big-eared bat as a sensitive species. This designation requires land use plans to address the species and its habitat and to incorporate the species' needs in a manner to reduce potential conflicts with other multiple use activities. On BLM-administered lands, BLM manages a sensitive species and its habitat to minimize or eliminate threats affecting the status of the species or to improve the condition of the species' habitat. BLM assists, as funding allows, in determining distribution, abundance, and condition of the species, and to manage the habitat in such a manner to improve the

conservation status of the species and ensure that BLM actions do not move the species towards needing to be listed (A. Fesnock 2015 pers. comm.).

However, BLM mine claimants conduct mining activities on BLM lands, and many of these claims include historic mines that shelter bats. The renewed mining activities, including entry into the mines, can disturb bats, especially Townsend's big-eared bats. A plan of operation does not need to be filed on small mining claims. The BLM sends letters to claimants asking them to make the historic mines safe and to prevent human entry and reduce liability. These notices do not mention bats or other wildlife, nor do they recommend methods for mine safety closure (such as inclusion of bat gates). Sometimes the mine portals are covered either temporarily or permanently without excluding bats first (P. Brown 2016 pers. comm.)

Based on information gathered for this status review report (A. Fesnock 2015 pers. comm.), Townsend's big-eared bats are known to occur on BLM lands throughout much of California. As with other lands, most records for the species are from roost structures, including mostly abandoned mines. The BLM has an active survey and assessment program that evaluates abandoned mines for public safety hazards, wildlife and historical resources, and recommended closure methods. Evaluations of abandoned mines conducted over the past 15 years indicate many such mines are used by Townsend's big-eared bats. Few repeat visits or monitoring programs have been implemented, however, and therefore inferences about population status or trend cannot be made. Many of the BLM roost sites surveyed since 1999 are being re-visited as part of the current CDFW-funded statewide survey project.

All of the BLM field offices in California consider Townsend's big-eared bat roost sites (both hibernacula and maternity roosts) to be important resources to protect and manage. Many such sites have been gated in the past two decades to allow bats to use the sites without human disturbance (BLM unpublished data). The BLM expects to continue with gating abandoned mines to protect bat habitat and for public safety (A. Fesnock 2015 pers. comm.).

U.S. Forest Service

The U.S. Forest Service in California lists Townsend's big-eared bat on its Regional Foresters Sensitive Species list. As such, the species is given almost as much protection as a species listed as threatened or endangered under the federal Endangered Species Act (L. Angerer 2015 pers. comm.). USFS projects and management actions are evaluated to ensure project effects do not put the species on a trend towards endangered or threatened status.

In particular, the USFS completes Biological Evaluations for all Sensitive Species prior to implementing projects and management actions. Each Biological Evaluation includes management recommendations for the Sensitive Species. In general, Townsend's big-eared bat colonies are protected. When a project is proposed that may impact a roost site (such as a mine closure or historical building removal) measures are implemented to replace the lost structure or to improve the use of the structure by bats after project completion.

Most known Townsend's big-eared bat roost sites on Forest Service lands are not consistently monitored (though with some exceptions, such as the Kentucky Mine colony in the Sierra National Forest). The overall strategy implemented by the USFS has been to protect and avoid impacts (L. Angerer 2015 pers. comm.). However, many of the mine closures use corrugated culverts because mine portal stability has been an issue on steep and wet hillsides. Without adequate pre- and post-closure surveys, the impact to Townsend's big-eared bat populations is not known (P. Brown, pers. comm.).

SUMMARY OF LISTING FACTORS (Cal. Code Regs., tit. 14, § 670.1

CESA directs CDFW to prepare this report regarding the status of Townsend's big-eared bat based upon the best scientific information available to CDFW. CESA's implementing regulations identify key factors that are relevant to the CDFW's analyses. Specifically, a "species shall be listed as endangered or threatened ... if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors: (1) present or threatened modification or destruction of its habitat; (2) overexploitation; (3) predation; (4) competition; (5) disease; or (6) other natural occurrences or human-related activities." (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A).)

The definitions of endangered and threatened species in the Fish and G. Code provide key guidance to CDFW's scientific determination. An endangered species under CESA is one "which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease" (Fish & G. Code, § 2062). A threatened species under CESA is one "that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by [CESA]." (*Id.*, § 2067.)

The following summarizes CDFW's determination regarding the factors to be considered by the Commission in making its decision on whether to list Townsend's big-eared bat. This summary is based on the best available scientific information, as presented in the foregoing sections of the report.

Present or threatened modification or destruction of its habitat

Disturbance, degradation, and loss of suitable roost sites is a recognized threat to Townsend's big-eared bat populations, both in natural roost sites such as large, old trees and caves, as well as in human-made roosts such as old buildings and mines. Although roost sites are now generally managed and protected better than in historical period, lacking the protections of CESA it is possible the species could be impacted at multiple roost sites in the future, which could lead to population-level impacts. However, there is no current indication that loss or disturbance of roost sites is a significant state-wide threat to the species at this time. Additionally, although impacts to foraging habitat could also affect the species, there is no indication that current impacts to foraging habitat pose a significant threat at this time.

Therefore, CDFW does not consider modification and destruction of habitat to be a significant threat to the continued existence of the Townsend's big-eared bat in California.[18]

Overexploitation

CDFW does not consider overexploitation to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Predation

CDFW does not consider predation to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Competition

CDFW does not consider competition to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Disease

White Nose Syndrome is an important potential threat to Townsend's big-eared bat in California. Monitoring and research to determine the species' susceptibility to the disease as well as its occurrence in western North American, especially now that it has been discovered in the Pacific Northwest, are needed to assess the actual level of this threat. As discussed above, however, this disease is not currently impacting Townsend's big-eared bat in California. Therefore, CDFW does not consider disease to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Other Natural Events or Human-Related Activities

Mining (including renewed mining), agricultural development and pesticide use, restoration or demolition of old buildings and other anthropogenic structures used as roosts, forest management, and recreational caving and mine exploration all have the potential to impact Townsend's big-eared bat populations. State and federal environmental review programs typically include assessment and disclosure of potential impacts to the species in the CEQA/NEPA process. Adequate environmental review should prevent such activities from affecting Townsend's big-eared bat at the population or statewide level. CDFW does not consider these activities to be a significant threat to Townsend's big-eared bat in California.

Climate change, especially more frequent and severe drought, has the potential impact Townsend's big-eared bat in California. Continued and increased monitoring of the species' abundance and distribution should help determine the actual impact of these threats to the species.

[18] One of the external expert reviewers of this report, Dr. Patricia Brown, disagrees with CDFW's assessment. In her review of the report she states lack of information regarding current habitat loss or degradation is not sufficient to conclude this threat is not significant.

MANAGEMENT RECOMMENDATIONS

These recommendations were developed by CDFW in accordance with the requirements of Fish and Game Code, section 2074.6. This list includes some recommendations developed by other authors, including Johnston et al. (2004), Ellison et al. (2003), Tigner and Stukel (2003), AGFD (2003), and Bradley et al. (2006). CDFW recommends these actions be implemented regardless of the Commission's decision on listing Townsend's big-eared bat as threatened or endangered. This list includes recommendations for actions that could be undertaken by CDFW as well as by other public agencies, non-governmental organizations, and private land owners.

Research and Monitoring Needs

- Complete comprehensive statewide assessment of Townsend's big-eared bat by 2017.
- Implement consistent long-term monitoring at representative Townsend's big-eared bat roost sites in California, including at both maternity and hibernation roosts.
- Design and test human-made structures suitable for use by Townsend's big-eared bat during the maternity and hibernation seasons.
- Create standardized procedures for monitoring Townsend's big-eared bat populations. Ensure all such studies will not adversely impact the subject populations. This should include formal study of the frequency of roost-switching and other movements, both to determine the degree such human study affects movements and to better understand detection probabilities for roost surveys and to develop guidance on the timing and numbers of survey visits needed to determine occupancy or probable absence.
- Conduct additional analyses of the possible effects of climate change and drought on Townsend's big-eared bat and determine best approaches to address possible adverse effects.
- Conduct research on the role environmental contaminants play in the health of Townsend's big-eared bat populations.
- Develop methods to create basal hollows in suitable large old trees.
- Conduct genetic studies to determine the population genetic structure of Townsend's big-eared bat in California, with special attention to the degree of divergence and isolation of populations on Santa Cruz Island relative to the mainland and between coastal and interior populations.

CDFW Administrative Actions

- If results of current or future statewide Townsend's big-eared bat surveys indicate a decline in the population status is occurring that may lead to endangerment, prepare a staff recommendation to list the species as Threatened or Endangered for consideration by the Fish and Game Commission.
- Working with partners at state and federal agencies, as well as private landowners, ensure that management of Townsend's big-eared bat roost sites is consistent with continued site occupancy at or above existing population levels.
- Attempt to secure new funding and position resources as a priority to establish a full-time permanent bat specialist position within the Nongame Wildlife Program of CDFW to address data assimilation and conservation of bats in California, including Townsend's big-eared bat.

- Support research on the design and effectiveness of human-made structures suitable for use by Townsend's big-eared bat during the maternity and hibernation seasons.
- Create interagency and other stakeholder cooperation in, and public support for, conservation efforts for Townsend's big-eared bat. Partner with non-governmental organizations such as Bat Conservation International, The Nature Conservancy, and local NGOs in such efforts.
- Develop greater awareness of Townsend's big-eared bat and other bat conservation and management issues within CDFW.
- Direct fiscal and position resources to complete the draft California Bat Conservation Plan.

Management of Known Roost Sites

- Prior to changing management of caves, mines, or buildings that could be used by Townsend's big-eared bat or other bat species, such sites should be evaluated and/or surveyed during appropriate seasons for their use by Townsend's big-eared bat.
- Existing roosts should be left undisturbed and occupied roosts should only be entered for management or research purposes.
- Bat-friendly gates should be installed at Townsend's big-eared bat roosts where other methods of controlling human entrance are not effective. Special consideration should be given to gate design to minimize risk of injury or unsuitability for Townsend's big-eared bat. Corrugated culvert gates should not be used.
- Abandoned mines suitable for use by Townsend's big-eared bat should not be closed in a manner that prevents bat use, or if they cannot be maintained then adequate mitigation and exclusion should be conducted prior to their closure. If renewed mining will close a mine, mitigation for replacement habitat should be implemented. Mitigation monitoring should be done by the appropriate agency to determine effectiveness.
- Effectiveness monitoring (use of data loggers to passively record bat use and human disturbance) should be implemented at gated roost sites and other roost sites actively managed for bat resources (as through signage, information for visitors, etc.).
- Ensure native vegetation and access to open water and/or riparian habitat within the vicinity of maternity roosts remains suitable for use by Townsend's big-eared bat. Analysis of habitat suitability should be made on a site-specific basis, but start with using the area within a 24-km radius of the roost site.
- Where a Townsend's big-eared bat or other bat roost site has a history of recreational use by humans, implement a management plan to ensure new impacts from human use do not occur. The Kentucky Mine Stamp Mill management plan (Tierney and Freeman 2007) is a good example of such a plan that appears to be successful.

Landscape Management Practices

- Developed springs and other water sources should be kept available for in-flight drinking.
- If protracted drought poses a threat to Townsend's big-eared bat, develop additional water sources for drinking and foraging in areas where open water and associated insect prey production might limit population size.
- Restore or enhance riparian habitat.

- Implement basal hollow creation projects to increase opportunities for Townsend's big-eared bat to use tree roosts in coastal redwood forests (and possibly in interior forests where large tree species, such as giant sequoia, have the potential to serve as roost sites)

CEQA Review of Proposed Projects

- Ensure direct and cumulative impacts from projects proposed under CEQA and CEQA-equivalent regulatory programs are not likely to result in a substantial reduction in population or range of Townsend's big-eared bat and other bat species.

Public Education and Outreach

- Conduct and cooperate with other agencies on public outreach events about Townsend's big-eared bat and other bat species.
- Disseminate the California Bat Conservation Plan to the public, when complete.
- Encourage citizen participation, as appropriate, in bat monitoring projects.
- Promote bat-friendly exclusions, including seasonally-appropriate timing of exclusions, where it is necessary to remove bats from buildings and other structures.

Health and Disease

- Continue and expand surveillance for WNS by state and federal agencies and researchers.
- Support research on the etiology and epidemiology of WNS on *Corynorhinus* species, including Townsend's big-eared bat.
- Continue and expand, if necessary, decontamination requirements for persons entering hibernacula for Townsend's big-eared bat and other hibernating bat species to minimize the risk of introducing the fungus that causes WNS.
- Work with other state and federal regulatory agencies to prevent the introduction of environmental contaminants that may affect the health of Townsend's big-eared bat and other bats. These may include aerial pesticide application and chemicals used in processing mined minerals.

LISTING RECOMMENDATION

CESA directs CDFW to prepare this report regarding the status of Townsend's big-eared bat in California based upon the best scientific information. CESA also directs CDFW based on its analysis to indicate in the status report whether the petitioned action is warranted. (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).). CDFW includes and makes its recommendation in its status report as submitted to the Commission in an advisory capacity based on the best available science. In consideration of the scientific information contained herein, CDFW has determined that the petitioned action is not warranted at this time.

PROTECTION AFFORDED BY LISTING

It is the policy of the State to conserve, protect, restore and enhance any endangered or any threatened species and its habitat. (Fish & G. Code, § 2052.) If listed as an endangered or threatened species,

unauthorized “take” of Townsend’s big-eared bat will be prohibited, making the conservation, protection, and enhancement of the species and its habitat an issue of statewide concern. As noted earlier, CESA defines “take” as to hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill. (*Id.*, § 86.) Any person violating the take prohibition would be punishable under State law. As to authorized take, the Fish & G. Code provides CDFW with related authority under certain circumstances. (*Id.*, §§ 2081, 2081.1, 2086, 2087 and 2835.) In general and even as authorized, however, impacts of the taking on Townsend’s big-eared bat caused by the activity must be minimized and fully mitigated according to State standards.

Additional protection of Townsend’s big-eared bat following listing is also likely with required public agency environmental review under CEQA and its federal counterpart, the National Environmental Policy Act (NEPA). CEQA and NEPA both require affected public agencies to analyze and disclose project-related environmental effects, including potentially significant impacts on endangered, rare, and threatened special status species. Under CEQA’s “substantive mandate,” state and local agencies in California must avoid or substantially lessen significant environmental effects to the extent feasible. With that mandate and CDFW’s regulatory jurisdiction generally, CDFW expects related CEQA and NEPA review will likely result in increased information regarding the status of Townsend’s big-eared bat in California as a result of, among other things, updated occurrence and abundance information for individual projects. Where significant impacts are identified under CEQA, CDFW expects required project-specific avoidance, minimization, and mitigation measures will also benefit the species. State listing, in this respect, and required consultation with CDFW during state and local agency environmental review under CEQA, would also be expected to benefit the species in terms of related impacts for individual project that might otherwise occur absent listing.

Listing Townsend’s big-eared bat increases the likelihood that State and federal land and resource management agencies will allocate funds towards protection and recovery actions. Funding for species recovery and management is limited, however, and there is a growing list of threatened and endangered species.

ECONOMIC CONSIDERATIONS

CDFW is charged in an advisory capacity in the present context to provide a written report and a related recommendation to the Commission based on the best scientific information available regarding the status of Townsend’s big-eared bat in California. The topic areas and related factors CDFW is required to address as part of that effort are biological and not economic. (See Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).)

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Townsend's big-eared bat CESA Status Review – Figures

Captions

1. Map showing geographic ranges of species and subspecies of North American long-eared bats as described by Handley (1959). Adapted from Piaggio and Perkins (2005, Figure 1).

2. CWHR geographic range map of Townsend's big-eared bat, with occurrence locations.

3. CWHR range map of Townsend's big-eared bat, with occurrence locations symbolized by time period.

4. Locations mentioned in the Population Trend section.

5. From Fellers and Halstead (2014, Figure 1). (A) Attempts to break into the Randall House, site of a *Corynorhinus townsendii* roost at Point Reyes National Seashore, California. (B) Annual number of adults (maximum count during May or June) and total *C. townsendii* (adults plus volant young; maximum count during July or August) emerging from roost at Point Reyes National Seashore.

6. Exit count data at Kentucky Mine Townsend's big-eared bat maternity colony (Sierra County), 1996 - 2005. All counts were conducted during the maternity season. A. All counts. B. Early maternity season counts (before late July), without counts when the colony likely roosted elsewhere. C. Late maternity season counts (late July and later), without counts when the colony was likely roosting elsewhere. (source: Marilyn Tierney, unpublished data, and Freeman 2012).

7. From Weller et al. (2014, Figure 2). Estimated trend (solid line), upper and lower 95% prediction intervals (dotted lines), and number of Townsend's bigeared bats (*Corynorhinus townsendii*) counted (solid circles) during hibernacula surveys at 22 caves in Lava Beds National Monument, Siskiyou County, California, during 1991–2012. Caves are ordered top left to bottom right as largest to smallest observed counts.

8. From Weller et al. (2014, Figure 4). Estimates, with 95% prediction intervals, for the total number of Townsend's big-eared bats (*Corynorhinus townsendii*) hibernating in 52 caves at Lava Beds National Monument, Siskiyou County, California, during 1991–2012. The total number of caves surveyed each year is denoted as n on the x-axis.

9. Late summer (August – mid-September) exit counts for the Townsend's big-eared bat maternity colony site at Hearst San Simeon State Park, 2000 – 2014 (R. Orr, pers. comm.). For years with more than one count was conducted during the late summer season, the date with the highest count is depicted.

10. Average application of pesticides (kg/ha) for California counties, 2013, plotted with Townsend's big-eared bat occurrence locations.

11. Current and future projected climatically-suitable areas for Townsend's big-eared bat in California (J. Stewart, unpublished data) under four projections of future climate. Climatically-suitable areas were modelled using MaxEnt and existing occurrence records. For the period 2070-2099, areas shown in dark blue remain suitable, areas shown in red are suitable under current climate conditions but are projected to become unsuitable, and areas in light blue are modelled as currently unsuitable but would become suitable in the future.

12. California abandoned mines. Department of Conservation Abandoned Mine Lands Program, July 2015.

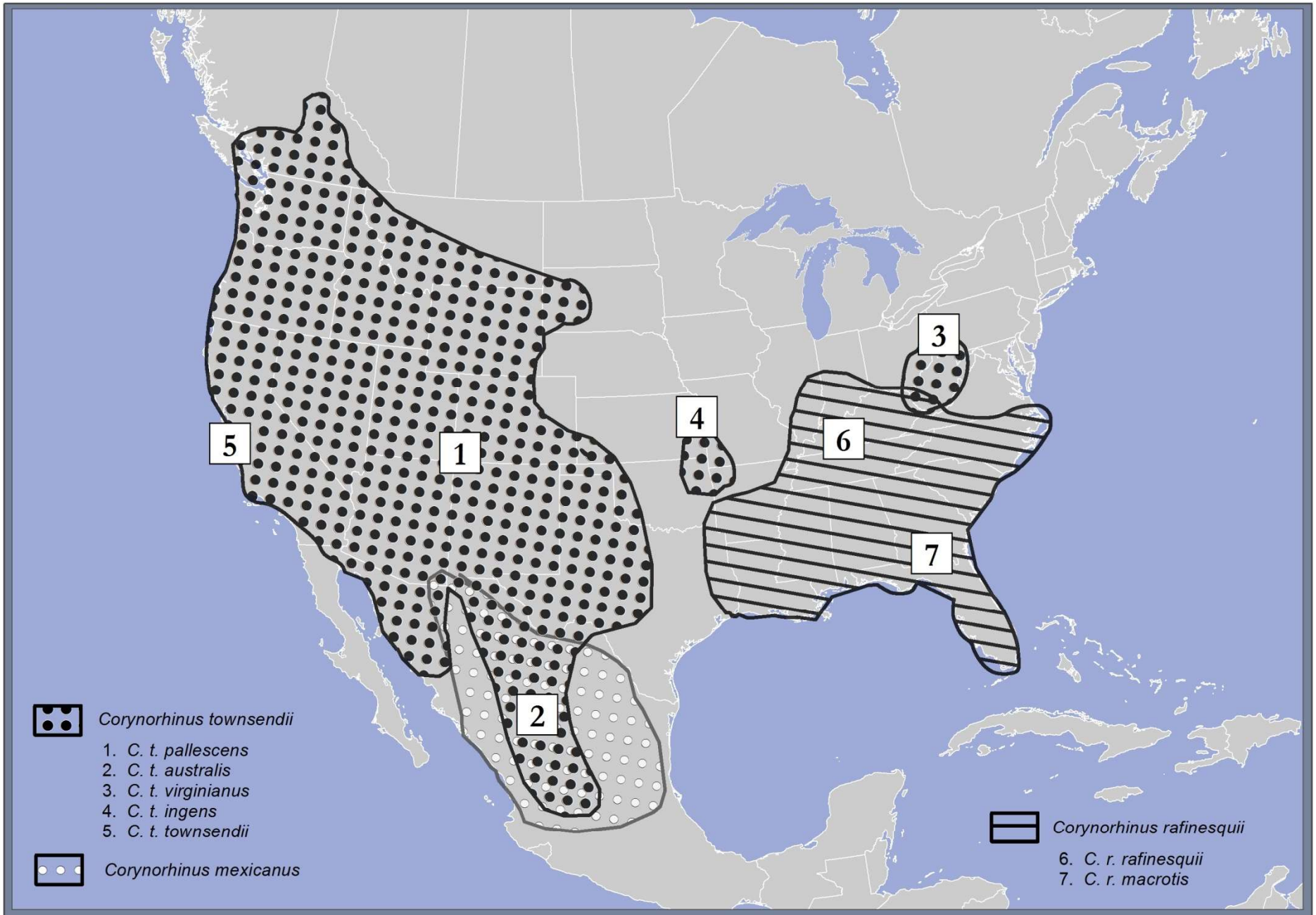


Figure1. GEOGRAPHIC RANGE OF SPECIES AND SUBSPECIES OF NORTH AMERICAN LONG-EARED BATS AS DESCRIBED BY HANDLEY (1959) IN PIAGGIO AND PERKINS (2005, FIGURE1).

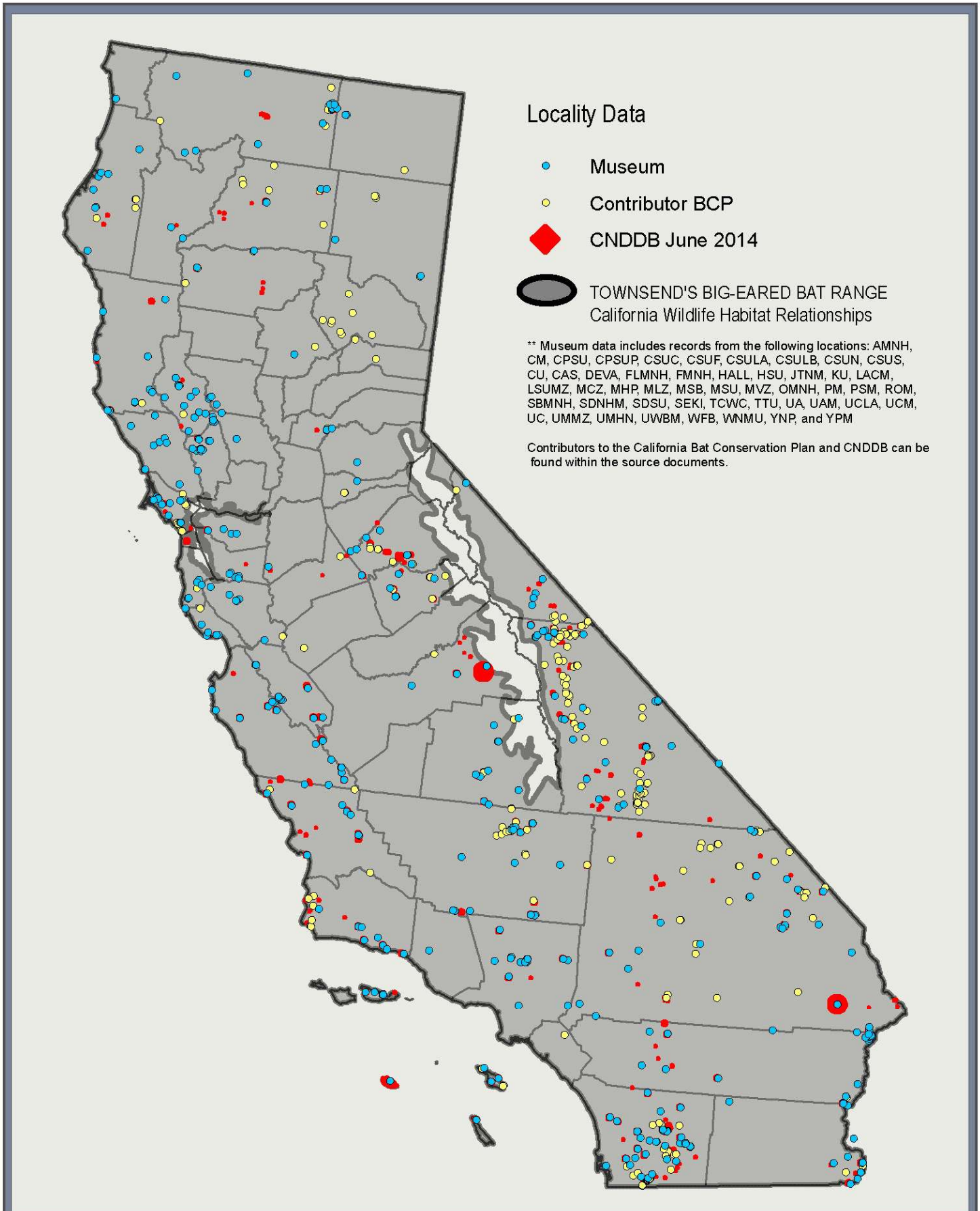


Figure 2. TOWNSEND'S BIG-EARED BAT *(CORYNORHINUS TOWNSENDII)* RANGE AND LOCALITY DATA

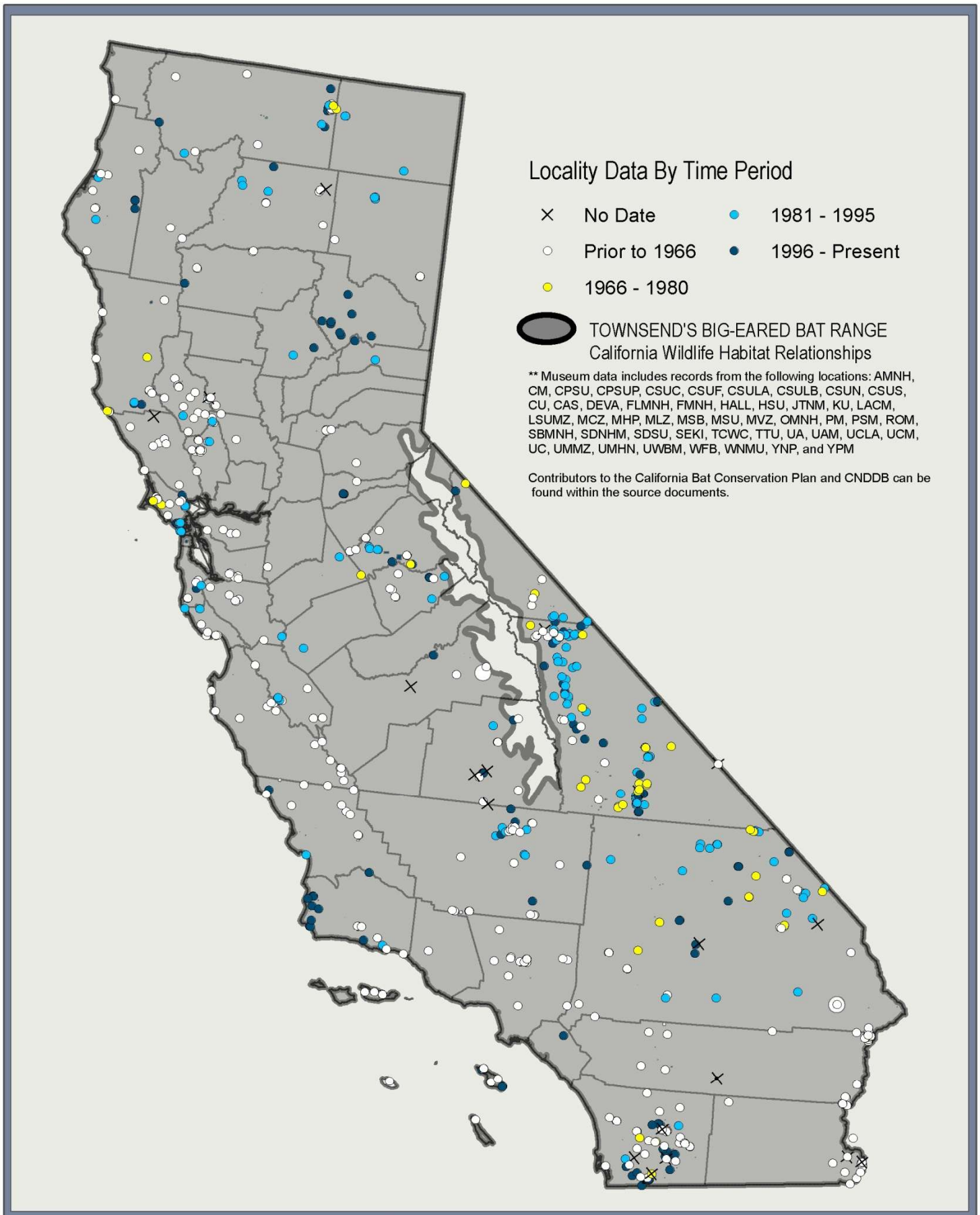


Figure 3. TOWNSEND'S BIG-EARED BAT *(CORYNORHINUS TOWNSENDII)* LOCALITY DATA BY TIME PERIOD

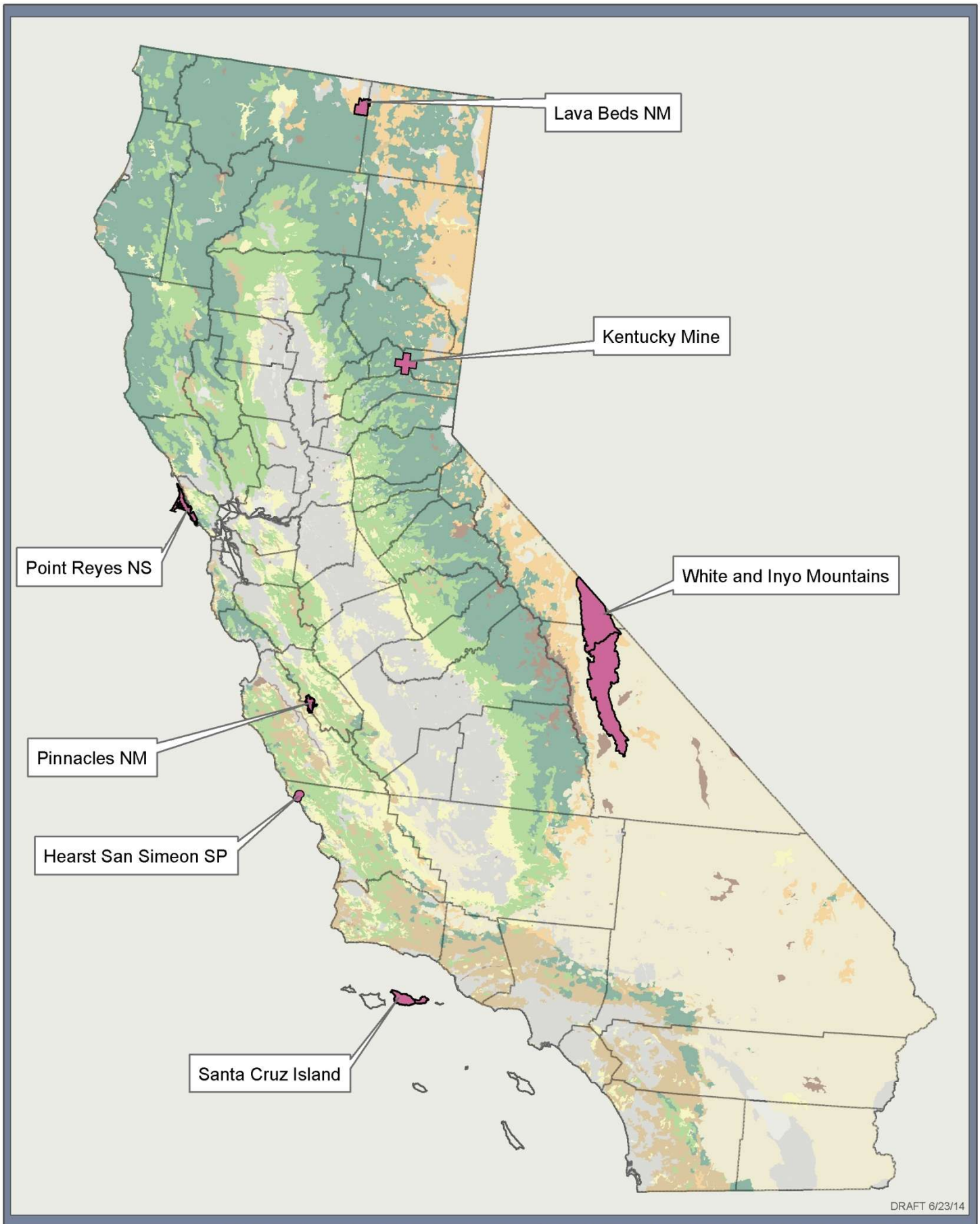
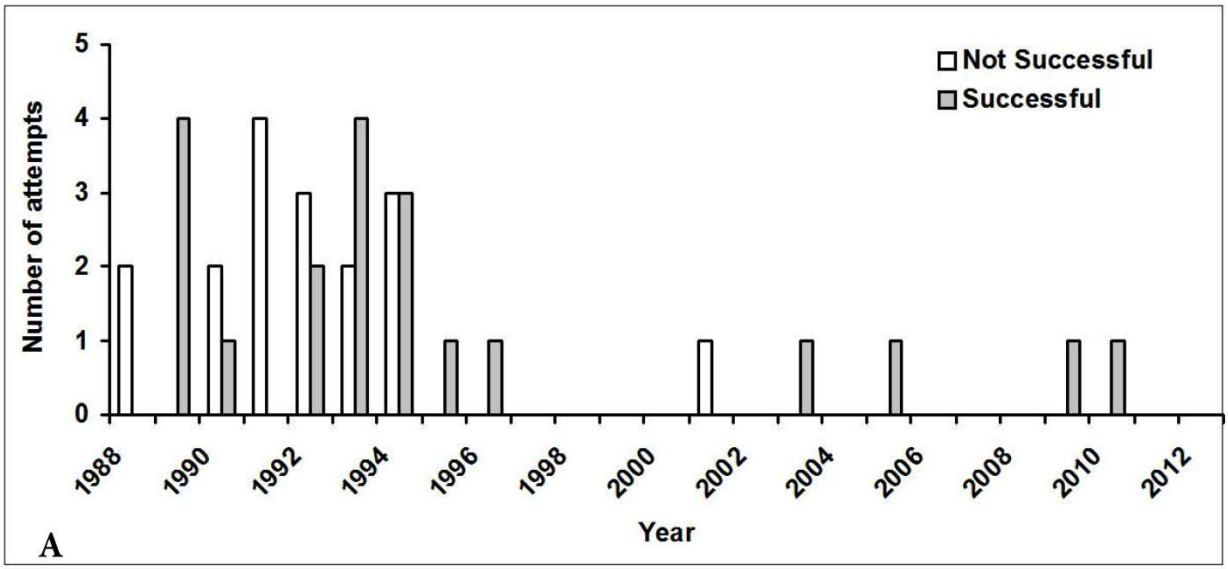


Figure 4. TOWNSEND'S BIG-EARED BAT *(CORYNORHINUS TOWNSENDII)* SITES MENTIONED IN TEXT

Figure 5.


Not Successful
Successful
Number of attempts
0
1
2
3
4
5
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Year
A

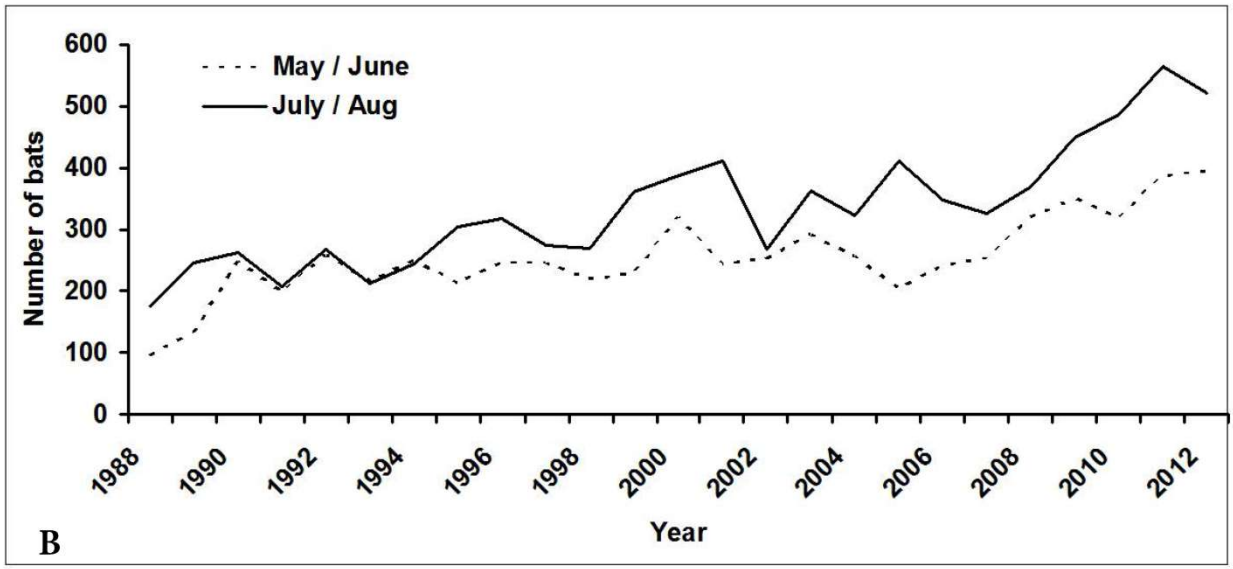

May / June
July / Aug
Number of bats
0
100
200
300
400
500
600
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Year
B

Figure 6. (A)

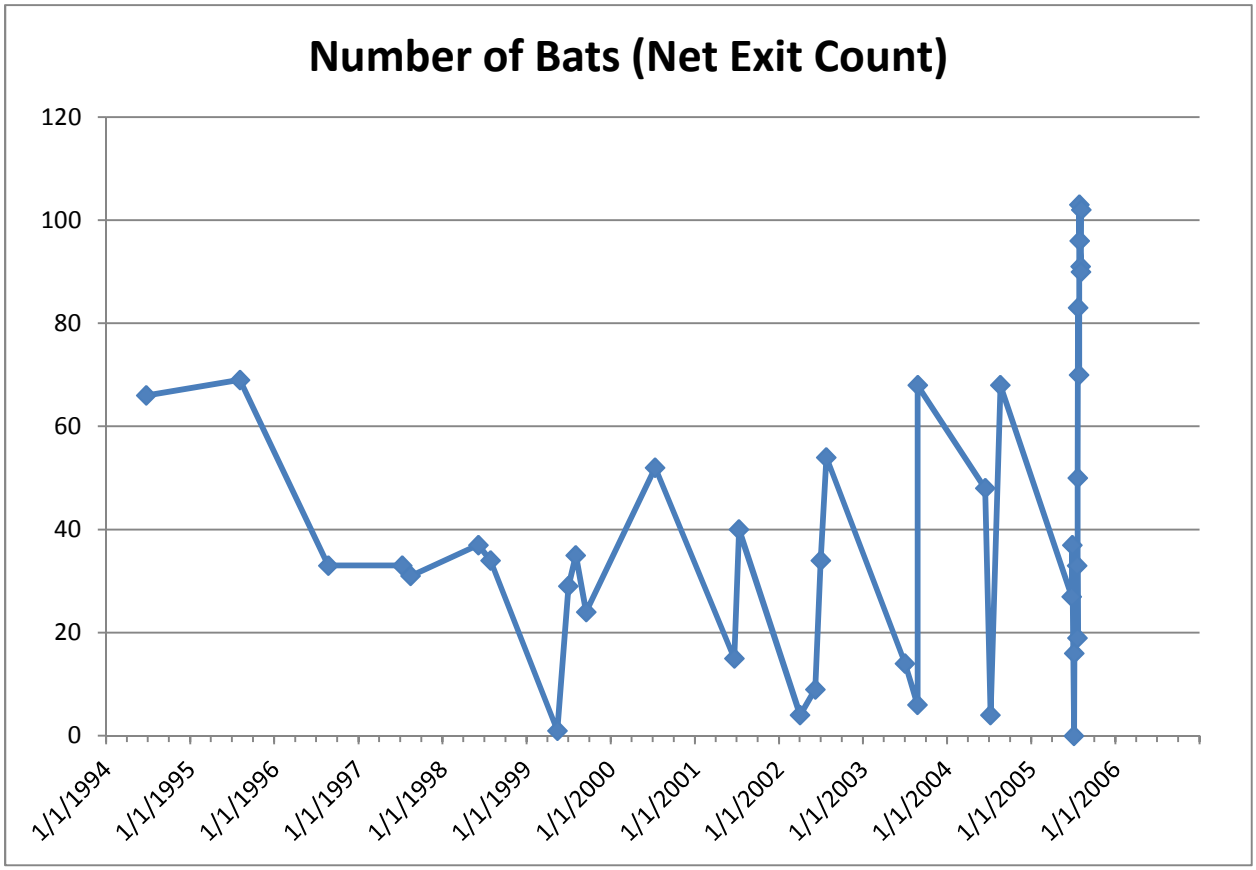
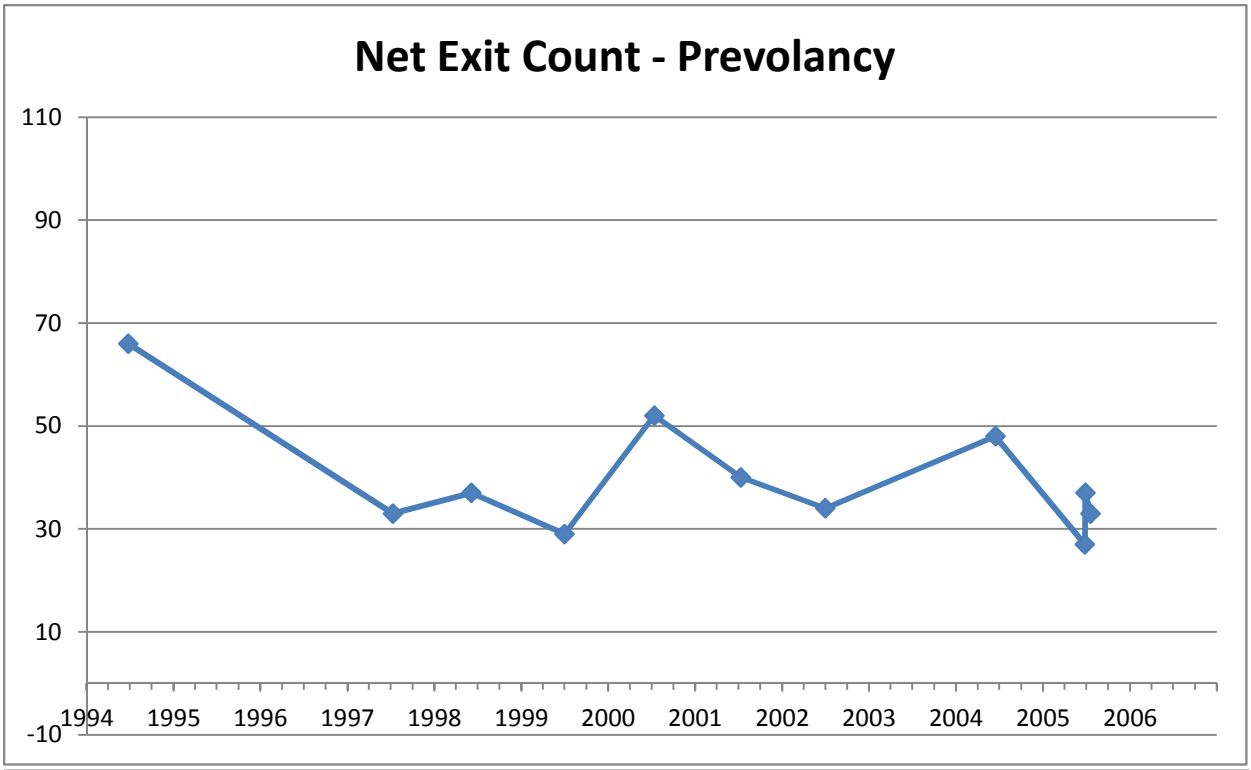

Number of Bats (Net Exit Count)
120
100
80
60
40
20
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004
1/1/2005
1/1/2006

Figure 6. (B, C)


Net Exit Count - Prevolancy
110
90
70
50
30
10
-10
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006

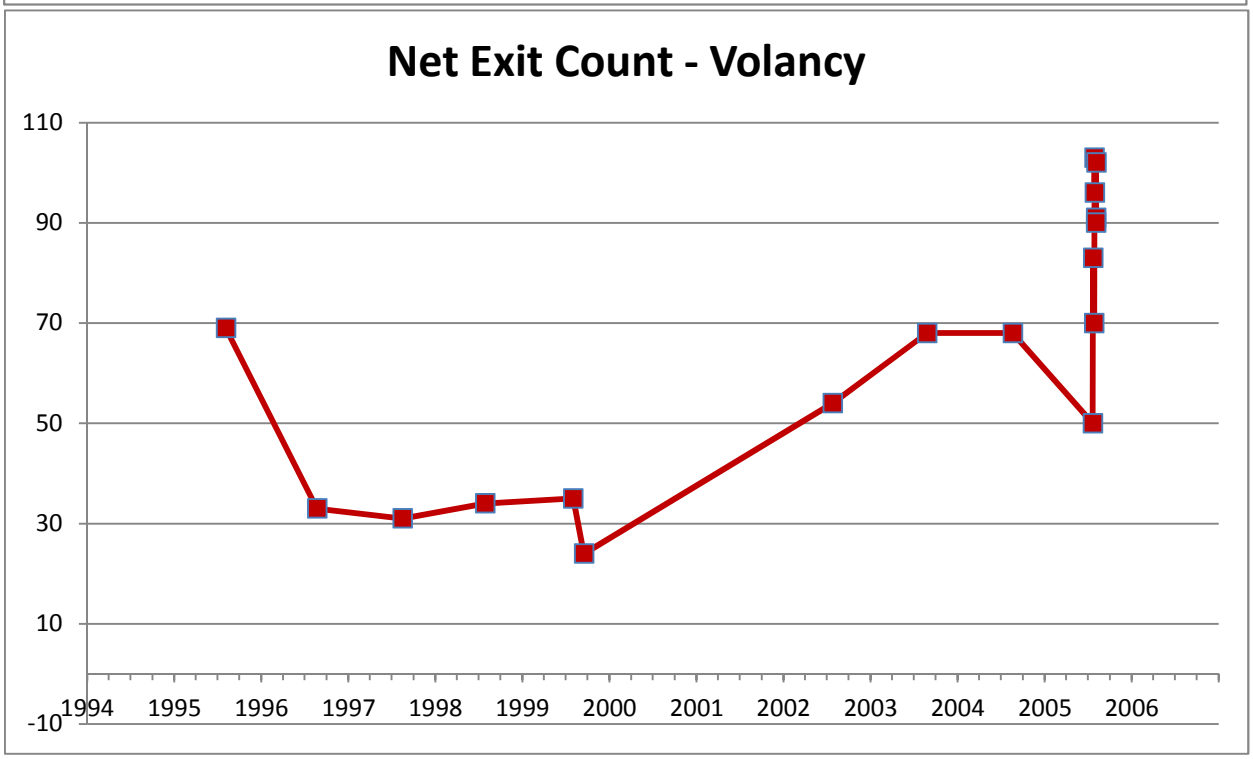

Net Exit Count - Volancy
110
90
70
50
30
10
-10
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006

Figure 7.

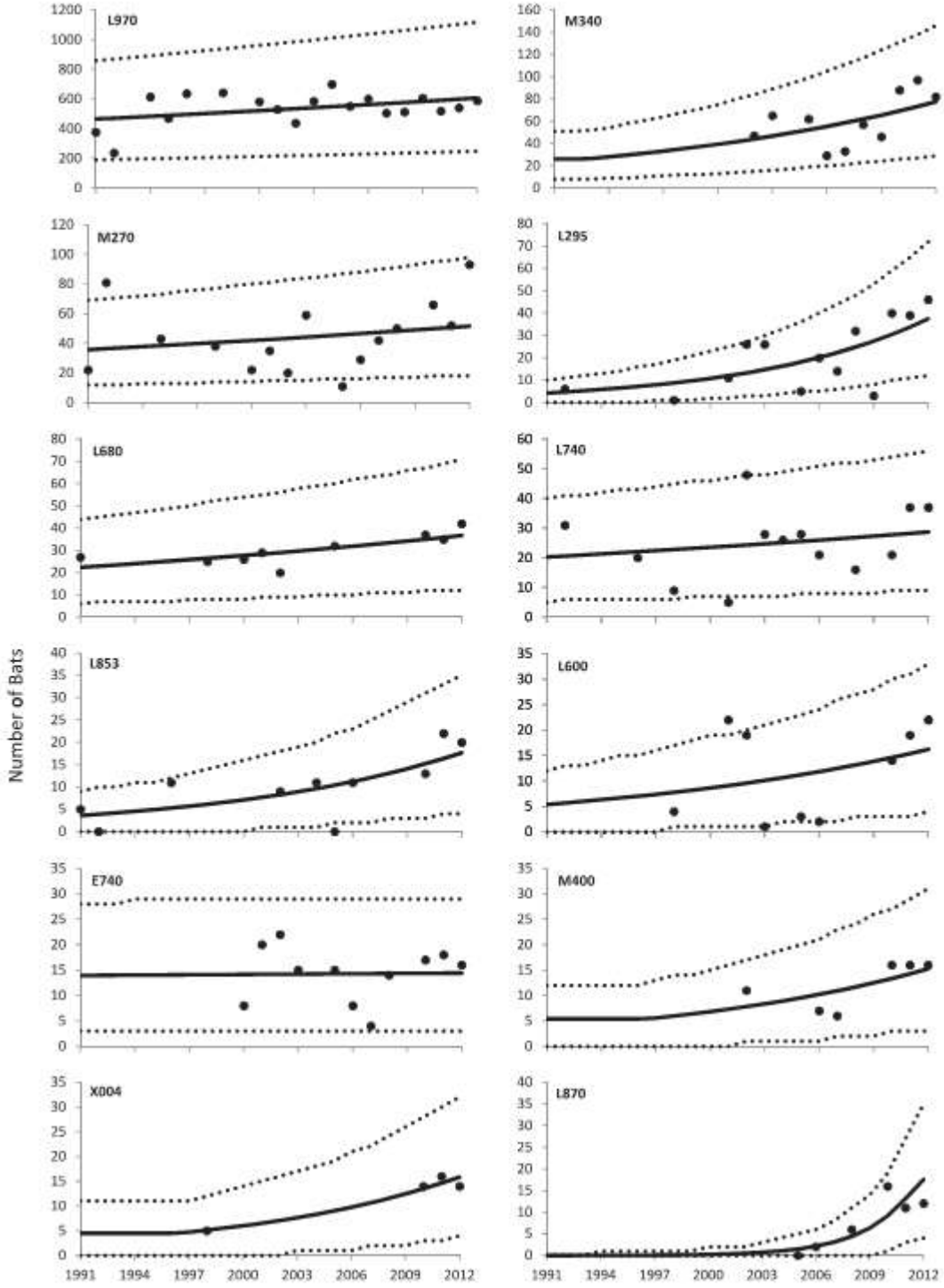

L970
M340
M270
L295
L680
L740
L853
L600
E740
M400
X004
L870
Number of Bats
1991
1994
1997
2000
2003
2006
2009
2012

Figure 7 (continued).

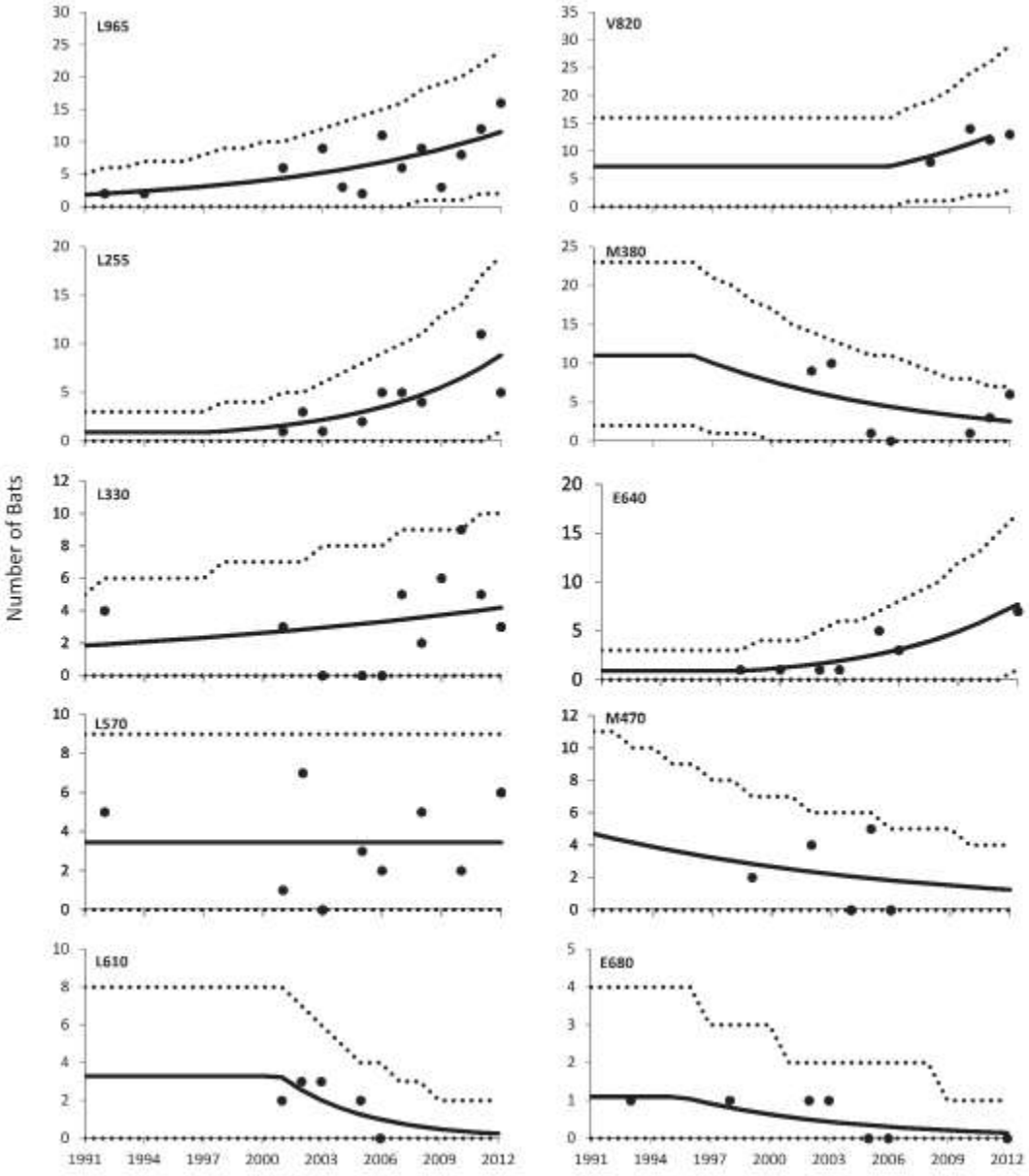


Figure 8.

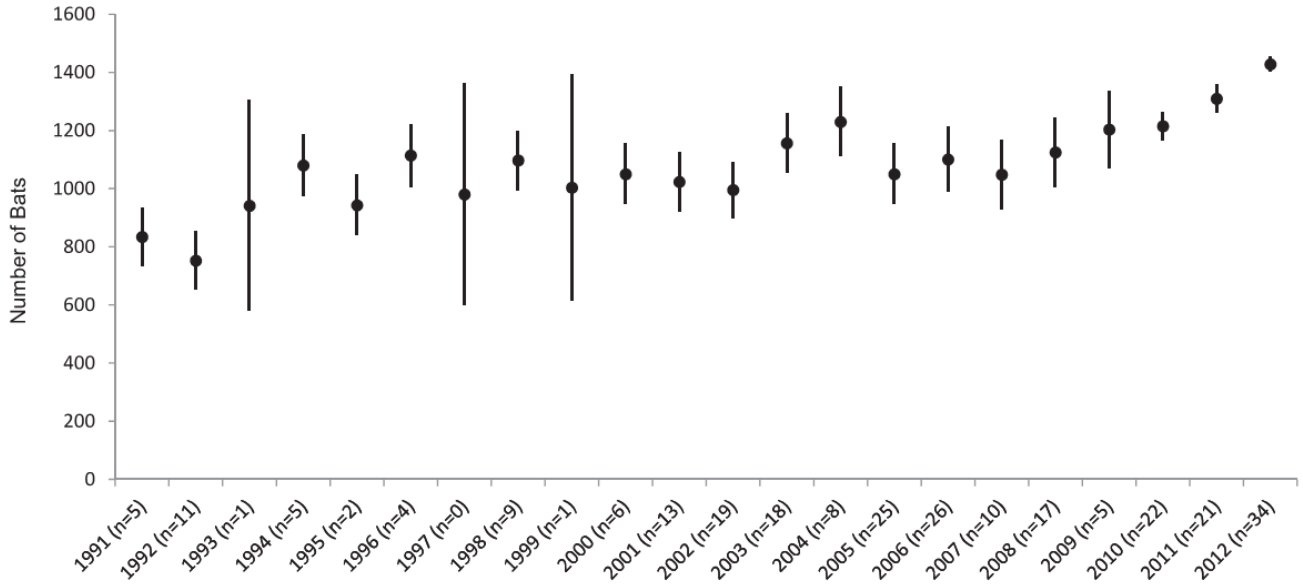
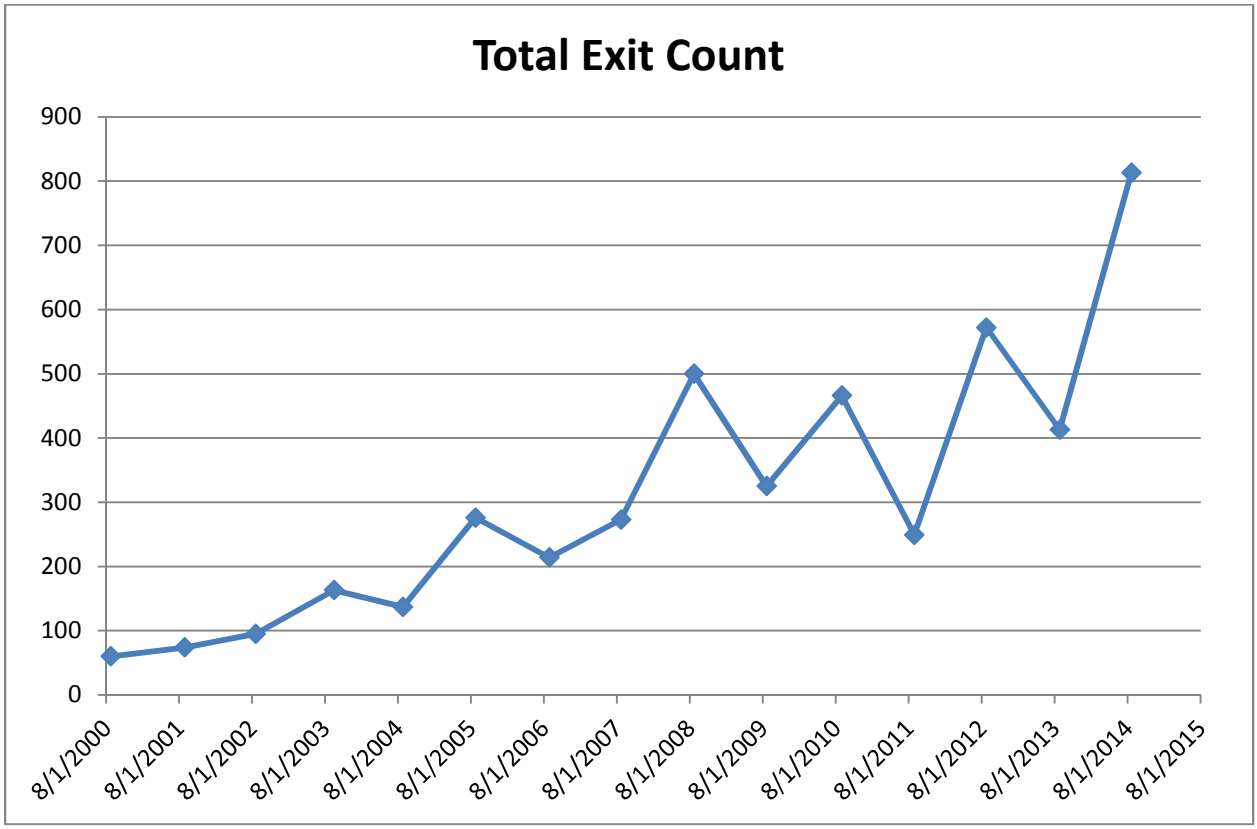

Number of Bats
1600
1400
1200
1000
800
600
400
200
0
1991 (n=5)
1992 (n=11)
1993 (n=1)
1994 (n=5)
1995 (n=2)
1996 (n=4)
1997 (n=0)
1998 (n=9)
1999 (n=1)
2000 (n=6)
2001 (n=13)
2002 (n=19)
2003 (n=18)
2004 (n=8)
2005 (n=25)
2006 (n=26)
2007 (n=10)
2008 (n=17)
2009 (n=5)
2010 (n=22)
2011 (n=21)
2012 (n=34)

Figure 9.


Total Exit Count
900
800
700
600
500
400
300
200
100
0
8/1/2000
8/1/2001
8/1/2002
8/1/2003
8/1/2004
8/1/2005
8/1/2006
8/1/2007
8/1/2008
8/1/2009
8/1/2010
8/1/2011
8/1/2012
8/1/2013
8/1/2014
8/1/2015

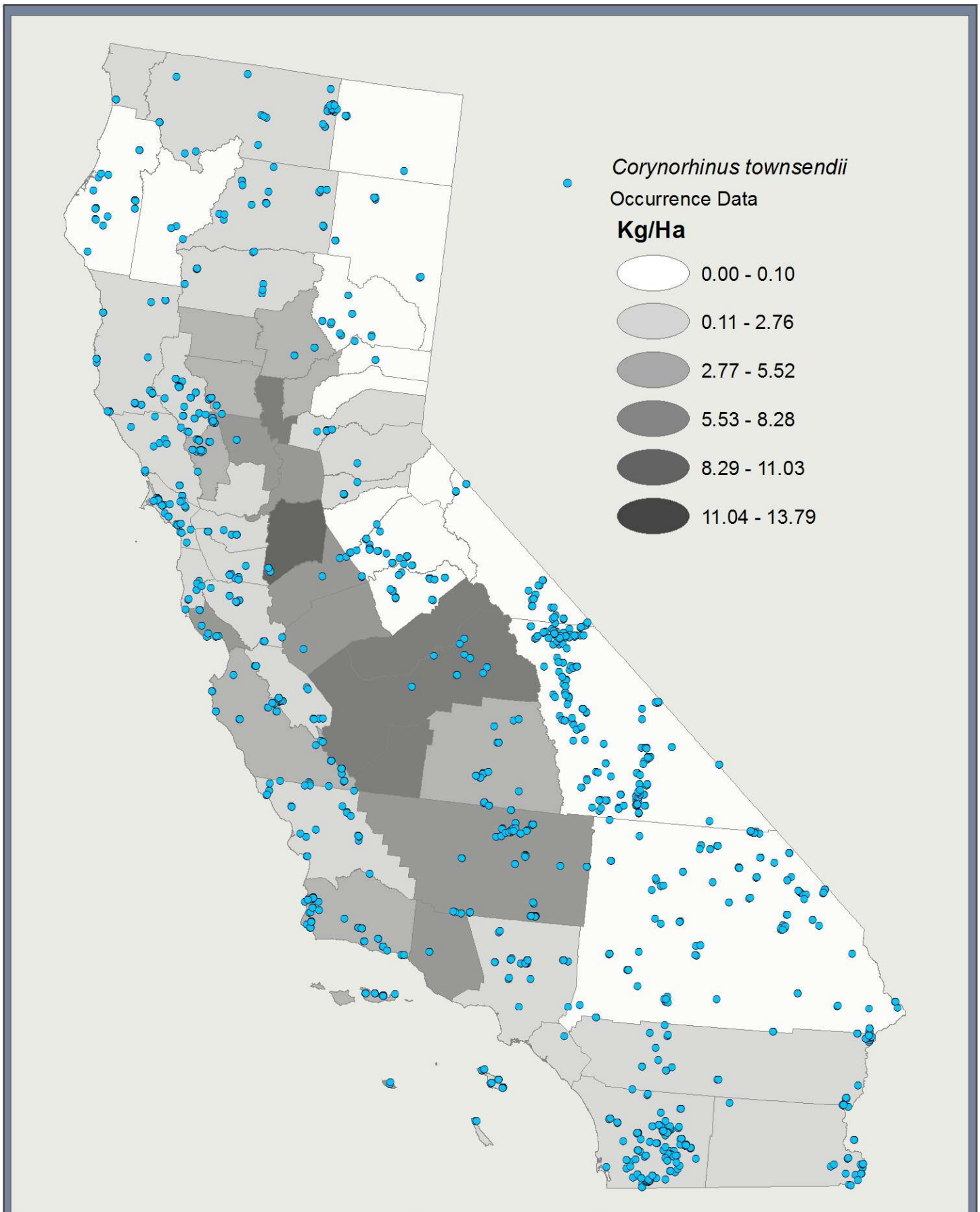


Figure 10. Average application of all types of pesticide (kg/ha) by county, 2013.

California Department of Pesticide Regulation. 2015. Summary of pesticide use report data – 2013. May, 2015. Available at http://www.cdpr.ca.gov/docs/pur/pur13rep/13sum.htm#pestuse .

Figure 11.

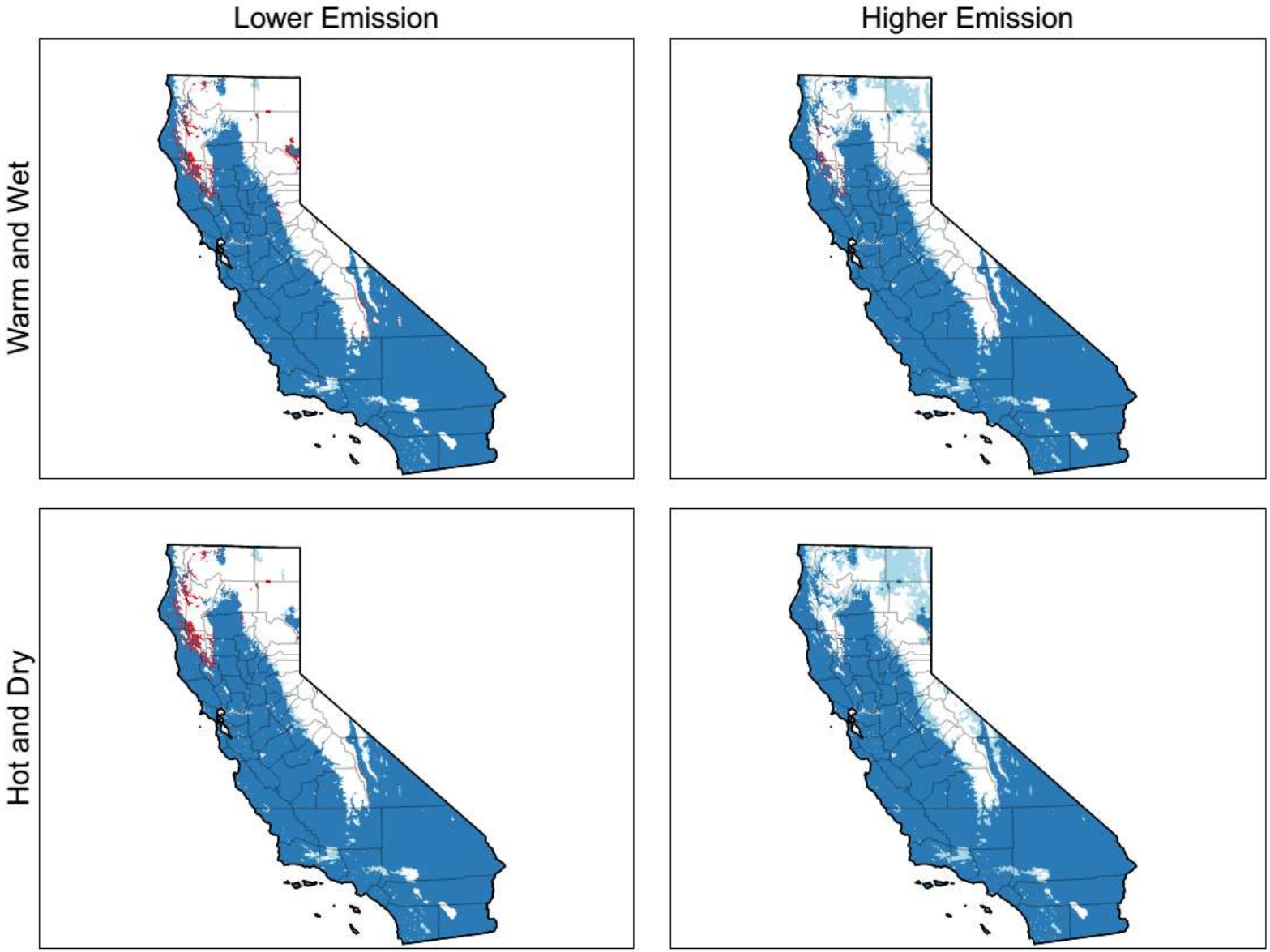


Figure 12.


EDMUND G. BROWN, JR., GOVERNOR, STATE OF CALIFORNIA
JOHN LAIRD, SECRETARY, NATURAL RESOURCES AGENCY
DAVID BUNN, DIRECTOR, DEPARTMENT OF CONSERVATION
OFFICE OF MINE RECLAMATION, ABANDONED MINE LANDS PROGRAM
CALIFORNIA ABANDONED MINES
POTENTIAL, INVENTORIED AND REMEDIATED
MINE FEATURE LOCATIONS
Physical Hazard Remediations*
* Remediations are AMLP data only.
Other agency closures exist, but are not shown on this map
USGS Mapped Mine Features*
* Based on USGS 7.5 minute topographical map mine symbols
AML Program Inventoried Features
Map produced by the Department of Conservation
Abandoned Mine Lands Program (AMLP), July 2015

Townsend's big-eared bat CESA Status Review – Tables

Captions

1. From Weller et al. (2014, Table 1). Number of caves searched and total number of Townsend's big-eared bats counted between November 15 and March 15 at Lava Beds National Monument, Siskiyou County, California, during the years 1991-2012. Cave L970 contained, by far, the largest number of hibernating bats in the monument.

2. Pinnacles National Park Townsend's big-eared bat maternity and hibernation roost count summary (NPS unpublished data). Visual counts made during one or more visits during the maternity and hibernation seasons. Where clusters of bats were observed, the number of bats were estimated from the area occupied, assuming between 100 and 150 individuals per square-foot of ceiling area. In years when more than one survey was made in a season, the highest count is reported here. To avoid excessive disturbance to roosting bats in some years, presence only of the maternity colony was noted, or a minimum number of bats was estimated.

3. Summary of Townsend's big-eared bat monitoring studies referenced in the report.

Table 1.

Year	No. of Caves Surveyed	Cave L970 Count	Total Count
1991	5	376	438
1992	11	236	384
1993	1	—	1
1994	5	614	643
1995	2	469	512
1996	4	637	672
1997	0	—	—
1998	9	643	727
1999	1	—	2
2000	6	582	640
2001	13	530	665
2002	19	437	702
2003	18	586	811
2004	8	699	739
2005	25	551	733
2006	26	601	756
2007	10	505	620
2008	17	513	723
2009	5	607	665
2010	22	519	1,026
2011	21	541	1,117
2012	34	588	1,346

Table 2.

Year	Total Maternity*	Total Hibernacula
1997	150-200 (including pups)	60
1998	300-400 (including pups)	114
1999	320 (including pups)	254
2000	200-300	252
2001	300-600 (including pups)	282+
2002	Present	50++
2003	150+	364
2004	300-450	378
2005	100+	409
2006	600-1000 (4 clusters)	384
2007	Unknown/Not surveyed at peak of maternity season	261
2008	200-300	396
2009	125-160+	75
2010	240-290+	44
2011	Present	15
2012	225-235++	51
2013	Present	40
2014	~250+	43
2015	440-615	

Table 3.

Hibernation	
Lava Beds National Monument	Statistically significant population increase over 22 years
White-Inyo Mountains	No statistical inference possible; many repeat visits had lower counts than initial visits 10-plus years earlier
Pinnacles National Park	No inference possible based on uneven monitoring effort
Maternity	
Randall House	Statistically significant population increase over 25 years
Kentucky Mine	Statistical tests not conducted, but colony appears to be stable
Lava Beds National Monument	No inference possible
Pinnacles National Park	Statistical tests not conducted, but colony appears to be stable or increasing
Hearst Castle	Statistical tests not conducted, but colony appears to be stable or increasing
Santa Cruz Island	No statistical tests conducted, but colony has decreased from historical size

APPENDICES

1. **Public Comment Summary**
2. **List of Peer Reviewers and Invitation Letters**
3. **Peer Reviewer Comments**

Appendix 1 – Summary of Public Comments

Public Notice regarding the Status Review for the American Townsend's Big-eared Bat
The Fish and Game Commission published the following Notice of Findings regarding the candidacy and status review of Townsend's big-eared bat in the California Regulatory Notice Register in the California Regulatory Notice Register on December 27, 2013 (Vol. 2013, No. 52-Z).

The Department released the attached announcement to news media on December 27, 2013. The Department released an announcement to news media at the same time. Both notices requested any information pertaining to the status of the species in California that might help inform a decision on whether to list the species as threatened or endangered.

The Department mailed the notice of Townsend's big-eared bat's candidacy and a request for information and comments to approximately 150 persons or offices of state and federal agencies, tribes, counties, industry, and non-governmental organizations. The complete mailing list is on file with the Department.

Summary of Comments Received
The Department received letters or emails from 39 individuals and organizations. Most of these communications provided information on Townsend's big-eared bat occurrences in or near public and private lands. A few, including a letter from the Petitioner, argued in support of listing the species as threatened or endangered.

These communications are on file with CDFW.

FISH AND GAME COMMISSION

NOTICE OF FINDINGS

Townsend's Big–eared Bat

(*Corynorhinus townsendii*)

NOTICE IS HEREBY GIVEN that, pursuant to the provisions of Section 2074.2 of the Fish and Game Code, the California Fish and Game Commission, at its June 26, 2013, meeting in Sacramento, California, accepted for consideration the petition submitted to list the Townsends Big–eared Bat as a threatened or endangered species. The Commission determined, based on the best available science, the extensive information contained in the petition, the Department of Fish and Wildlife petition evaluation report, and oral testimony that designating Townsend's Big–eared Bat as an endangered or threatened species under CESA may be warranted (see Sections 2073.5 and 2074.2 of the Fish and Game Code).

Pursuant to subdivision (a)(2) of Section 2074.2 of the Fish and Game Code, the aforementioned species is hereby declared a candidate species as defined by Section 2068 of the Fish and Game Code.

Within one year of the date of publication of this notice of findings, the Department of Fish and Wildlife shall submit a written report, pursuant to Section 2074.6 of the Fish and Game Code, indicating whether the petitioned action is warranted. Copies of the petition, as well as minutes of the June 26, 2013, Commission meeting, are on the Commission web site or available for public review from Sonke Mastrup, Executive Director, Fish and Game Commission, 1416 Ninth Street, Box 944209, Sacramento, California 94244–2090, phone (916) 653–4899. Written comments or data related to the petitioned Action should be directed to the Commission at the aforementioned address.

/s/
Sonke Mastrup
Executive Director
California Fish and Game Commission

California Department of Fish and Wildlife News Release

December 27, 2013

Contacts:

Scott Osborn, CDFW Wildlife Branch, (916) 324-3564
Kyle Orr, CDFW Communications, (916) 322-8958

CDFW Seeks Public Comment Related to Townsend's Big-eared Bat

The California Department of Fish and Wildlife (CDFW) is seeking public comment on a proposal to list the Townsend's big-eared bat as an endangered or threatened species.

Townsend's big-eared bats (Corynorhinus townsendii) range throughout much of western North America, including most of California. They are active at night and roost in colonies or individually in caves, mines, large old trees, large undisturbed spaces in buildings and other structures with large quiet spaces. Disturbance and loss of large colony roosts sites during the maternity and hibernation seasons are considered primary factors that may negatively impact the species in California, although disease, climate change, pesticide use and other factors may also negatively affect populations.

In November 2012, the Center for Biological Diversity submitted a petition to the California Fish and Game Commission to formally list the Townsend's big-eared bat as a threatened or endangered species. The commission published findings of its decision to advance the species to candidacy on Dec. 27, 2013, triggering a 12-month period during which CDFW will conduct a status review to inform the commission's decision on whether to list the species.

As part of the status review process, CDFW is soliciting public comment regarding the species' ecology, biology, life history, distribution, abundance, threats and habitat that may be essential for the species, and recommendations for management of the species. Comments, data and other information can be submitted in writing to:

California Department of Fish and Wildlife
Nongame Wildlife Program
Attn: Scott Osborn
1812 9th Street

Appendix 2 – List of External Peer Reviewers and Invitation Letters

CDFW solicited the assistance of the following persons to review and provide comments on the draft Townsend's big-eared bat status review report, dated January 7, 2016:

Patricia E. Brown, Ph.D.
Brown-Berry Consulting

Gary M. Fellers, Ph.D.
U.S. Geological Survey (retired)

William E. Rainey, Ph.D.
UC Berkeley Center for Integrative Biology

Richard E. Sherwin, Ph.D.
Christopher Newport University

Joseph Szewczak, Ph.D.
Humboldt State University

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Director's Office
1416 Ninth Street, 12th Floor
Sacramento, CA 95814
www.wildlife.ca.gov

EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

January 7, 2016

Dr. Patricia Brown
Brown-Berry Consulting
134 Eagle Vista
Bishop, CA 93514

Subject: Townsend's big-eared bat (*Corynorhinus townsendii*); Department of Fish and Wildlife, Peer Review Status Report

Dear Dr. Brown:

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife Status Report of Townsend's big-eared bat (*Corynorhinus townsendii*, hereafter COTO). A copy of the Department of Fish and Wildlife's (Department's) peer review Status Report dated January 7, 2016, is enclosed for your use in that review. The Department seeks your expert analysis and input regarding the scientific validity of the report and its assessment of the status of COTO in California based on the best scientific information currently available. The Department is interested in and respectfully requests that you focus your peer review effort on the body of relevant scientific information and the Department's related assessment of the required population and life history elements prescribed in the California Endangered Species Act (CESA). **The Department would appreciate receiving your peer review input on or before February 8, 2016**.

The Department seeks your scientific peer review as part of formal proceedings pending before the California Fish and Game Commission under CESA. As you may know, the Commission is a constitutionally established entity distinct from the Department, exercising exclusive statutory authority under CESA to list species as endangered or threatened (Fish & G. Code, § 2070). The Department serves in an advisory capacity during CESA listing proceedings, charged by the Fish and Game Code to focus on the best scientific information available to make related recommendations to the Commission (Fish & G. Code, § 2074.6).

The Commission first received the petition to list COTO under CESA in November 2012. On November 14, 2013, the Commission published findings formally designating COTO as a candidate for listing as threatened or endangered under CESA. COTO is currently protected under CESA in California in that capacity.

The peer review draft Status Report forwarded to you today reflects the Department's effort over the past two years to identify and analyze the best scientific information available regarding the status of COTO in California. At this time, the Department believes the best available science indicates that listing the species as endangered or threatened under CESA is not warranted. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop and finalize its recommendation to the Commission as required by the Fish and Game Code. Our expected recommendation to the Commission at this point may change or be modified following your input.

We ask you to focus your peer review on the best scientific information available regarding the status of COTO in California. As with our own effort to date, your peer review of the science and analysis regarding each of the population and life history categories prescribed in CESA are particularly important (Cal. Code Regs., tit. 14, § 670.1(i)(1)(A)) (i.e., present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) as well as whether it indicates, in your opinion, that COTO is at serious risk of becoming extinct throughout all or a significant portion of its range in California, or whether the species is likely to become so in California in the foreseeable future. Please note that the Department releases this peer review report to you solely as part of the peer review process, and it is not yet public.

For ease of review, the Department would prefer to receive your comments in "track changes" format. However, comments in list form by page and line number of the report is also acceptable. Please submit your comments electronically to Dr. Scott Osborn. Dr. Osborn can be reached via email at scott.osborn@wildlife.ca.gov, or directly by telephone at 916-324-3564. If there is anything the Department can do to facilitate your review, please let us know.

Following receipt and consideration of peer review comments, the Department will prepare and submit its final Status Report and related recommendation to the Commission. After at least a 30 day public review period, the Commission will consider the petition to list COTO, the Department's Status Report and related recommendations including peer review, and public testimony during a regularly scheduled Commission meeting prior to making their decision.

Thank you again for your contribution to the status review effort and the important input it provides during the Commission's related proceedings.

Sincerely,

Eric Loft, Ph.D., Chief
Wildlife Branch
Wildlife and Fisheries Division

Enclosure

ec: Department of Fish and Wildlife

Karen Miner, Nongame Wildlife Program Manager
Wildlife Branch
Wildlife and Fisheries Division
Karen.miner@wildlife.ca.gov

Scott Osborn, Senior Environmental Scientist
Wildlife Branch
Wildlife and Fisheries Division
Scott.osborn@wildlife.ca.gov

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Director's Office
1416 Ninth Street, 12th Floor
Sacramento, CA 95814
www.wildlife.ca.gov

EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

January 7, 2016

Dr. William E. Rainey
U.C. Berkeley Center for Integrative Biology
2556 Hilgard Avenue
Berkeley, CA 94709

Subject: Townsend's big-eared bat (*Corynorhinus townsendii*); Department of Fish and Wildlife, Peer Review Status Report

Dear Dr. Rainey:

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife Status Report of Townsend's big-eared bat (*Corynorhinus townsendii*, hereafter COTO). A copy of the Department of Fish and Wildlife's (Department's) peer review Status Report dated January 7, 2016, is enclosed for your use in that review. The Department seeks your expert analysis and input regarding the scientific validity of the report and its assessment of the status of COTO in California based on the best scientific information currently available. The Department is interested in and respectfully requests that you focus your peer review effort on the body of relevant scientific information and the Department's related assessment of the required population and life history elements prescribed in the California Endangered Species Act (CESA). **The Department would appreciate receiving your peer review input on or before February 8, 2016**.

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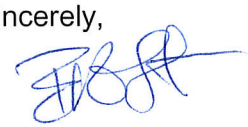
Thank you again for your contribution to the status review effort and the important input it provides during the Commission's related proceedings.

Sincerely,



Eric Loft, Ph.D., Chief
Wildlife Branch
Wildlife and Fisheries Division

Enclosure

ec: Department of Fish and Wildlife

Karen Miner, Nongame Wildlife Program Manager
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State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Director's Office
1416 Ninth Street, 12th Floor
Sacramento, CA 95814
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EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

January 7, 2016

Dr. Richard E. Sherwin
Department of Biology, Chemistry, and Environmental Science
Christopher Newport University
1 University Place
Newport News, VA 23606-2998

Subject: Townsend's big-eared bat (*Corynorhinus townsendii*); Department of Fish and Wildlife, Peer Review Status Report

Dear Dr. Sherwin:

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife Status Report of Townsend's big-eared bat (*Corynorhinus townsendii*, hereafter COTO). A copy of the Department of Fish and Wildlife's (Department's) peer review Status Report dated January 7, 2016, is enclosed for your use in that review. The Department seeks your expert analysis and input regarding the scientific validity of the report and its assessment of the status of COTO in California based on the best scientific information currently available. The Department is interested in and respectfully requests that you focus your peer review effort on the body of relevant scientific information and the Department's related assessment of the required population and life history elements prescribed in the California Endangered Species Act (CESA). **The Department would appreciate receiving your peer review input on or before February 8, 2016**.

The Department seeks your scientific peer review as part of formal proceedings pending before the California Fish and Game Commission under CESA. As you may know, the Commission is a constitutionally established entity distinct from the Department, exercising exclusive statutory authority under CESA to list species as endangered or threatened (Fish & G. Code, § 2070). The Department serves in an advisory capacity during CESA listing proceedings, charged by the Fish and Game Code to focus on the best scientific information available to make related recommendations to the Commission (Fish & G. Code, § 2074.6).

The Commission first received the petition to list COTO under CESA in November 2012. On November 14, 2013, the Commission published findings formally designating COTO as a candidate for listing as threatened or endangered under CESA. COTO is currently protected under CESA in California in that capacity.

The peer review draft Status Report forwarded to you today reflects the Department's effort over the past two years to identify and analyze the best scientific information available regarding the status of COTO in California. At this time, the Department believes the best available science indicates that listing the species as endangered or threatened under CESA is not warranted. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop and finalize its recommendation to the Commission as required by the Fish and Game Code. Our expected recommendation to the Commission at this point may change or be modified following your input.

We ask you to focus your peer review on the best scientific information available regarding the status of COTO in California. As with our own effort to date, your peer review of the science and analysis regarding each of the population and life history categories prescribed in CESA are particularly important (Cal. Code Regs., tit. 14, § 670.1(i)(1)(A)) (i.e., present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) as well as whether it indicates, in your opinion, that COTO is at serious risk of becoming extinct throughout all or a significant portion of its range in California, or whether the species is likely to become so in California in the foreseeable future. Please note that the Department releases this peer review report to you solely as part of the peer review process, and it is not yet public.

For ease of review, the Department would prefer to receive your comments in "track changes" format. However, comments in list form by page and line number of the report is also acceptable. Please submit your comments electronically to Dr. Scott Osborn. Dr. Osborn can be reached via email at scott.osborn@wildlife.ca.gov, or directly by telephone at 916-324-3564. If there is anything the Department can do to facilitate your review, please let us know.

Following receipt and consideration of peer review comments, the Department will prepare and submit its final Status Report and related recommendation to the Commission. After at least a 30 day public review period, the Commission will consider the petition to list COTO, the Department's Status Report and related recommendations including peer review, and public testimony during a regularly scheduled Commission meeting prior to making their decision.

Thank you again for your contribution to the status review effort and the important input it provides during the Commission's related proceedings.

Sincerely,

Eric Loft, Ph.D., Chief
Wildlife Branch
Wildlife and Fisheries Division

Enclosure

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CHARLTON H. BONHAM, Director

January 7, 2016

Dr. Gary M. Fellers
U.S. Geological Survey
Western Ecological Center
Point Reyes National Seashore
Point Reyes, CA 94956

Subject: Townsend's big-eared bat (*Corynorhinus townsendii*); Department of Fish and Wildlife, Peer Review Status Report

Dear Dr. Fellers:

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife Status Report of Townsend's big-eared bat (*Corynorhinus townsendii*, hereafter COTO). A copy of the Department of Fish and Wildlife's (Department's) peer review Status Report dated January 7, 2016, is enclosed for your use in that review. The Department seeks your expert analysis and input regarding the scientific validity of the report and its assessment of the status of COTO in California based on the best scientific information currently available. The Department is interested in and respectfully requests that you focus your peer review effort on the body of relevant scientific information and the Department's related assessment of the required population and life history elements prescribed in the California Endangered Species Act (CESA). **The Department would appreciate receiving your peer review input on or before February 8, 2016**.

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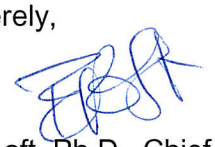

Eric Loft, Ph.D., Chief
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Wildlife and Fisheries Division

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EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

January 7, 2016

Dr. Joe Szewczak
Department of Biological Sciences
Humboldt State University
1 Harpst Street
Arcata, CA 95521

Subject: Townsend's big-eared bat (*Corynorhinus townsendii*); Department of Fish and Wildlife, Peer Review Status Report

Dear Dr. Szewczak:

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife Status Report of Townsend's big-eared bat (*Corynorhinus townsendii*, hereafter COTO). A copy of the Department of Fish and Wildlife's (Department's) peer review Status Report dated January 7, 2016, is enclosed for your use in that review. The Department seeks your expert analysis and input regarding the scientific validity of the report and its assessment of the status of COTO in California based on the best scientific information currently available. The Department is interested in and respectfully requests that you focus your peer review effort on the body of relevant scientific information and the Department's related assessment of the required population and life history elements prescribed in the California Endangered Species Act (CESA). **The Department would appreciate receiving your peer review input on or before February 8, 2016**.

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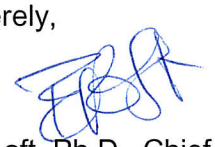

Eric Loft, Ph.D., Chief
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Wildlife and Fisheries Division

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Appendix 3 – Peer Reviewer Comments

Reviewers' comments on the draft Townsend's big-eared bat status review report, dated January 7, 2016, follow.

STATE OF CALIFORNIA
NATURAL RESOURCES AGENCY
DEPARTMENT OF FISH AND WILDLIFE

EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE

REPORT TO THE FISH AND GAME COMMISSION

A STATUS REVIEW OF
TOWNSEND'S BIG-EARED BAT (*CORYNORHINUS TOWNSENDII*)
IN CALIFORNIA

CHARLTON H. BONHAM, DIRECTOR
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

Draft Date: January 7, 2016

Report to the Fish and Game Commission

A Status Review of Townsend's Big-Eared Bat in California

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FIGURES, TABLES, and APPENDICES follow text.

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Executive Summary

[To be completed following external review]

INTRODUCTION

Petition Evaluation Process

On November 1, 2012, the California Fish and Game Commission (Commission) received the "Petition to List the Townsends big-eared bat *(Corynorhinus townsendii*) as endangered under the California Endangered Species Act" (dated October 18, 2012; hereafter, the Petition), as submitted by the Center for Biological Diversity. Commission staff transmitted the Petition to the Department of Fish and Wildlife (CDFW) pursuant to Fish and Game Code (Fish & G. Code) section 2073 on November 9, 2012, and the Commission published formal notice of receipt of the Petition on November 30, 2012 (Cal. Reg. Notice Register 2012, No. 48-Z, p. 1747). After evaluating the Petition and other relevant information CDFW possessed or received, CDFW provided the Commission with the a report "Evaluation of the Petition from the Center for Biological Diversity to List Townsend's Big-Eared Bat (*Corynorhinus townsendii*) as Threatened or Endangered Under the California Endangered Species Act" (Evaluation). CDFW determined, pursuant to Fish & G. Code § 2073.5, subdivision (a), that sufficient scientific information exists to indicate that the petitioned action may be warranted and recommended the Commission accept the Petition (CDFG 2013). At its scheduled public meeting on June 26, 2013 in Sacramento, California, the Commission considered the Petition, CDFW's Evaluation and recommendation, and comments received. The Commission found that sufficient information existed to indicate the petitioned action may be warranted and accepted the Petition for Consideration. Upon publication of the Commission's notice of its findings, Townsend's big-eared bat was designated a candidate species on November 14, 2013 (Cal. Reg. Notice Register 2013, No. 52-Z, p. 2092).

Department Status Review

Following the Commission's action designating the Townsend big-eared bat as a candidate species, and pursuant to Fish & G. Code section 2074.4, CDFW solicited information from agencies, educational institutions, tribes, and the public to inform the review of the species' status using the best scientific information available. This report contains the results of CDFW's status review, including independent peer review of the draft report by scientists with expertise relevant to the Townsend big-eared bat. At its scheduled public meeting on December 3, 2014 in Van Nuys, California, the Commission granted CDFW a six-month extension to facilitate external peer review. The purpose of this status review is to fulfill the mandate as required by Fish & G. Code section 2074.6 and to provide the Commission with the most current, scientifically-based information available on the status of Townsend big-eared bat in California and to serve as the basis for CDFW's recommendation to the Commission.

BIOLOGY AND ECOLOGY[1]

Species Description

Townsend's big-eared bat is a medium sized (10-12 g) bat with an adult forearm length of 39-48 mm and ear length of 30-39 mm. Townsend's big-eared bat generally has buffy brown dorsal fur with somewhat paler underparts (Barbour and Davis 1969, Kunz and Martin 1982). Among western North American bats, Townsend's big-eared bat is unique with its combination of a two-pronged, horseshoe-shaped lump on the muzzle and large, long ears. Although other California bats have long ears, no other has both large ears and the two-pronged nose lump. The other large-eared bat species have other characteristics that readily distinguish them from Townsend's big-eared bat.

Townsend's big-eared bat has relatively broad and short wings, which provides a low body mass-to-wing area ratio (wing load) (Norberg and Rayner 1987). Low wing loading confers high maneuverability and good economy of power, and take-off at low speeds. It may also allow the species to take advantage of pulses in prey availability by ingesting a large mass of insects when they are available (Norberg and Rayner 1987).

Systematics

Townsend's big-eared bat (Class Mammalia, Order Chiroptera) is in the Microchiropteran family Vespertilionidae, which contains the most species of the four bat families in the United States. There are two other species of *Corynorhinus*: *Corynorhinus rafinesquii,* Rafinesque's big-eared bat, and *Corynorhinus mexicanus,* the Mexican big-eared bat. The North American genus of big-eared bats now known as *Corynorhinus* was for several decades known as *Plecotus*, and much of the older scientific literature used that name.

There are five currently recognized subspecies of Townsend's big-eared bat in the United States (Handley 1959, Piaggio and Perkins 2005)(see Figure 1). Two of the subspecies (*C. t. townsendii* and *C. t. pallescens*) occur throughout much of western North America (including California), two (the Ozark big-eared bat, *C. t. ingens,* and the Virginia big-eared bat, *C. t. virginianus*) occur in the eastern United States, and one (*C. t. australis*) is distributed primarily in Mexico but also extends into Texas. Both of the eastern subspecies of Townsend's big-eared bat (the Ozark and Virginia big-eared bats) are listed by the U.S. Fish and Wildlife Service as Endangered.

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[1] Much of the information presented here on the biology of Townsend's big-eared bat has been adapted from the draft species account prepared by E.D Pierson, W.E. Rainey, and L. Angerer for the California Bat Conservation Plan (CDFW in prep.). Personal communications and personal observations cited without a year reference are from the draft species account. All other personal communications were between the referenced person and Scott Osborn, CDFW Senior Environmental Scientist with the Wildlife Branch, Nongame Wildlife Program.

This classification scheme follows the presumed evolutionary history of Townsend's big-eared bat and related bats species. Tumlison and Douglas (1992) used cladistics analysis of shared acquired characteristics to determine that the New World *Corynorhinus* species comprise a distinct lineage from both the Old World *Plecotus* species (which they had formerly been grouped with under the genus name *Plecotus*) and two other big-eared bat genera (*Idionycteris* and *Euderma*).

Piaggio and Perkins (2005) examined the evolutionary relationships within the *Corynorhinus* genus using both mitochondrial and nuclear DNA. Their results confirmed the status of the five Townsend's big-eared bat subspecies, suggested that Townsend's big-eared bat and *Corynorhinus mexicanus* are more closely related to each other than to *Corynorhinus rafinesquii*, and that levels of genetic divergence among the Townsend's big-eared subspecies are relatively high (Piaggio and Perkins 2005).

Within Townsend's big-eared bat itself, DNA analysis has shown the western-most subspecies, *C. townsendii townsendii*, may have diverged from the other Townsend's big-eared bat subspecies between 41,000 and 64,000 years ago, while *C. townsendii pallescens* diverged 12,000 to 23,000 years ago, and *C. townsendii australis* diverged between 6,000 and 20,000 years ago (Smith et al. 2008). The timings of divergence and geographic pattern of the subspecies' ranges today suggested to the authors that the subspecies developed during periods of extensive glaciation in western North America when Townsend's big-eared bat populations were isolated from each other. Other mitochondrial DNA evidence suggests an earlier divergence of the five Townsend's big-eared bat subspecies (possibly as earlier as 1 million years ago), with subsequent effects on distribution during the Pleistocene (Lack and Van Den Bussche 2009).

Geographic Range and Distribution

Townsend's big-eared bat ranges throughout much of the western United States and Canada (Figure 1). In California, its geographic range is generally considered to encompass the entire state, except for the highest elevations of the Sierra Nevada (Figure 2). Within the general range, there are areas of greater and lesser probability of occupancy by Townsend's big-eared bat. Populations are concentrated in areas offering caves (commonly limestone or basaltic lava) or mines as roosting habitat.

Conversely, a general lack of Townsend's big-eared bat records in the Central Valley and Imperial Valley (Figure 2), along with a paucity of suitable roost structures, suggests these areas are unlikely to harbor populations of resident Townsend's big-eared bat.

The species is found from sea level along the coast to 1,820 m (6,000 ft) in the Sierra Nevada (Dalquest 1947, Pearson et al. 1952, Pierson and Rainey 1998). In the White Mountains, summer records for males extend up to 2,410 m (7,900 ft), and hibernating groups have been found in mines as high as 3,188 m (10,460 ft) (Szewczak et al. 1998). Maternity colonies are more frequently found below 2,000 m (6,560 ft) (Pierson and Fellers 1998, Szewczak et al. 1998). Outside California, Townsend's big-eared bat has been found to 2,400 m (7,900 ft) (Jones 1965, Jones and Suttkus 1971) and 2,900 m (9,500 ft) (Findley and Negus 1953).

As for the two Townsend's big-eared bat subspecies that occur in California, *C. t. townsendii* occurs primarily in the western-most portion of the species' range in California, Oregon, Washington, Nevada, Idaho, and possibly southwestern Montana and northwestern Utah. *C. t. pallescens* occurs in all the same states as *C. t. townsendii*, plus in more interior portions of the continent in Arizona, Colorado, New Mexico, Texas, and Wyoming (Handley 1959, Piaggio and Perkins 2005). Throughout much of their range in California, Idaho, Nevada, Oregon and Washington there are extensive zones of intergradation for the two subspecies and it is often not possible to assign individuals to one subspecies or the other.

Population Genetics

Genetic studies can inform our understanding of animal populations, including the amount of mixing between subpopulations and level of genetic variability among and between individuals or subpopulations. Smith (2001) demonstrated the Townsend's big-eared bat populations in Oklahoma show high movement (high gene flow) of males across her study area (nuclear microsatellite DNA results) but low movement of females (mitochondrial DNA results). This suggests high site fidelity of females to their natal roosts relative to males. The female subpopulations were highly differentiated from each other, but also highly variable within the subpopulations.

Miller's (2007) study of Townsend's big-eared bat population genetics in southeastern Idaho used nuclear DNA to show most individuals within hibernacula were not closely related to each other, contrary to an earlier suggestion by Pearson (1959) that Townsend's big-eared bats within a hibernaculum should be closely related, since Townsend's big-eared bat mate at their hibernacula and have high fidelity to these sites. Miller (2007) suggested that "juveniles may disperse from natal colonies before settling and becoming philopatric to a single [hibernation] site, which could create these communities of unrelated individuals." Alternatively, it is possible that Townsend's big-eared bats in her study area are either not loyal to a single hibernaculum or do not mate at the hibernacula in which they over winter. She also found that adult females in maternity colonies are more closely related to each other than are juveniles, which is consistent with males dispersing longer distances than females.

The study by Piaggio and others (2009) of populations structure, genetic diversity, and dispersal among three subspecies of Townsend's big-eared bat in the Rocky Mountains region (*townsendii*, *pallescens*), and in the southeastern U.S. (the endangered *virginianus* subspecies) used both nuclear and mitochondrial DNA analyses. Their study indicated significantly lower genetic diversity in *virginianus*, compared to the other two subspecies, which is expected due to the lower overall population size of *virginianus*. Their study also indicated relatively low levels of gene flow among populations of the *townsendii* and *pallescens* subspecies, which tend to be isolated. On the other hand, some gene flow can occur at distances of 310 km between roosts, which (with other recent data) suggests that Townsend's big-eared bat may move greater distances than typically thought. These genetic results are consistent with the observation that a simple geographic demarcation between the *pallescens* and *townsendii* subspecies is not sufficient to differentiate between individuals of the two subspecies.

Reproduction and Development

Townsend's big-eared bat is a colonial species. Maternity colonies form between March and June, with the timing varying based on local climate, elevation, and latitude. Colony size ranges from a few dozen to several hundred individuals. Mating generally takes place in both migratory sites and hibernacula between September or October and February. "Swarming" – a behavior at non-maternity roost sites where both sexes mix in autumn prior to moving to hibernacula – has been observed during the latter half of September in the Mojave Desert. Females are generally reproductive in their first year, whereas males do not reach sexual maturity until their second year. Gestation length varies with climatic conditions, but generally lasts from 56 to 100 days (Pearson et al. 1952). Some evidence indicates maternity colonies may have up to three different roost sites for given stages of reproduction – one each for pregnancy, birthing, and rearing (Sherwin et al. 2000). In complex mines, the colony may move to different areas in the same mine in response to different roost temperatures.

A single pup is born between May and July (Easterla 1973, Pearson et al. 1952, Twente 1955). Townsend's big-eared bat pups average 2.4 g at birth, nearly 25% of the mother's postpartum mass (Kunz and Martin 1982). While adult males are typically solitary during the maternity season, adult females and their pups cluster together in colonial roosts (Pearson et al. 1952). Aggregations in maternity roosts have typical densities of between 100 and 150 adults and young per square foot of roost surface area occupied. Such clustering minimizes heat loss and allows more energy to be used for milk production (adults) and growth (pups). Young bats are capable of flight at 3 to 3.5 weeks of age and are gradually weaned by 2 months (Pearson et al. 1952). Nursery colonies start to disperse in August about the time the young are weaned and break up altogether in September and October (Pearson et al. 1952, Tipton 1983).

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Vital Rates (Reproduction, Survival)

Maximum fecundity per adult female is one pup per year. Pearson et al. (1952) estimated an average fecundity for the colonies in their study to be about 0.45 female pups per adult female per year. Examining exit count data from an undisturbed colony where counts were made both before and after young Townsend's big-eared bat became volant, it appears that the number of bats may increase by a factor of 1.5 to 2 (unpublished CDFW analysis of Kentucky Mine counts in 2005 and 2006). Assuming a 50:50 sex ratio of young, this would be equivalent to recruitment rates of 0.25 to 0.5 female young per adult female.

Pearson et al. (1952) estimated annual survival at about 50% for the first year of life and about 80% for adults. The authors determined these survival rates, combined with their estimates of fecundity, were "just sufficient" to maintain a stable population during the years these colonies were studied (Pearson et al. 1952). Ellison (2010) estimated winter survival in a Washington Townsend's big-eared bat population to range between 54% and 76%, with higher survival for females than for males. Band recoveries have yielded individual longevity records of 16 years, 5 months (Paradiso and Greenhall 1967) and 21 years, 2 months (Perkins 1994).

Behavior

Townsend's big-eared bat's susceptibility to disturbance at roost sites is usually cited as a key behavioral characteristic putting the species at conservation risk (Twente 1955, Barbour and Davis 1969, Humphrey 1969, Humphrey and Kunz 1976). As summarized by Pierson et al. (1991):

> Townsend's big-eared bats are so sensitive to human disturbance that simple entry into a nursery roost can be enough to induce the colony to abandon a site (Mohr 1972, Humphry and Kunz 1976). Activities as apparently harmless as recreational caving have been shown to have negative impacts and have driven Townsend's big-eared bat from a number of their traditional roost sites in California (Graham 1966, Pierson, unpubl. data).

Pearson (1952) documented temporary abandonment of maternity roosts in California as a direct result of his research team entering the roost site to band young. Fellers and Halstead (2015) showed a strong negative relationship between attempted unlawful entries into the Randall House Townsend's big-eared bat maternity roost (coastal Marin County) and overall colony reproductive success on an annual basis.

Contrary to the general pattern of susceptibility to disturbance, one Townsend's big-eared bat maternity colony in California has demonstrated some tolerance to disturbance (Freeman 2012). The Kentucky Mine colony in Sierra County has persisted despite daily tours in the historic stamp mill building where the bats typically roost, though some impacts to the colony and changes in behavior (including temporary roost abandonment) have occurred there over the years (M. Tierney pers. comm. 2015). It should be noted the Kentucky Mine roost site is managed under guidance that emphasizes quiet, predictable disturbance events (tours) and minimizes other, novel types of disturbance. Clark et al. (1997) also noted one of the eastern Townsend's big-eared bat subspecies, the Ozark big-eared bat (*C. townsendii virginianus*) did not abandon roosts or caves despite some human entry and surmised the *virginianus* subspecies may tolerate more human activity than the western subspecies.

Once a roost site has been successfully colonized by Townsend's big-eared bat (whether for the active or hibernation season), it is likely to be used in subsequent years, so long as it remains suitable (Humphrey and Kunz 1976). However, it is not unusual for maternity colonies to switch roosts during the course of the season (Fellers and Pierson 2002, Sherwin et al. 2000, 2003). Disturbance events, as noted above, may trigger a temporary abandonment of the preferred roost. In some cases, different roosts may be used to provide more optimal conditions during different phases of the maternity season (early and late pregnancy, early and late pup-rearing).

Night roosts are used opportunistically during breaks from foraging. Such roosts probably allow the bats to rest and digest meals while minimizing predation risk. Townsend's big-eared bat appears not to show particularly high fidelity to night roosts (Fellers and Pierson 2002). During early-evening foraging bouts of six light-tagged Townsend's big-eared bat in Oklahoma, Caire et al. (1984) documented their study animals rested between bouts of foraging about 17% of the time under observation. It is likely the overall resting time between foraging bouts in a given night is greater.

Diet

Diet has not been examined in detail for any California population of Townsend's big-eared bat. It is likely that Townsend's big-eared bat here, as elsewhere, is a Lepidopteran specialist, feeding primarily on medium-sized moths, but with occasional captures of other insects, including flies, beetles, and aquatic insects (Ross 1967, Whitaker et al. 1977, 1981, Dalton et al. 1986, Sample and Whitmore 1993, Furford and Lacki 1998, Dodd and Lacki 2007).

Vocalizations

Townsend's big-eared bat produces ultrasonic calls that are used for navigating in the dark, and for locating and capturing prey, as well as for social communication. While cruising or searching for prey, a semi-regular pattern of calls is emitted at 10 to 20 calls per second (Kunz and Martin 1982). Search- and cruising calls are usually simple downward sweeps in frequency, typically starting at about 40 to 45 kHz and ending at about 19 to 23 kHz, with the maximum power (volume) produced at about 21 to 26 KHz (J.M. Szewczak, unpublished data 2011). Calls may include sounds produced at the harmonic frequencies at two- and three times the fundamental call frequencies – sometimes with more power applied to a harmonic than to the fundamental call. Townsend's big-eared bat is commonly known as a "whispering" bat, because of the relatively low power of its calls – typically about 40 to 50 dB quieter than those of *Myotis lucifugus* (Kunz and Martin 1982). The relatively low volume of its echolocation calls makes Townsend's big-eared bat difficult to detect with acoustic equipment.

Predation

Pearson et al. (1952) discounted predation as a factor limiting Townsend's big-eared bat populations, but individuals may be preyed upon by a variety of native and non-native predators, as has been documented for other bats. Hensley et al. (1995) listed several potential predators of Townsend's big-eared bat in the recovery plan for the endangered Ozark big-eared bat (*C. townsendii virginianus*), including raccoons (*Procyon lotor*), bobcats (*Lynx rufus*), house cats (*Felis catus*), skunks (*Mephitis*, *Spilogale*), and snakes. These and other generalist predators, such as ringtails (*Bassariscus astutus*) likely take Townsend's big-eared bat opportunistically in California.

Fellers and Halstead (2015) stated several owl species known to prey on bats may have influenced Townsend's big-eared bat emergence times at the Randall House maternity roost. These include great horned owls (*Bubo virginianus*), barn owls (*Tyto alba*), and spotted owls (*Strix occidentalis*). Townsend's big-eared bat's tendency to avoid foraging in open grassland and other areas of low vegetation cover has been hypothesized to be a mechanism for avoiding aerial predators such as owls (Pierson and Fellers 1999); however, this behavior may also be driven by the distribution of the bat's prey.

Fellers (2000) also reported that non-native black rats (*Rattus rattus*) preyed upon young Townsend's big-eared bats at the Randall House roost before measures were taken to prevent rat entry into the structure.

Movements

Migration. Townsend's big-eared bat is considered a relatively sedentary species, for which no long-distance migrations have been reported (Barbour and Davis 1969, Humphrey and Kunz 1976, Pearson et

al. 1952). The longest movement known for this species in California is 32.2 km (20 mi) (Pearson et al. 1952). There is some evidence of local migration, perhaps along an elevation gradient.

Townsend's big-eared bats in Oregon appear to move from their hibernacula to active season (maternity) roosts over a period of several nights, using interim roosts before settling into the maternity roost (Dobkin et al. 1995). This study recorded a maximum distance between hibernation site and foraging areas of 24 km (15 mi).

Feeding. Despite its reputation as a sedentary species, Townsend's big-eared bat may cover a lot of ground while foraging each night. As described in one species account for Townsend's big-eared bat (WBWG 2005), "these bats often travel large distances while foraging, including movements of over 150 kilometers during a single evening (R. Sherwin pers. comm.). Evidence of large foraging distances and large home ranges has also been documented in California (E.D. Pierson pers. comm.)."

Thermoregulation and Hibernation

Townsend's big-eared bat, like most mammals, maintains a high body temperature primarily through heat produced by its metabolism. High metabolic rate and elevated (and typically constant) body temperature allow mammals to maintain high aerobic activity levels, which in turn has allowed them to occupy ecological niches only available to highly energetic animals. Like many bat species inhabiting temperate regions, Townsend's big-eared bat uses torpor[2] as a physiological and behavioral strategy in winter to deal with diminished food resources and cool or cold ambient temperatures, which make it energetically costly to maintain normal high body temperature. By allowing body temperature to cool to near ambient, bats in torpor reduce their energy expenditure to a small fraction of what would be used to keep body temperature elevated. Despite the energy savings conferred by torpor, hibernating bats may lose more than 50% of their body mass during the hibernation season (Humphrey and Kunz 1976). Townsend's big-eared bat and other bats that use torpor have a suite of physiological adaptations to allow them to remain healthy during torpor and to arouse at the appropriate times.

An important behavioral trait of hibernators is the selection of suitable sites for the inactive period. Townsend's big-eared bat hibernation sites are generally caves or mines (Pearson et al. 1952, Barbour and Davis 1969), although animals are occasionally found in buildings (Dalquest 1947). Deep mine adits and shafts, known to provide significant hibernating sites in New Mexico (Altenbach and Milford 1991), may also be important in California. Winter roosting is typically composed of mixed-sexed groups from

[2] "Torpor" is a general term for reduced metabolic rate and body temperature. For animals adapted to use torpor as described, it can range from "shallow torpor" which occurs when winter temperatures are relatively mild and where the animal may only drop its body temperature a few degrees, to deep hibernation, which occurs in more extreme cold. In hibernation, ambient temperatures may be near or below freezing and the torpid animal may maintain its temperature just above freezing. Bats in hibernation may appear almost completely inanimate with no visible sign of breathing. Arousal from deep torpor may take many minutes to over an hour. Bats in shallow torpor may respond to handling or other stimuli by slowly moving and visibly breathing, and will often arouse in several minutes.

a single individual to several hundred or several thousand individuals; however, behavior varies with latitude. In areas with prolonged periods of non-freezing temperatures, Townsend's big-eared bat tends to form relatively small hibernating aggregations of single to several dozen individuals (Barbour and Davis 1969, Pierson et al. 1991, Pierson and Rainey 1998). Larger aggregations (75-460) are confined to areas that experience prolonged periods of freezing temperatures (Pierson and Rainey 1998).

Studies in the western U.S. have shown that Townsend's big-eared bat selects winter roosts with stable, cold temperatures, and moderate air flow (Humphrey and Kunz 1976, Kunz and Martin 1982). Individuals roost on walls or ceilings, often near entrances (Humphrey and Kunz 1976, Twente 1955). If undisturbed, individuals will frequently roost less than 1 m (3 ft) off the ground (P. Brown pers. obs; Perkins et al. 1994), and have been found in air pockets under boulders on cave floors (E. Pierson pers. obs.). Temperature appears to be a limiting factor in roost selection. Recorded temperatures in Townsend's big-eared bat hibernacula range from -2.0°C to 13.0°C (28°F to 55°F) (Humphrey and Kunz 1976, Genter 1986, Pearson et al. 1952, Pierson et al. 1991, Twente 1955), with temperatures below 10°C (50°F) being preferred (Perkins et al. 1994, Pierson and Rainey 1998). Within a hibernaculum, Townsend's big-eared bat most frequently hibernates singly, but pairs and small clusters of torpid individuals are observed. In the White and Inyo mountains, larger groups were observed in sites where air temperature was around 5°C (41°F) while smaller groups occurred at locations with air temperatures that were colder (Szewczak et al. 1998). In the Mojave Desert in the winter, hibernating Townsend's big-eared bat have been found at temperatures of 15.5°C (60°F) as these might be the coolest temperatures available (P. Brown pers. obs.).

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The period of hibernation is shorter at lower elevations and latitudes. Coastal populations of Townsend's big-eared bat, which experience particularly mild winters, may use shallow torpor on a daily basis and may be active at any time to take advantage of warm weather and prey availability (Pearson et al. 1952).

Thermoregulation is also an important aspect of the active season for Townsend's big-eared bat, especially for the energetically-demanding processes of pregnancy and lactation. Adult females form maternity colonies in the warmest available suitably-protected roost sites. Such warm locations minimize the energy lost as heat during pregnancy and help newborn and young pups conserve energy for growth. Clustering behavior of females and their young further enhances energy conservation and cluster size has been observed to increase and decrease based on the ambient temperature of the roost site (Betts 2010).

Habitat Utilization

Habitat associations for Townsend's big-eared bat in California include the inland deserts Colorado, Mojave and Great Basin); cool, moist coastal redwood forests; oak woodlands of the inner Coast Ranges and Sierra Nevada foothills; and lower to mid-elevation mixed coniferous-deciduous forests. Townsend's big-eared bat has also been observed hibernating in the bristlecone-limber pine habitat (Szewczak et al. 1998) of the White Mountains (Inyo County). Distribution is patchy within these types and is strongly correlated with the availability of caves and cave-like roosting habitat, with population centers occurring in areas dominated by exposed, cavity forming rock and/or historic mining districts

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(Genter 1986, Graham 1966, Humphrey and Kunz 1976, Kunz and Martin 1982, Perkins et al. 1994, Pierson and Rainey 1998). The species' habit of roosting on open surfaces within roost sites makes it readily detectable and it is often the species most frequently observed (typically in low numbers) in caves and abandoned mines throughout its range.

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Roosting Habitat. Townsend's big-eared bat prefers open surfaces of caves or cave-like structures, such as mine adits and shafts (Barbour and Davis 1969, Graham 1966, Humphrey and Kunz 1976). It has also has been reported in such structures as buildings, bridges, and water diversion tunnels that offer a cavernous environment (Barbour and Davis 1969, Dalquest 1947, Howell 1920, Kunz and Martin 1982, Pearson et al. 1952, Perkins and Levesque 1987, Brown et al. 1994, Pierson and Rainey 1998). It has been found in rock crevices and, like a number of bat species (Gellman and Zielinksi 1996), in large hollow trees (Fellers and Pierson 2002, Mazurek 2004). Roosting structures often contain multiple openings. The species seems to prefer dome-like areas, possibly where hott or cold air is trapped (warm pockets for maternal roosting, cold pockets for hibernation).

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Specific roosts may be used at only one time of year or may serve different functions throughout the year, such as for maternity roosts, hibernation, or other uses (Sherwin et al. 2000, 2003). Roosting surfaces often occur in locations with partial light during the day; however, some roost surfaces have been found very deep inside caves or mines. Of 54 maternity roost sites tabulated by Pierson and Fellers (1998), 43% were in caves, 39% were in mines, and 18% were in buildings.

Townsend's big-eared bat appears to have fairly restrictive roost requirements (Humphrey and Kunz 1976, Perkins et al. 1994, Pierson et al. 1991). Roost temperature appears to be critical (Lacki et al. 1994, Pearson et al. 1952, Pierson and Rainey 1998). Temperatures vary in maternity roosts throughout California from 19°C (66°F) in cooler regions to 30°C (86°F) in warmer southern regions (Pierson et al. 1991). Some colonies are known to change roosts during the maternity season, using cooler roosts earlier in the year when only pregnant females are present (Pierson et al. 1991, P. Brown pers. comm., V. Dalton pers. comm.) and using warmer roosts while pup-rearing. Roost dimensions are also important. The majority of the roosts examined in California are fairly spacious, at least 30 m (100 ft) in length, with the roosting surface located at least 2 m (6.5 ft) above the ground, and a roost opening at least 15 cm by 62 cm (6 inches by 24 inches) (Pierson et al. 1991). Maternity clusters are always situated on open surfaces, often in roof pockets or along the walls just inside the roost entrance, within the twilight zone.

Night roosts include caves, rock shelters, open buildings, mines and bridges. They may be smaller than typical day roosts and are almost always singly occupied (Pierson and Fellers 1998).

Foraging Habitat. Foraging associations include edge habitats along streams and areas adjacent to and within a variety of wooded habitats (Brown et al. 1994, Fellers and Pierson 2002, Pierson et al. 2002). Radiotracking and light-tagging studies have found Townsend's big-eared bat foraging in a variety of habitats, including within collapsed lava tubes and trenches (Pierson and Fellers 1998). Brown et al. (1994) showed that on Santa Cruz Island in California, Townsend's big-eared bat avoided the lush introduced vegetation near their day roost, and traveled up to 5 km (3 mi) to feed in native oak and

ironwood forest. P. Brown (pers. comm.) also documented Townsend's big-eared bat foraging in desert canyons with water and riparian vegetation on the west slopes of the Panamint Mountains (Inyo County). Usually the water is covered by vegetation in these canyons, and not accessible for drinking.

Radiotracking and light-tagging studies in northern California have found Townsend's big-eared bat foraging within forested habitat, within the canopy of oaks (Pierson and Rainey unpubl. data), and along heavily vegetated stream corridors, avoiding open, grazed pasture land (Fellers and Pierson 2002). In Oklahoma, *C. townsendii ingens* more frequently used edge habitats (along intermittent streams) and open areas (pastures, agricultural fields, native grass) compared to wooded habitat (Clark et al. 1993), but also tended to focus foraging along canyon walls (Caire et al. 1984).

Light-tagging studies in West Virginia (V. Dalton pers. comm.) showed a bimodal foraging pattern for *C. t. virginianus*, with animals foraging over hayfields during the first part of the night, and within the forest later in the night, traveling up to 13 km (8 mi) from the day roost. They foraged as long as weather permitted in the fall, and were periodically active in winter (Pierson et al. 1991). Townsend's big-eared bats have been observed flying in a snowstorm (G. Tatarian pers. comm.).

Comment [PB1]: Observed with night vision equipment, or during the day or mist netted?

CONSERVATION STATUS

Despite the long-standing designation of Townsend's big-eared bat as a Species of Special Concern in California (Williams 1986), there has not been a statewide effort to assess the conservation status of the species since Pierson and Rainey's work in the late 1980s and early 1990s (Pierson and Rainey 1998). CDFW is working with a contract team from Humboldt State University and Texas A & M University to survey maternity roosts and hibernacula over the next two years. This effort will serve as a comprehensive update to the Pierson and Rainey effort, but the results of this new project will not be available until 2017.

Comment [PB2]: Not an update to Pierson as population counts are not taken, only presence or absence of bats (i.e. the population could be declining since Pierson and Rainey 1998.

In the meantime, and in the interest of informing the Commission's decision on whether to list Townsend's big-eared bat according the statutory schedule required by CESA, CDFW offers the following summary of the conservation status of the species. This summary is based on a variety of recent and on-going efforts to study and monitor Townsend's big-eared bat in California and elsewhere.

Regulatory Status

State, federal and non-governmental organizations designate "at risk" species (e.g., threatened and endangered species, Species of Special Concern, Species of Greatest Conservation Need, etc.) and assess and rank their conservation needs. Status designations for Townsend's big-eared bat are summarized below by jurisdiction or organization:

State of California Status. The Fish and Game Commission designated Townsend's big-eared bat a "candidate" for listing as endangered or threatened under CESA, effective December 27, 2013. With the notice of its candidacy for listing, the CESA prohibition against unauthorized "take" of Townsend's big-eared bat is currently in effect. (Fish & G. Code, §§ 2080, 2085). "Take" is defined in the Fish & G. Code as to hunt, pursue, catch, capture, or kill, or to attempt to engage in any of these activities. (*Id.*, § 86.) Take of species protected by CESA, including Townsend's big-eared bat, may be authorized under certain circumstances.

"Species of Special Concern" (SSC) is a Department administrative designation intended to alert biologists, land managers, and others to a species' declining status and to encourage additional management considerations for these species to ensure population viability and to preclude the need for listing. SSCs are defined as species, subspecies, or distinct populations of an animal native to California that currently satisfies one or more of the following (not necessarily mutually exclusive) criteria: extirpated from the State or, in the case of birds, in its primary seasonal or breeding role; listed under the federal Endangered Species Act (but not CESA) as threatened or endangered; meets the State definition of threatened or endangered but has not been formally listed; is experiencing, or formerly experienced, serious (noncyclical) population declines or range retractions (that have not been reversed) that, if continued or resumed, could qualify it for State threatened or endangered status; has naturally small populations exhibiting high susceptibility to risk from any factor(s), that if realized, could lead to declines that would qualify it for State threatened or endangered status (Comrack et al. 2008).

Townsend's big-eared bat has been designated as a Mammal Species of Special Concern (MSSC) since the list was established in 1986 (Williams 1986). The MSSC list is now undergoing a formal update and revision using an objective, criterion-based method developed by CDFW (see Shuford and Gardali 2008 for a recent published example of the current method). As part of the update process, Townsend's big-eared bat has been evaluated, scored, and ranked using eight criteria along with all other terrestrial mammal taxa naturally occurring in California. Based on current information, it is likely Townsend's big-eared bat will be on the updated MSSC list (assuming it is not CESA-listed as threatened or endangered first).

Projects carried out on state and private lands that are funded or authorized by public agencies (such as highway construction, residential and commercial development, and energy development projects) are subject to the provisions of California Environmental Quality Act (California Public Resources Code, Division 13, section 21000 *et seq*. and Guidelines published under the California Code of Regulations, Title 14, section 150000 *et seq*.). CEQA requires that actions that may substantially reduce the habitat, decrease the number, or restrict the range of any species that can be considered rare, threatened, or endangered (regardless of status under state or federal law) must be identified, disclosed, considered, and mitigated or justified. (Cal. Code Regs., tit. 14, §§ 15065(1), 15380.) Impacts to species identified as SSCs should be carefully evaluated in CEQA planning documents.

In summary, as a Candidate for CESA listing, Townsend's big-eared bat enjoys a high-level of assessment and disclosure of potential impacts of proposed CEQA projects. The standard "no-take" requirement for projects helps ensure that population-level impacts do not occur when a project is implemented. Should the species not be listed, then the SSC designation should still ensure that proposed projects include assessment and disclosure of potential impacts, but protection from impacts is less certain and take of individuals may occur.

Federal Status. The two western subspecies of Townsend's big-eared bat are not currently listed as endangered or threatened nor are they candidates for listing under the federal Endangered Species Act. Two eastern subspecies are listed as Threatened under the ESA. Several federal land management agencies (e.g., U.S .Forest Service, Bureau of Land Management) have special management designations for the species. See the EXISTING MANAGEMENT, MONITORING, AND RESEARCH ACTIVITIES section below for additional information on federal agency management of Townsend's big-eared bat.

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Status in Surrounding States.

Oregon – The Oregon Department of Fish and Wildlife (ODFW) designates Townsend's big-eared bat as a Sensitive/Critical species.[3] Sensitive species are "naturally-reproducing fish and wildlife species, subspecies, or populations which are facing one or more threats to their populations and/or habitats. Implementation of appropriate conservation measures to address the threats may prevent them from declining to the point of qualifying for threatened or endangered status." The Critical designation

[3] http://www.dfw.state.or.us/wildlife/diversity/species/sensitive_species.asp

indicates ODFW has determined that Townsend's big-eared bat is a species "imperiled with extirpation from a specific geographic area of the state because of small population sizes, habitat loss or degradation, and/or immediate threats. Critical species may decline to point of qualifying for threatened or endangered status if conservation actions are not taken."

Nevada – The Nevada Department of Wildlife (NDOW) does not have a special status designation for Townsend's big-eared bat. However, the Nevada Bat Conservation Plan (Bradley et al. 2006), which was adopted by a variety of state agencies and federal agency offices in Nevada, including NDOW, designates the species as "Sensitive." The Nevada Bat Conservation Plan designates the conservation risk to Townsend's big-eared bat as "High" (Bradley et al. 2006). According to the plan, "A far more broad-scaled and complete monitoring effort is needed in Nevada to truly discern the status and trend of this species."

Arizona – The Arizona Game and Fish Department (AGFD) published the Arizona Bat Conservation Strategic Plan (AGFD 2003). The plan outlines the current status of all 28 bat species occurring in Arizona. For Townsend's big-eared bat, the plan states that population trends and conservation status of the species is unclear, though some losses of maternity roost sites are known to have occurred. AGFD published an update to its State Wildlife Action Plan (SWAP) in 2011 (AGFD 2011), in which it designates Townsend's big-eared bat as a Tier 1B Species of Greatest Conservation Need. That status is based primarily on AGDF's determination that the species is in a "demographically poor situation: Unusually low birth rates or high death rates combined with small or declining population size. Demographic rates are affected by known stressors likely causing a worsening situation in parts of Arizona." The Arizona SWAP also notes the species' vulnerability due to its concentration at certain points in its life cycle (colonial roosting habits) and an unknown population trend in the state.

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Non-governmental Organization Designations. NatureServe, a non-profit conservation organization whose mission is to provide the scientific basis for effective conservation action through its network of natural heritage programs, ranks Townsend's big-eared bat as a whole and each of the two non-listed subspecies (*pallescens* and *townsendii*) as "G3G4/T3T4" throughout their respective geographic ranges This designation indicates uncertainty regarding conservation status, which may be characterized as either Apparently Secure (G4/T4) or Vulnerable (G3/T3).

NatureServe defines "Vulnerable" as "at moderate risk of extinction or elimination due to a restricted range, relatively few populations, recent and widespread declines, or other factors" and "Apparently Secure" as "Uncommon but not rare; some cause for long-term concern due to declines or other factors." (http://explorer.natureserve.org/granks.htm).

International Union for the Conservation of Nature (IUCN). The current version of the IUCN Red List (http://www.iucnredlist.org/details/17598/0) designates Townsend's big-eared bat as a 'Least Concern' species based on the latest assessment of the species range-wide. The IUCN had previously designated the species in 1996 as 'Vulnerable.' The Least Concern designation is based on "its wide distribution, presumed large population, occurrence in a number of protected areas and because it is unlikely to be declining at nearly the rate required to qualify for listing in a threatened category."

The Western Bat Working Group (WBWG) is a consortium of agency biologists, consultants, academic researchers, and other interested persons throughout the western states and Canada working to ensure a coordinated approach to bat conservation in western North America (http://wbwg.org/). Based on its initial assessment of the conservation status of western bat species in 1998, WBWG rated Townsend's big-eared bat as "high" priority (the highest conservation concern designation). According to the WBWG website, this designation "represents those species considered the highest priority for funding, planning, and conservation actions. Information about status and threats to most species could result in effective conservation actions being implemented should a commitment to management exist. These species are imperiled or are at high risk of imperilment."

Bat Conservation International (BCI) is a not-for-profit organization dedicated to the conservation of "the world's bats and their ecosystems to ensure a healthy planet." BCI does not have an assessment of the conservation status of Townsend's big-eared bat on its website, but has published articles related to the importance of proper mine and cave management to ensure successful roosting of this and other cave/mine-dwelling bat species.

Current Distribution

Based on recent records, Townsend's big-eared bat appears to have declined throughout much of its historic range in California. Figure 3 displays Townsend's big-eared bat observations in California symbolized by time period of observation. The observations are from a number of sources, including museum specimens, observations submitted to the California Natural Diversity Database (CNDDB), and capture and acoustic records from biologists permitted by CDFW to study Townsend's big-eared bat. An obvious pattern of a reduction in distribution is apparent in Figure 3, as occurrences are now rarer in coastal areas than before urbanization.

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Comment [PB3]: Figure 3 shows a decline from its historic range as the recent green dots are fewer in number and absent from many areas in CA where there were yellow historic dots.

Comment [PB4]: Not the best tool for studying a bat with low amplitude echolocation signals.

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Population Trends

Summary of Pierson and Rainey (1998) Statewide Assessment and Other Information Cited in the Petition

To describe Townsend's big-eared bat population trend in California, the Petition relied heavily on the work conducted by Pierson and Rainey (1998) for the Department of Fish and Game. Pierson and Rainey conducted surveys of Townsend's big-eared bat maternity colonies and hibernacula throughout much of the species' range in California during the period 1987 to 1991. Their study focused primarily on maternity colonies to assess population status and reproductive capacity. In addition to visiting and counting the numbers of bats at all known large (> 30 females) Townsend's big-eared bat maternity colony roost sites in California, the authors also searched for additional or alternate roost sites within 15 km (9.3 mi) of the known sites. The authors also visited five known Townsend's big-eared bat hibernation sites in California and described the observations of other researchers at several other hibernation sites. The authors developed several measures of population status and trend in their study, including total estimated number of adult females at maternity colonies in the state, total number of colonies, average size of maternity colonies, and average and total size of hibernation colonies.

The work by Pierson and Rainey (1998) showed a marked decline in the population size of Townsend's big-eared bat over the period between the original surveys of the maternity colony roost sites and the re-surveys conducted by the authors. Eighteen historically known maternity colonies with population counts were assessed in the study. The original dates of detection ranged from 1918 to 1974, with most of the original surveys conducted in the 1930s through 1960s. Six of the colonies appeared to have been extirpated, five had declined in number of females by more than 20%, four had remained relatively constant in numbers, and three colonies had increased by more than 20%. The authors lumped all 18 colonies' original population counts to get a historical-period population estimate of 3,004 adult females. Based on their counts during the 1987-1991 surveys, they estimated these colonies had declined by 55% to a total of 1,365 adult females.

The authors also found a decline in the total number of colonies known from the historical period to the resurveys. Of 46 historically-known maternity colonies (many without population counts), the authors could not find 24 (either at the original site or within 15 km (9.3 mi) of the original site), which represented a 52% decrease in the number of historically-known colonies.

Additional maternity colonies were located in the period after 1980, either by the authors or reliably reported to the authors by other researchers. These colonies were sufficiently distant from historically-known colonies for the authors to conclude they were not part of the historical set. Although no conclusion about population trend could be made based on the inclusion of the additional colonies, Pierson and Rainey's (1998) point estimate for the total known adult female Townsend's big-eared bat population size in California was 4,252 individuals, which distributed among 39 maternity colonies. The authors cited reliable reports of four other colonies of unknown size. The Petition cites reports and personal communications of an additional four maternity colonies known as of 2003, as well as observations of lactating females in areas without known colonies, suggesting there are additional maternity colonies not yet discovered.

Pierson and Rainey (1998) also compared the average size of the 18 historically-known maternity colonies to the 38 colonies with population estimates known at the time of their study. They found average number of adult females in the historical colonies to be 164, while the currently-known colonies averaged 112 females. Thus, the recent colony size was 32% smaller than the historical colony size.

Pierson and Rainey (1998) also assessed the size of five historically-known hibernation colonies in California. One of the colonies (at Lava Beds National Monument) had remained stable at approximately 30 individuals. The other four, which had original counts of between 55 and 177 bats, showed dramatic declines of between 70% and 94%. These sites were in Shasta, Lake, and Napa counties.

The Petition also cited observations by Williams (1986), who was an active researcher of the conservation status of mammals in California in the latter half of the 20th century. As mentioned in the Petition, Williams (1986) stated his impression that Townsend's big-eared bat had been common in central California through the 1960s, but had dramatically declined by the early 1970s. Williams (1986) mentioned that he had only captured one individual Townsend's big-eared bat during his 14 years of

work in central California in the 1970s and 1980s. Townsend's big-eared bat has been recently observed in the central coast area of California, on Department lands and Vandenberg Air Force Base (R. Stafford 2014, 2015 pers. comm.; R. Evans 2014 pers. comm.). These observations, which included a maternity roost site for both of the jurisdictions, as well as a large extant maternity colony at Hearst San Simeon State Historical Monument, indicate the species continues to occur in the region, although no information on population or range trend is available for this area.

Comment [PB5]: Numbers?

Other published observations of declines in Townsend's big-eared bat colonies in the Sierra Nevada and lower Colorado River (LCR) area (Graham 1966, Stager 1939) were mentioned in the Petition. Grinnell (1914) first discovered the "pale lump-nosed bat" in the Riverside Mountains roosting "at the end of a sloping drift in the Steece copper mine". Howell (1920) visited the Old Senator Mine near the LCR (6 miles north of Potholes) on May 14, 1918 and "found about a hundred females, each with a naked young from a few days old to a quarter grown, clinging to the roof of a gallery at the two-hundred-foot level. They were in close formation, but not touching one another, and, although not as wild as California leaf-nosed bats, they were quite ready to fly. The only way we could capture them was wildly to grab at a bunch with both hands." Neither the Senator nor the Steece Mine currently have Townsend's big-eared bat colonies (Brown and Berry 2003).

Stager (pers. comm.) describes a cluster of Townsend's big-eared bats 3 x 12 feet across in the main level of the Alice Mine in the Riverside Mountains. The estimated cluster density in most maternity colonies is 100 bats/ square foot (Pierson and Rainey, 1996). At this density, the colony in the Alice Mine in the 1930s would have been over 3000 bats. The last specimen collected from the Alice was in April 1954. When P. Brown first visited the Alice Mine in August 1968, piles of old guano remained, but these have now been trampled to dust. The Mountaineer Mine in the Riverside Mountains is the only mine along the main LCR that is currently known to shelter a Townsend's big-eared bat maternity colony (Brown and Berry 2003). The dense native vegetation documented by Stager (1939) has been removed along the LCR over the past 50 years and replaced with agricultural fields that are subjected to extensive pesticide spraying. In forested areas, spraying for lepidopteran species may alter the prey base for big-eared bats (Perkins and Schommer, 1991; Brown *et al.* 1994). The loss of foraging habitat, combined with pesticide spraying and human intrusion in the roosts may be contributing factors in the decline of Townsend's big-eared bat populations.

In summary, the best quantitative information on the population status of Townsend's big-eared bat cited in the Petition is Pierson and Rainey's (1998) statewide assessment, which showed that, of the 18 historically-known maternity roost sites with population counts, six of the colonies had been extirpated by the time the authors conducted their work. Another six colonies showed a decline in the number of adult female Townsend's big-eared bat present. Although five colonies had increased in size (and one

remained stable at 50 females), the overall decline in numbers from the historical period appeared to be substantial.

These comparisons between historical and recent colony numbers, colony size, and total population counts suggested that, as of the early 1990s, there had been a decline in the total population of Townsend's big-eared bat in California since the early 20th century. This decline may have been substantial, but the historical data set was limited and therefore the magnitude of the population decline could not be exactly determined. In combination with other aspects of the species' biology and observations of human disturbance at Townsend's big-eared bat roost sites, the trend information collated by Pierson and Rainey (1998) led to the inference that the California Townsend's big-eared bat population had declined over the several decades before their study.

CDFW is aware of ongoing efforts to monitor or revisit several important Townsend's big-eared bat maternity and hibernation roosts in California. These efforts include monitoring at both hibernation and maternity colonies at Lava Beds National Monument (S. Thomas 2013 pers. comm.), revisiting known Townsend's big-eared bat hibernacula in the White and Inyo mountains (Szewczak et al. 1999, M. Morrison 2013 pers. comm.), long-term annual counts of a maternity colony in a historical building in Sierra County (W. Copren 2013 pers. comm.), as well as at other sites. The following section summarizes recent results from these ongoing monitoring efforts.

Townsend's Big-Eared Bat Roost Site Monitoring Case Studies

To assess Townsend's big-eared bat population trends since Pierson and Rainey's (1998) work, CDFW has compiled information from a number of maternity and hibernation roost sites from around California. The following is a summary of studies that assess the population trend at specific sites. While this summary does not comprise a statistically valid estimate of the Townsend's big-eared bat population size or trend statewide, it does illustrate how population status varies around the state, as well as how management of roost sites directly affects the population status in an area. Locations referenced here are depicted in Figure 4.

Comment [PB6]: Need to add Briggs Mine (Inyo County; Lower Colorado River (Imperial and Riverside Counties, and China Lake Naval Weapons Center (Inyo County).

Randall House Maternity Roost (Marin County). Fellers and Halstead (2015) reported results from 25 years of monitoring the Randall House maternity roost site in Marin County. The Randall House is a two-story late 19th Century ranch house situated in a valley at Point Reyes National Seashore. It was last used by humans in the 1970s and in 1987 was discovered to be the site of a Townsend's big-eared bat maternity colony. At that time, the colony numbered 95 adult females. The site had been subject to repeated break-ins by local teenagers prior to 1987, but upon discovery of the Townsend's big-eared bat colony, the National Park Service fortified the house against unauthorized entry and has since maintained the house for use by the bats.

Using night-vision equipment, Fellers and his collaborators conducted 178 exit counts of Townsend's big-eared bat during the maternity season between 1988 and 2012. In addition to information on the number of adult females and young present at the site, this long-term monitoring study also yielded important information on the effects of human disturbance on colony status, effects of season and

environmental factors on emergence time from the roost, and other natural history aspects of the species.

Over the course of the 25-year study, the Randall House Townsend's big-eared bat maternity colony increased in size (see Figure 5B). Adult female maximum number recorded increased from 95 in 1988 to 395 in 2012. The maximum recorded number of adult females plus volant young increased from 176 to 512. The annual rate of increase was estimated to be 8.7% for adult females and 5.3% for volant young.

Attempted and successful break-ins to the roost building occurred occasionally during the study period, despite increased security at the site. These disturbance events were documented and the authors found a significant negative correlation between disturbance events and subsequent numbers of adult females and volant young (compare Figures 5A and 5B). In other words, there were fewer Townsend's big-eared bat adults and young at the roost site in years with human disturbance events.

The authors note the Randall House is one of the most important remaining Townsend's big-eared bat maternity roost sites in coastal California. Because of the NPS commitment to maintaining the Randall House for Townsend's big-eared bat use, it is one of the few maternity roosts classified by Pierson and Rainey (1998) as "secure." Prior to its discovery in 1987, two other nearby historical roost sites (the Olema Inn and an old barn near Inverness) had already been lost. Fellers and Halstead (2015) note that only one other Townsend's big-eared bat maternity roost is known in the area and, although also located on NPS land, it is structurally dilapidated and its long-term suitability for Townsend's big-eared bat use is questionable. Like other old wooden buildings used by Townsend's big-eared bat around the state, these structures are vulnerable to degradation and loss over time. Replacement structures tend to be made of materials and use designs less suitable for bats.

Nevertheless, the Randall House is an example of how management of a roost structure may allow Townsend's big-eared bat to continue to occupy an area and even expand in numbers over time.

Kentucky Mine Maternity Roost (Sierra County). The Kentucky Mine Historic Park and Museum is located in Sierra City, Sierra County, at an elevation of 1340 m (4400 ft). The Kentucky Mine Townsend's big-eared bat maternity colony was not known at the time of Pierson and Rainey's 1980s and early 1990s statewide assessment. The colony primarily roosts in a historical mine building (a stamp mill used to crush ore excavated from the nearby mine), but the bats appear to also use the nearby mine itself as an alternate roost site (M. Tierney 2015 pers. comm.).

As described by Freeman (2012), unlike most Townsend's big-eared bat maternity colonies, "this colony has acclimated to a level of disturbance typically considered intolerable for *C. townsendii*. The Sierra County Historical Society leads tours twice a day through the stamp mill throughout the maternity period. During these tours, guides wind up a massive iron stamp and let it pound down to demonstrate how it crushes rocks to remove the gold. This noisy activity frequently occurs directly beneath the roosting bats and causes the entire building to quiver. The grounds surrounding the stamp mill permit daily public use. On weekends, human disturbance continues into the night. An outdoor amphitheater

located less than 50 meters from the colony is used for concerts during the nursery season. This colony persists despite these disturbances."

Comment [PB7]: Since the colony was only documented after the tours and human disturbance has in progress, there is no way to assess how large the colony was prior to the disturbance. Only a small fraction of the original population may be "acclimated".

The U.S. Forest Service prepared a management plan for the colony in 2007 (Tierney and Freeman 2007) and the Sierra County Historical Society, which operates the park and museum, cooperates with the U.S. Forest Service to manage the risk of disturbance to the colony by following the recommendations of the plan (W. Copren 2012 pers. comm.; M. Tierney 2015 pers. comm.). Among the plan's guidelines are measures to make the on-going human activities at the roost site consistent and predictable to allow the bats to acclimate to disturbance.

Exit counts from the stamp mill during the maternity season have been conducted by the U.S. Forest Service and others since 1994, along with occasional roost counts within the stamp mill and exit counts from the shafts of the mine itself. Data are available for the period 1994 through 2005 (Tierney, unpublished data). Depending on year, the counts at the stamp mill were conducted at various times during the maternity season (and therefore may include either adult females only or adult females and their young). The counts were sometimes conducted on nights when the colony was apparently roosting at an alternative site. The exit count data at first glance is irregular (Figure 6A).

Comment [PB8]: All the dates on figure 6A are 1/1---not a time for exit counts.

Removing exit counts at the stamp mill roost with anomalously low numbers suggesting the bats were roosting at an alternative site (counts with fewer than 20 bats in years with other counts of 40 or more bats) and by separating the counts into the pre-volancy and volancy periods of the young (before mid-July and after the third week of July), a clearer pattern develops (Figures 6A and 6B).

Comment [PB9]: An alternate roost site is not the only conclusion for fewer bats exiting. Reproductive failure could also have occurred due to disturbance and abandonment of the juvenile bats.

Early season counts (consisting of adult females only) at the Kentucky Mine have generally been in the range of 30 to 50 bats since the first count of 66 bats was made in late June 1994. After young achieve flight starting around the last week of July, counts have varied between lows of around 35 in the late 1990s to between 50 and about 100 in the early 2000s (Figure 6A). Exit count data at the mine shaft roost site in late August and early September 2003 totaled 140 and 168 bats, but it is possible these very late counts included adult males as well as females and young of the year (Figure 6B).

Comment [PB10]: Definitely would have included males in the early fall.

CDFW does not have access to more recent exit count data from Kentucky Mill, but the U.S. Forest Service's estimate from data collected subsequent to 2005 is that the colony size has been fairly stable at or near 100 adult females (M. Tierney 2015 pers. comm.; K. Freeman 2015 pers. comm.).

Lava Beds National Monument Maternity Roosts (Siskiyou and Modoc counties). Lava Beds National Monument (LBNM) is located in northeastern California. The monument contains the largest concentration of lava caves in the contiguous United States; LBNM staff had identified more than 750 caves by 2013. The extensive network of caves at Lava Beds National Monument in Siskiyou and Modoc counties is considered a major population center for California's Townsend's big-eared bat population (Pierson and Rainey 1998). During the last statewide assessment of the species, it was estimated that a quarter of the state's breeding female population occurred at LBNM (Pierson and Rainey 1998). These caves have been monitored for Townsend's big-eared bat presence during the maternity season over the past couple of decades, but because of Townsend's big-eared bat's known sensitivity to disturbance,

most surveys during the active season have been limited to quick checks for presence or absence of bats (T. Weller 2014 pers. comm.). Counts of bats were infrequently made during these surveys and only rough estimates of bat numbers are available. In accordance with cave resource management guidelines, caves where Townsend's big-eared bats were observed during the active season were then subsequently closed to recreational access.

Comment [PB11]: Why not exit counts?

Comment [PB12]: Closure by gating, or just signs (not usually effective).

Efforts to monitor the Townsend's big-eared bat population at LBNM during the maternity season take a light-touch approach to minimize the risk of disturbance at the roost sites. Three Townsend's big-eared bat maternity colonies are monitored for presence/absence and to collect cave microclimate data (temperature and relative humidity). Depending on staff availability, the monitoring occurs on a variable schedule of between once per week to once per month (Katrina Smith 2015 pers. comm.). Exit counts have also been conducted, but conditions are not conducive to accurate counts (Katrina Smith 2015 pers. comm.).

Comment [PB13]: Need to elaborate

As part of his analysis of recent (1990s and later) Townsend's big-eared bat monitoring data from LBNM, Weller attempted to discern patterns of occupancy by date and location during the active season (T. Weller 2014 pers. comm.). Apart from very general conclusions about the timing of the maternity season, no pattern of occupancy in particular caves at particular dates, nor trend in bat population size, may be discerned from these data (T. Weller 2014 pers. comm.). Weller concluded the known roost-switching behavior of Townsend's big-eared bat during the maternity season and the opportunistic and infrequent attempts to monitor Townsend's big-eared bat at LBNM during the active season preclude inferences about active season population trends using existing data. He advocated instead the use of Townsend's big-eared bat counts at hibernacula, where individual bats may reliably be counted during the inactive season (and without undue disturbance of the bats) as the preferred method to estimate population size and trend. See below for a summary of results of LBNM hibernaculum monitoring (Weller et al. 2014).

Lava Beds National Monument Hibernacula (Modoc and Siskiyou counties). The Lava Beds area of northern California is home to one of the most important populations of Townsend's big-eared bat in California (Pierson and Rainey 1996). The National Park Service at Lava Beds National Monument (LBNM) has monitored winter bat use of the lava tubes and caves for many years (Weller et al. 2014). Townsend's big-eared bat are the most commonly encountered bat species in winter because of their habit of roosting in the open, but Myotis bats (*Myotis* sp.) and big brown bats (*Eptesicus fuscus*) are also occasionally observed (Katrina Smith 2015 pers. comm.).

NPS considers the period from November 15 to March 15 to encompass the Townsend's big-eared bat hibernation season at LBNM. Any bat survey completed in caves during this period is included in the LBNM bat database and is considered hibernacula monitoring data. In recent years, a focused effort to monitor the hibernating bat population at LBNM has been conducted, with one entire week in mid-winter devoted to completing as many bat hibernacula surveys as possible. NPS staff and collaborators use a stratified random sampling method to select caves for survey based on the number of bats seen there in previous years. This allows collection of annual data on large known hibernacula and also to survey sites that have never been visited in winter. Using this method, in the past few years NPS has

discovered four new hibernation sites with more than 30 bats, plus several sites with smaller numbers of Townsend's big-eared bat.

Winter bat surveys at LBNM use headlamps and other caving gear to enter caves to tally all visually observed hibernating bats. Townsend's big-eared bats typically hibernate singly or in small groups, generally consisting of fewer than 20 individuals, though larger clusters are occasionally observed. Along with counts of bats by species and location within the caves, cave microclimate data (air temperature, ceiling temperature, and relative humidity) are also recorded (Katrina Smith 2015 pers. comm.).

Weller et al. (2014) analyzed the results of NPS Townsend's big-eared bat hibernacula monitoring data from a 22-year period (1991-2012) at LBNM to determine if a trend in the number of Townsend's big-eared bat hibernating could be discerned. Over this period, bats were counted in a total of 52 caves. Although a concerted effort was made by NPS to monitor hibernating bats each year, the number of caves visited and number of surveys conducted varied based on staff availability. These analyses were also used to design a flexible yet statistically robust monitoring program in future years.

Weller et al. (2014) used regression analysis to model the changes and trend in Townsend's big-eared bat numbers at each cave that had at least four surveys conducted from 1991 and 2012, and for which at least half of the surveys had at least one bat recorded. Using these models, the authors generated predicted numbers of Townsend's big-eared bat for each cave in non-survey years, as well as for 2012. The 2012 predictions were compared to the actual counts for that year. They also estimated the total number of Townsend's big-eared bat hibernating in all the caves each year by combining actual counts and estimated numbers.

Seventeen of the 22 caves monitored during at least four years had a positive trend in the number of hibernating Townsend's big-eared bat during the 22-year study period (Figure 6), although not all of these were statistically significant. Most of these caves had large numbers of hibernating Townsend's big-eared bat. The decreasing trends for the other five caves were not statistically significant, nor did any of these caves ever have more than 10 Townsend's big-eared bat observed in a count.

Comment [PB14]: How many are statistically significant? Should only count

Comment [PB15]: What number is considered large (too subjective). Is there any data before 22 years?

The authors estimated the number of hibernating bats in the 52 surveyed caves increased from 834 bats in 1991 to 1,427 bats in 2012 (Figure 7). The estimated cumulative annual growth rate for the 52 caves over the period 1991–2012 was about 1.8% (Figure 8). The estimated annual population growth rate for the caves surveyed most often was about 4%. Estimates based on data from 1991 to 2011 generally predicted the 2012 counts well; however, the actual bats counted in most caves exceeded the predicted numbers in 2012. Seven caves had their highest count in 2012 and another three equaled their previous high count.

Although 52 caves among the 97 surveyed during the 22-year study period were observed to have hibernating Townsend's big-eared bats during one or more years, Cave L970 stands out as an especially important site. In 1990, 376 bats were counted there and it has consistently held the majority of bats counted each year (see Table 1 from Weller et al. 2014).

Although the authors list a number of caveats regarding their results, they are "confident that the number of bats in the 52 surveyed caves has increased or, at the least, remained stable." They state "the increasing number of hibernating individuals reaffirms LBNM as a population stronghold for Townsend's big-eared bats in a state (Pierson and Rainey 1998) and region (Pierson et al. 1999) where it is considered imperiled. Potential ecological explanations for the increase in hibernating bats are unclear but could be related to changes in management policy at LBNM. Beginning in 1991, approximately 10 caves were closed during the maternity period to limit disturbance of maternity colonies by visitors. Lava Beds National Monument also closed winter hibernation sites to visitors, starting with a few sites in the 1990s and increasing to nearly 20 caves by 2012."

Pinnacles National Park Maternity and Hibernation Roosts (San Benito County). Pinnacles National Park, located about 65 km (40 mi) east of Monterey, encompasses approximately 9,700 ha (24,000 acres). Pinnacles National Monument (later Park) was established to protect and allow public use of the unique talus cave systems found there, which are formed from the remnants of a 23-million-year-old volcano. The Townsend's big-eared bat maternity colony that occurs in the cave system at Pinnacles National Park was not known at the time of Pierson and Rainey's statewide survey in the 1980s and early 1990s. Following its discovery in 1997, NPS closed the cave to the public for 4 years to allow the bats undisturbed use of the cave and to determine how best to manage the site (NPS 2002). The Pinnacles roost site is used by the local Townsend's big-eared bat population both for hibernation and for the maternity season. Portions of the cave are warm enough during the maternity season for gestation and pup-rearing, while other sections are cool enough in the winter to provide a suitable environment for hibernation. After the period of study, NPS adopted a management policy for the site that allows park visitors to seasonally access the portions of the caves not in use by the bats (NPS 2002, Paul Johnson 2015 pers. comm.).

NPS conducts annual monitoring of the Townsend's big-eared bat population, usually during both the maternity and hibernation seasons, to determine the effectiveness of this management strategy as well as to verify the dates for shifting visitor access. Because of the porous nature of the talus caves at Pinnacles, it is not possible to conduct exit counts at one or a few entrances to the roosts. Instead, NPS staff attempt to conduct visual counts of the maternity colony and hibernating bats within the roosts. Precise counts are not always possible due to limited access by humans to areas used by the bats, as well as the importance of minimizing disturbance to the roosting bats.

Over the period from 1997 to 2014, the total maternity colony size (sometimes including pups) has ranged from about 150 to possibly as high as 1000 individuals; though in most years the total maternity colony size ranges between 200 and 400 individuals (Table 2). The hibernaculum counts are generally lower than the maternity roost counts (possibly due to dispersed winter roosting habits), ranging from about 15 to 400 individuals, with many years having counts of around 200 individuals (Table 2). The annual count data shows an early increase in the total numbers of Townsend's big-eared bat individuals counted in both the maternity and hibernation seasons. This apparent increase in colony size may be attributed to the public cave closure from 1997 to 2002, followed by the adoption of the current management strategy of seasonal public access to the caves. Additional factors affecting the data are

the intensity and frequency of survey effort in a given year. According to the NPS staff familiar with the surveys, the later years reported here had fewer survey visits to the roost site, which made it less likely that peak numbers would be detected in a given year (Paul Johnson 2015 pers. comm.). Despite the apparent decline in colony size since 2005-2006, NPS considers the Pinnacles Townsend's big-eared bat population to be relatively stable (Paul Johnson 2015 pers. comm.).

Hearst Castle Maternity Roost (San Luis Obispo County). The Townsend's big-eared bat maternity colony at Hearst San Simeon State Historical Monument was not known at the time of Pierson and Rainey's (1998) statewide survey. The Townsend's big-eared bat roost site was discovered during an assessment by Department of Parks and Recreation (DPR) of the bats occurring at Hearst Castle in 2000 (K. Miner 2015 pers. comm.). The maternity roost site is located in a cavernous space within the reinforced concrete stair and landing structure at the main entrance to the complex of mansions that comprise Hearst Castle. Prior to the survey, the space was regular inspected for structure integrity and used for closed-space rescue training by park staff during the maternity season, who reported that bats were disturbed by their presence. Once discovered that it was being used by Townsend's big-eared bats, DPR limited entry during the maternity season to only necessary safety inspections. Prior to 2003, Townsend's big-eared bats entered and exited the roost space through a narrow space below a screened door, forcing the bats to crawl on the ground. In 2003, the site was modified by adding two openings to the roost at more typical locations above the ground and sized to accommodate flying Townsend's big-eared bats accessing the site (R. Orr 2015 pers. comm.). DPR also developed management guidance to ensure maintenance and repair activities at the site have minimal impact on roosting bats, including Townsend's big-eared bat (DPR 2003).

Exit counts conducted by DPR staff since 2000 suggest the management of the site has enabled the colony to thrive. Most of the exit counts at the Townsend's big-eared bat roost have been conducted during late August, at which time the counts would likely include both adult females and their volant young and possibly adult males, as well. Late summer exit counts ranged from 60 to 95 total individuals prior to the roost entrance modification work. Since the modification and adoption of the bat protection policy in 2003, total counts of Townsend's big-eared bat during the late summer have increased fairly steadily through the years (Figure 9). Over the period 2012-2014, late summer counts ranged from 413 to 813 total Townsend's big-eared bat individuals at the site.

Comment [PB16]: Thrive is too subjective, especially since no historic data.

Santa Cruz Island Maternity Colony (Channel Islands National Park). Santa Cruz Island is the largest and most habitat-diverse of California's Channel Islands and it is the only Channel Island known to harbor a large reproductive colony of Townsend's big-eared bats (Brown et al. 1994). A small colony of less than 10 bats was discovered in a mine on Santa Catalina Island in 2001 (Brown and Berry 2002). Because of its distance to the mainland, the Santa Cruz and Santa Catalina Island Townsend's big-eared bat populations may be isolated from other Townsend's big-eared bat populations. If so, it is possible the island populations may have unique genetic characteristics. The Santa Cruz Island colony was first described in 1939 as roosting in a 2-story ranch house at Prisoners Harbor on the north-central side of the island. At that time, it was estimated to number more than 300 individuals, which were likely both adult females and their volant young (Brown et al. 1994). A total of 246 individuals were taken for

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scientific collections in 1939 and two subsequent collection trips in 1949 and 1964 (Brown et al. 1994). Pierson and Rainey (1998) cited Museum of Vertebrate Zoology records as stating the colony in 1948 numbered 150 adult females.

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At some point between the mid-1960s and 1974, the Prisoners Harbor ranch house was demolished. Despite extensive searches, Townsend's big-eared bat roosting in substantial numbers on Santa Cruz Island were not observed again until 1991, when they were reported to Pat Brown as occurring in the Bakery in an old adobe building at Scorpion Ranch on the northeast end of the island (Brown et al. 1994). It is not clear whether the Scorpion Ranch site was colonized by Townsend's big-eared bat displaced from Prisoners Harbor or if it was already in use prior to the loss of the Prisoners Harbor site. The National Park Service has since then assumed management of the entire island, including the Scorpion Ranch buildings, as part of the Channel Islands National Park.

NPS and others have conducted regular exit counts at the maternity roost site during the spring (adult females only) and late summer (adult females and their young). Exit count data available to CDFW suggest the number of Townsend's big-eared bats at Scorpion Ranch have never been as high as at the Prisoners Harbor roost site. Spring counts in the early 2000s ranged from about 50 to 105 adult females, while fall counts ranged from about 75 to 165 adult females and their young.

Work was conducted in 2009 to renovate and reoccupy other portions of the old adobe building. Exit counts by NPS personnel at the bakery roost site continued during maternity season during this time (T. Coonan 2014 pers. comm.). During the 4-year period from 2010 to 2013, the bakery roost site was abandoned, either temporarily (2010 and 2011) or for the remainder of the maternity season (2012 and 2013). The latter abandonment events resulted in the known death of pups at the caves to which the adult females had moved. Early season counts suggest between 60 and 90 adult females arrived at the roost site each year. The cause(s) and exact dates of abandonment are not known, but could include public visitor entry over the half-door into the roost site or other activity in and around the building, including use of other rooms within the building by NPS personnel.

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Proposals have been made to increase monitoring activity at the maternity roost site to more closely track human activity and bat numbers (T. Coonan 2014 pers. comm.), as well as to exclude human entrance into the roost site with a bat-friendly gate. These proposals have not been implemented due to lack of funding (T. Coonan 2014 pers. comm.).

In summary, the Santa Cruz Island Townsend's big-eared bat population has fared relatively poorly since it was first described in 1939. Repeated collections for scientific purposes, demolition or reconfiguration of roost sites, and disturbance have all impacted the population, which had its highest recorded number (more than 300) reported when it was first counted. Although the failed or reduced recruitment that occurred during 2010 through 2013 may not yet have significantly reduced the population size of this long-lived species, repeated reproductive failures will impact the age structure of the population. If reproductive failure of this colony continues, it is possible the Santa Cruz Island Townsend's big-eared bat population may become extirpated.

White-Inyo Mountains Hibernacula (Tulare and Mono counties). Szewczak et al. (1998) conducted an extensive survey program for bats in the White and Inyo Mountains from 1990 through 1996. As part of that survey effort, many observations of Townsend's big-eared bat were made, along with counts of Townsend's big-eared bat in individual hibernacula, which typically were in caves and abandoned mines. The authors have revisited many of the hibernation roosts since the original study was completed (M. Morrison 2014 pers. comm.). Some hibernation sites were repeatedly surveyed over multiple years while others were surveyed only once.

Morrison and Szewczak conducted 92 surveys of 47 sites within 28 different mines and caves in the study area from 1991 to 2014 (M. Morrison 2014 pers. comm.). Counts of hibernating Townsend's big-eared bat ranged from 0 to 80 individuals per site. The median count per site for all Townsend's big-eared bat surveys was 4 individuals. Of the 47 sites, 33 were surveyed more than once. Of these, 62% of the sites had a decrease in the number of hibernating Townsend's big-eared bat, 19% showed an increase in numbers, 16% showed an initial increase but then decreased in recent years, and 3% showed an initial decrease and then increase in recent years. A mean decrease of 3 individuals per site was recorded among the revisited sites.

These data from Townsend's big-eared bat hibernacula in the White and Inyo mountains are preliminary and do not lend themselves to strong conclusions. However, the preliminary data suggest that, unlike the situation at Lava Beds National Monument, the Townsend's big-eared bat population in the southeastern part of the state may be decreasing. China Lake Naval Weapons Center (Inyo County). A mine in Wilson Canyon sheltered a maternity colony of approximately 100 adult female TBEB (P. Brown pers.obs.). The mine had had seismic monitoring equipment installed, possibly done in the winter when the bats were not present. In late summer When P. Brown and E.D. Pierson visited the mine in late summer 1989, dozens of mummified juvenile TBEB were hanging from the ceiling and on the floor. The equipment had been removed by the Navy during the bats' active season, probably while the adults and young were present. Another maternity colony of over 200 adult female TBEB monitored by P. Brown in the 1980s in the Redwing Mine at the mouth of Mountain Springs Canyon has disappeared as of July 2015.

The Briggs Project in the Panamint Mountains (Inyo) destroyed one of the largest maternity colony sites in that area (occupied by over 240 adult TBEB). The bats were evicted, and after several years a smaller maternity colony (~60) formed in the nearby Goldtooth Mine that had been set aside as the mitigation site in the original BLM record of decision. About 5 years ago as the price of gold increased, the operating mine was allowed to expand into the Goldtooth Mine and the bats were again evicted. Obviously mitigation in perpetuity does not apply to active gold mines.

Summary of Population Monitoring Studies. Table 3 summarizes the results of monitoring of Townsend's big-eared bat hibernation and maternity colonies at the aforementioned sites. Two of the sites (one hibernation and one maternity) had statistically significant increases in total population size over two-plus decades of monitoring. There have been significant declines in the maternity colonies on Santa Cruz Island, the Panamint Mountains and China Lake Naval Weapons Center; and in the hibernacula in the White and Inyo mountains. Because the total current Townsend's big-eared bat

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population the status of many roost sites in California are unknown, CDFW applied for and received a State Wildlife Grant from the U.S. Fish and Wildlife Service to conduct a two-year study to address this information need. This study, which is being conducted in collaboration with researchers from Humboldt State University and Texas A&M University, will provide a current snapshot of the species' population size relative to the estimates made by Pierson and Rainey (1998) for the historical period (pre-1980) as well as the estimates made by Pierson and Rainey based on their own survey work in the 1980s and 1990s. It is hoped that the current study will provide CDFW and the Fish and Game Commission a much clearer picture of the species' status in California than do the isolated case studies summarized here. The results of the two-year study are expected to be available by June 2017

Comment [PB17]: No counts being made at most colonies, just presence or absence, so data will not be comparable to historic Pierson and Rainey and other counts.

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Threats

CDFW has identified the following factors as potential threats to the continued existence of Townsend's big-eared bat in California: loss, degradation, and disturbance at roost sites; loss and degradation of foraging habitat; disease; mining; environmental contaminants; climate change and drought; and overexploitation. Each of these topics is addressed below. Competition for resources (such as prey, water, and cover habitat) with other native or introduced species was considered as a potential threat but eliminated from further consideration due to lack of evidence that it may pose a threat to the continued existence of the species.

Roosting Site Loss, Structural Degradation, and Disturbance.

The availability of suitable roosting habitat is often considered as a limiting factor for western bat populations. For example, Pierson (1998) stated "considerable evidence suggests that roosts are limiting for many bat species." Hayes (2003) cites several authors that "hypothesized [roosts] to be the primary factor" limiting bat populations. That roosts may limit bat populations, including Townsend's big-eared bat, is a reasonable conclusion, given bats may use multiple roost sites with different characteristics during the year; that roost site suitability may be based on a narrow range of suitable temperatures, relative humidity, physical dimensions, and so on; and that such sites may occur in low numbers on the landscape.

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Impacts to roost sites are an important threat to Townsend's big-eared bat. Such impacts include both physical loss/modification of the roost site as well as disturbance of bats at the roost site.

Within the North Coast region of California, the loss of old-growth conifers with large, cavernous basal hollows during late 19th and early to mid-20th century industrial-scale logging is presented as a likely explanation for the apparent decline of Townsend's big-eared bat populations in the coastal forest of northern and central California (Pierson and Rainey 1998). The association of Townsend's big-eared bat with large basal hollows has been demonstrated by the work of Pierson and Fellers (1998) and Mazurek (2004).

More recent and ongoing forestry practices that could impact Townsend's big-eared bat include harvest of remnant old-growth trees with suitable roosting cavities, as well as disturbance associated with timber operations, increased access to roost sites by human visitors, loss of oak woodlands (which may

provide roost sites and certainly provide foraging habitat), conversion of forest to agriculture such as vineyards, and application of chemicals.

New and renewed mining operations have the potential to impact Townsend's big-eared bat roosting in old shaft/adit mines, either through disturbance of roosting bats or by destroying the old mine by conversion to open pit-style mining, or through natural collapse of abandoned mines. Four examples of the destruction or loss of Townsend's big-eared bat roost sites are described in the Petition.

Comment [PB18]: There are more than these to cite

Dam construction or modification can result in the inundation of Townsend's big-eared bat roost sites. The Petition mentions one large colony that was displaced by construction of the New Melones Dam on the Stanislaus River. As stated in the Petition, much of the dam-building, reconstruction, and license renewal in California occurs at the same elevations in the foothills of the Sierra Nevada and Klamath and Trinity mountains that are optimal for Townsend's big-eared bat roost sites.

Although generally considered a cave/mine roosting bat, Townsend's big-eared bat also roosts in large spaces in old buildings and in cavernous spaces in bridges and dams. Bats in such sites are subject to disturbance when humans enter for inspections or other activities. The roost sites themselves are subject to eventual deterioration or demolition. Pierson and Rainey (1998) documented the loss of several Townsend's big-eared bat roost sites found in buildings.

Comment [PB19]: Need more information and quantify

There is an increasing interest among recreational explorers in caves and abandoned mines. Multiple posts on U tube and websites such as the Mojave Underground document entry into abandoned mines for recreational exploration, and often include videos or notes about bats encountered, which usually are TBEB. There is also a collectible market for mining artifacts. People entering mines can disturb bats during the critical maternity and hibernation seasons. Townsend's big-eared bat appears to be particularly susceptible to such disturbance. Recreationists and homeless persons may also enter old buildings used as roosts and disturb bats. A house at the CDFW Chorro Creek Wildlife Area has provided a roost site for a Townsend's big-eared bat maternity colony off and on for several years. The site has been repeatedly abandoned by the bats after break-ins followed by subsequent re-occupancy after the house is resealed (R. Stafford 2014 pers. comm.). The same pattern of partial or complete abandonment has been observed at the Randall House maternity roost site (Fellers and Halstead 2015) and other sites.

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A mine in the Tungsten Hills north of Bishop contained a maternity colony of over 200 TBEB in July 2008. In preparation for gating in fall 2011, it was visited by a BLM biologist who noted a maternity cluster near the mine portal on July 21. Since the maternity colonies prefer warm temperatures, it is common for them to roost very close to the surface in the summer in an exposed position that makes them especially vulnerable to disturbance from even casual entry into the mine. Returning a week later, the same biologist was dismayed to discover dead bats hanging from the ceiling and on the floor. P. Brown collected 46 juveniles that had starved, but much of the mine is inaccessible (raises and winzes) and more bats could have been present or removed by scavengers. The mine was gated in fall 2011 and has been surveyed every summer since then. No bats were present in the summer of 2012. However, 50 TBEB were observed exiting on June 14, 2014 indicating a portion or remnant of the colony has returned, but not in

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the numbers observed prior to the disturbance. The bat colony lost at least a year or two or reproductive recruitment.

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While it is certainly true that natural roosting habitat for Townsend's big-eared bat has been impacted by humans over the past 150 years, it is important to consider that historical mining and building construction also added to the total available roost habitat in the state in the late 1800s and early 1900s. Assuming roost habitat is one limiting factor for Townsend's big-eared bat, it is likely that the carrying capacity for the species actually increased in the historical mining districts of California with the advent of historical mining and construction of buildings, assuming that appropriate foraging habitat is maintained with a commuting distance of the roost . Most caves and mines could provide shelter for thousands of bats, but the foraging habitat will limit the population. It is unknown, however, to what degree the documented populations losses at natural roost sites of caves and large old trees with basal hollows have been offset by presumed historical population increases at manmade roost sites. Commercial caves throughout the state were developed prior to any surveys conducted for bats. Many of these old buildings and mines themselves have been subsequently impacted, and in many cases lost, since the historical period. Moreover, with the documented loss of approximately 95% of old-growth coastal redwood forest on California's North Coast (Fox 1989), it is likely that this region has suffered a substantial decrease in roost site and foraging habitat availability during the historical period.

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Comment [PB20]: Carrying capacity is more dependent on foraging habitat

Comment [PB21]: If an animal chooses a roost, it is habitat, although it may be manmade.

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In summary, CDFW considers loss, degradation, and disturbance at roost sites to be an important threat to Townsend's big-eared bat in California. Given the species' known susceptibility to disturbance, its reliance on roost sites with a relatively narrow range of suitability, and the colonial nature of the species, especially during the maternity season, it is possible that population-level or even statewide impacts could occur to the species from the loss or disturbance at relatively few roost sites.

Loss of Foraging Habitat (including water)

Loss of suitable foraging habitat has previously been identified as a threat to Townsend's big-eared bat (Pierson and Rainey 1998, Pierson and Fellers 1998; Brown and Berry 2003). Ideal habitat for foraging likely includes a mix of edge and continuous vegetation cover. Land management practices that create large openings of low shrub or grass cover in forest and woodland areas, such as agricultural development and extensive clear-cutting probably reduce foraging habitat suitability for the species. Likewise, residential and urban development reduce available foraging habitat. This is especially true in the extensive, highly-developed regions along California's South Coast and Bay Area. Although individual Townsend's big-eared bats may still make forays into these areas, it is unlikely that breeding populations could be supported in urbanized areas such as Orange County (S. Remington, Master's thesis).

It has been estimated that 95 percent of California's riparian habitat, which is important for foraging Townsend's big-eared bats, has been lost to vegetation clearing or conversion and inundation behind dams (Katibah 1984). Climate change, including the effects of protracted or severe drought, may also negatively affect foraging habitat suitability and insect prey availability, both through vegetation changes and reductions in free surface water availability.

In summary, CDFW considers loss of foraging habitat to be a potential threat to Townsend's big-eared bat in California.

White Nose Syndrome and other Disease

White Nose Syndrome (WNS) is a disease that has killed more than 6 million bats in eastern North America (USFWS 2012). It is caused by *Pseudogymnoascus destructans* (Pd), a cold-loving fungus that is thought to have been introduced into northeastern North America from Europe sometime in the early 2000s. The fungus grows in the skin and other tissues of hibernating bats and may affect multiple physiological systems of the bats during the winter period. The most obvious effect on hibernating bats is that infected individuals arouse from deep torpor much more frequently and for longer periods than non-infected bats, which drastically reduces the fat reserves needed to sustain the bats until insect prey is available in the spring. Most affected bats die of starvation, with mortality rates for some species (e.g., *Myotis lucifugus*, the little brown bat) approaching 100% in some eastern hibernacula[4].

WNS has not yet been detected in western North America west of Nebraska. Surveillance studies to sample for the Pd fungus have yet to detect it California (W. Frick 2012 pers. comm.). Pd has been detected from swabs taken from the fur of Townsend's big-eared bats in WNS-affected areas in the eastern United States, but so far WNS (the disease) has not been observed to manifest in the eastern subspecies (A. Ballmann 2015 pers. comm.). The western subspecies could be susceptible.

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Little is known about the occurrence of other diseases, such as rabies, in Townsend's big-eared bat. Based on recent submissions of bats to state and county public health test labs, there is nothing to suggest Townsend's big-eared bat populations in California have been subject to recent disease outbreaks (CDPH unpublished data 2015).

CDFW considers WNS an important potential threat to California populations of Townsend's big-eared bat. Based on observations in the eastern U.S., the species' susceptibility to the disease is unclear. Continued monitoring of hibernating bats (as at Lava Beds National Monument), surveillance for the fungal agent of WNS, and incorporation of measures to reduce the risk of introducing or transmitting the fungus to hibernation sites in California are all important measures to reduce the risk of WNS to California populations. CDFW does not consider other diseases such as rabies to be a threat to the Townsend's big-eared bat in California.

Environmental Contaminants

Environmental contaminants include both naturally occurring and human-generated toxins that may affect the health of plants or animals. Naturally occurring toxins, such as heavy metal minerals, sulfur oxides, ammonia, and carbon dioxide, generally do not naturally occur in sufficient concentrations to impact Townsend's big-eared bat populations and will not be addressed here. Human-produced toxins may be released or applied to the environment in many forms. Of greatest potential impact to

[4] https://www.whitenosesyndrome.org/

Townsend's big-eared bat are toxins used for control of agricultural and other pests (pesticides), byproducts of mining and ore processing, and air quality contaminants.

Pesticides. The California Department of Pesticide Regulation publishes an annual Pesticide Use Report for California (available at www.cdpr.gov). These reports provide information on the types, amounts, and general location of pesticides used each year in the state. According to the 2013 annual report (CDPR 2015), a total of about 88 million kg of all types of pesticides were applied in California. Figure 10 (based on data provided in CDPR 2015, Table 1), depicts the 2013 average application (kg/ha) of all pesticides for each county in California. Pesticide use appears to be greatest in the San Joaquin Valley, an area with relatively few recorded observations of Townsend's big-eared bat. However, as noted in the Petition, drift of agricultural pesticides is known to occur – for example, pesticide chemicals applied in the Central Valley have been detected in frogs living in the Sierra Nevada (Sparling et al. 2001).

The most recent Pesticide Use Report (PUR-2013, CDPR 2015), which reports annual pesticide use for many classes of pesticides, states "regression analyses on use from 1996 to 2013 do not indicate a significant trend of either increase or decrease in total pesticide use." However, inspection of the report's figures suggests that total use of certain classes of pesticides has decreased over the period 1995-2013, while others have remained roughly the same or increased. In particular, the most heavily used classes of pesticides (Fungicide/Insecticide, Insecticide) have shown a fairly marked decrease over the period (see Figure 1 of the PUR-2013). CDPR also tracks use of various pesticide chemical classes, including "reproductive toxicity" chemicals, carcinogens, cholinesterase-inhibiting chemicals (organophosphates and carbamates), groundwater-impacting chemicals, toxic air contaminants, fumigants, and biopesticides (microorganisms and naturally-occurring chemicals used in lieu of synthetic chemicals). Some classes, such as the "reproductive toxic" chemicals, cholinesterase-inhibiting chemicals, and groundwater-impacting chemicals, have clearly decreased in usage (see Figures 6, 7, and 8 of PUR-2013). Others, such as carcinogens (PUR Figure 6), air contaminants (PUR Figure 9), and Fumigants (PUR Figure 10) have varied somewhat over the years but do not show a trend in use. Biopesticides (PUR Figure 12) have shown a steady increase in use over the report period.

The extent pesticide use in California impacts Townsend's big-eared bat populations is unknown; however, it is likely that some Townsend's big-eared bat individuals, at least, are impacted where these toxins are concentrated, either by ingestion of prey (including the potential for bioaccumulation within prey or bat) or water contaminated by pesticides, or by absorption through the skin after contact with pesticides in the air or on surfaces. These impacts may result from both lethal and sub-lethal exposure effects on survival and reproduction. While it is encouraging that use of some of the most environmentally damaging pesticides has decreased over the past two decades, it is unknown what level of threat the current and future levels of application pose to Townsend's big-eared bat populations. The decrease in the insect prey of the bats by any kind of pesticides needs to be evaluated.

Mine Toxins. Mineral extraction can result in pools of water contaminated with toxic chemicals. Such toxic pools have long been recognized as a threat to wildlife, including bats that may drink from them (Clark and Hothem 1991). A CDFG warden found dead TBEB along the perimeter of an open cyanide leech pond in the Owen's Valley near Independence in the 1980s (P. Brown pers. comm.). The rising

price of gold in the 1980s led to the renewal of mining using cyanide leaching as an extraction method in gold fields previously considered depleted. See the section on Mining for more information on renewed mining). The research and publicizing of the threat to wildlife of open cyanide ponds resulted in greater attention to this problem by federal and state regulators (S. Reeves 2015 pers. comm.), as well as industry-led measures to reduce the environmental hazards associated with cyanide leach fields (SME 2014).

The "International Cyanide Management Code for the Manufacture, Transport, and Use of Cyanide In the Production of Gold" is an industry voluntary program for gold mining companies. It is intended to provide for the safe management of cyanide and cyanidation mill tailings and leach solutions. Companies that adopt the code must have their mining operations that use cyanide to recover gold audited by an independent third party to determine the status of code implementation. Those operations that meet the code requirements can be certified. The code was developed by a multi-stakeholder steering committee under the guidance of the United Nations Environmental Program and the International Council on Metals and the Environment (http://www.cyanidecode.org/about-cyanide-code#sthash.4jbDJ744.dpuf).

According to available information, the largest gold mines in California are certified under the code (S. Reeves 2015 pers. comm.). Although toxic leach fields and ponds remain a potential threat to Townsend's big-eared bat, CDFW believes that oversight of the mining industry by BLM, regional Water Quality Control Boards, and the California Geological Survey minimize the risks associated with mine toxins to an acceptably low level.

Air Quality. As described in the Petition, poor air quality on a local or regional basis may result from wildfires, human transportation, energy production and manufacturing activities, ground disturbance, and erosion and loss of native vegetation cover. Although it is reasonable to conclude that Townsend's big-eared bat (and bats in general) may be affected by poor air quality due to their high metabolic rate when active, CDFW is not aware of any research indicating an impact of air pollutants in bat populations in California.

Climate Change

As described in CDFW's document outlining the agency's plans to address climate change (CDFG 2011), "a growing body of scientific research indicates California's remarkable diversity of habitats and wildlife is threatened by climate change. Ecological changes, including changes in species' distributions, timing of life cycles, and abundance, have already occurred in California over the past century in concert with increases in average temperature and changes in precipitation patterns (California Natural Resources Agency 2009). Existing stressors such as wildfires and associated foraging habitat loss, human population growth and associated land use changes, water management conflicts, invasive species, and other widespread stressors will be exacerbated by climate change, and could increase negative impacts to ecosystems beyond the effects of individual stressors."

To assess the potential for future climate change to affect the distribution of Townsend's big-eared bat, Stewart (J. Stewart, unpublished data) conducted MaxEnt modeling using climatic variables to model the

current and possible future distribution of the species under several projections of future climate during the period 2070 to the end of the 21st Century. This method uses the concept of a "climate envelope", the geographic area with a climate suitable for a species' survival. Such "envelopes" are generally expected to move up in elevation and north in latitude in the future with a warming climate.

The best predictors of Townsend's big-eared bat distribution in California were temperature and snowpack, with average amount of snowpack providing the most parsimonious model – that is, the species is less likely to occur in areas with greater snowpack (J. Stewart 2015 pers. comm.). Under four different future climate change projections (generally described as Warm-Wet and Hot-Dry) and two greenhouse gas emission scenarios (High and Low), Townsend's big-eared bat is projected to fare reasonably well, in terms of availability of climatically suitable habitat in California (see Figure 11). Although under some scenarios the species' suitable range is projected to retract in some areas (red areas in the figure), most of the currently-suitable modeled habitat is projected to remain suitable. Some areas, notably in the northern and higher elevations areas of the state, are projected to increase in suitability in the future. Under the worst-case scenario for Townsend's big-eared bat, 88% of current known locations for the species are projected to remain suitable. Other scenarios indicated 90% to 95% of current locations would remain suitable.

Comment [PB23]: There is no data to support this since it is almost impossible to survey bats hibernating in the winter in areas with great snowpack.

Comment [PB24]: The conclusion needs more substantiation than a pers. comm.

Mining

California has a long history of mining due to its variety of mineral and geologic resources. California ranked second nationwide in production of minerals other than fossil fuels (Department of Conservation 2000). Starting even before the Gold Rush era of the mid-1800s, tens of thousands of mines have been excavated in the state. The Abandoned Mine Lands Unit (AMLU) of the California Department of Conservation (Department of Conservation 2009) estimates that there are approximately 47,000 abandoned mine sites in California. Although mines exist throughout the state, the majority of these mines are concentrated in the desert regions and western Sierra Nevada foothills (see Figure 12). Approximately two-thirds of abandoned mine sites are on federal land, 31% are on private land, and 2% are on state and local government land.

Comment [PB25]: Who is Stewart---not a bat biologist

Comment [PB26]: Not the same species

Comment [PB27]: The current drying of springs and riparian systems for foraging habitat for all bats, plus the loss of roosting and foraging habitat due to wildfires is due to climate change and it is significant and will be more so.

Deleted: Stewart (2015 pers. comm.) suggests these results are not surprising, given the generally wide distribution of Townsend's big-eared bat in California, as well as its broad distribution in North America, including south through much of Mexico to the edge of the tropics. While such modeling may not accurately or precisely predict future habitat suitability for a species, and additional work is needed to ensure that future climate does not substantially impact Townsend's big-eared bat (for example, though loss of surface water and suitable foraging habitat, or de-coupling of suitable roost site structures from suitable climate areas), at this time CDFW has determined that climate change

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Comment [PB28]: I think since 2000, AZ and NV are above CA.

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Comment [PB29]: No bat surveys required for closure

Mines provide important shelter for Townsend's big-eared bat and other bat species that evolved to roost in natural caves and crevices. Historic underground mining has created habitat for bats and other wildlife. Eighty percent of the mines in the western U.S. show some evidence of bat activity (Tuttle and Taylor 1998). Mines may be used by Townsend's big-eared bat year round for their roosting needs. These include critically important maternity and hibernation seasons. Large, structurally diverse mines may provide both warm roosts for maternity colonies and the cool or cold temperatures during hibernation (Pierson and Fellers 1998, Pierson and Rainey 1991, 1998; Pierson et al. 1999).

Mines may also offer prey such as moths and other insects and open water for drinking in chambers that intercept ground water. Such water resources are especially important in desert regions where surface water may be uncommon.

Because of the importance of historical and abandoned mines to Townsend's big-eared bats, several management issues related to mines and mining may pose a threat to the species. These include:

closure of mines (either due to natural erosion or intentional for hazard abatement), renewed mining, environmental contamination, and human disturbance at mine roosts. The latter two topics are discussed elsewhere in the Threats section of this report.

Abandoned Mine Lands (AML) programs are tasked with the closure of open mines hazardous to human safety. To determine the appropriate closure method at a mine, it is necessary to determine through surveys what species may be using the mine. Permanent abandoned mine closure methods have resulted in the destruction of roosting habitat and have also caused direct mortality of bats by trapping them within the closed mine without exclusion at the appropriate season (Brown 1995b; Altenbach and Pierson 1995). Bat conservationists have advocated for assessment and planning for the appropriate mine closure method (fences, bat gates, cupolas, large grates) that allow bats to pass through openings too small for humans, while maintaining air flow patterns crucial for internal habitat conditions (Sherwin *et al.* 2009). Not all mine closure techniques presumed to be bat friendly are accepted by TBEB. Recent installation of two corrugated culverts with inserted angle iron bars in the Bishop BLM FO resulted in the abandonment by the maternity colony of TBEB of one mine and the use of an alternate traditional gated entrance by another. A similar event of roost abandonment appears to have happened at a maternity colony in the Gem Mine in the Panamint Mountains in Death Valley National Park after culvert installation (P.Brown pers. obs.) Whereas bats will fly through smooth- walled culverts, the corrugation appears to interfere with echolocation (Brown and Simmons 2015; Simmons and Brown 2015). Unfortunately, this has been the closure method of choice for some agencies, especially the Forest Service.

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California's Department of Conservation has an AML unit that is actively engaged in reducing the hazards associated with open mines. It works with state and private mine owners to ensure that wildlife-compatible closure methods are implemented. It also coordinates with federal land management agencies for closures on BLM and other federal lands. See http://www.conservation.ca.gov/omr/abandoned_mine_lands for more information on AML issues in California.

Modern methods of mineral extraction have allowed mining companies to renew mining in historical areas previously abandoned. For example, the use of chemical extraction methods for gold from open pit mines often occurs directly in areas with abandoned shaft mines. Renewed mining in historical mine districts has the potential to impact Townsend's big-eared bat and other bat species where the modern mine obliterates the previous underground mine (Pierson et al. 1991). One of the largest maternity colonies in the California desert was removed at the Briggs Mine in Inyo County (Brown pers comm). In addition, renewed mining may impact native vegetation and water sources used for foraging around the mine, and may introduce chemical contaminants used for mineral extraction to the environment. See the section on Environmental Contaminants for more information on this aspect of mining impacts to bats.

In summary, CDFW considers the impacts associated with mine closures and renewed mining to be important potential threats to Townsend's big-eared bats. Active AML programs at the state and federal level should minimize the threat of mine closures to sensitive species. Environmental review of proposed mining projects through CEQA and NEPA should ensure adequate assessment and disclosure of potential impacts to Townsend's big-eared bat of such projects. Provided such programs are adequately funded by state and federal agencies, it is likely that population-level impacts associated with legacy mines and renewed mining may not occur. However, there is less certainty that important roost sites and Townsend's big-eared bat populations would be adequately protected in the absence of a listing of the species as threatened or endangered, especially if the price of gold and other minerals increases as it did a decade ago, and more renewed mining in historic districts becomes economically feasible. A population of TBEB will be impacted by the recently permitted Golden Queen Mine at Soledad Mountain near Mojave, CA. No adequate mitigation is in place that might mitigate for impacts or ensure survival of that population.

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Overexploitation (for Scientific Use)

As a nongame mammal (defined in Fish and Game Code section 4150), Townsend's big-eared bat is not harvested or collected for commercial or personal use. Collection of Townsend's big-eared bat does occur in California on a limited basis for bona fide scientific and educational purposes. Such collection is regulated according to Fish and Game Code (sections 1002 *et seq*.), which is administered by CDFW.

In the past, scientific collections were made on a much greater scale than occurs today. The mammal collections at the Museum of Vertebrate Zoology, Los Angeles County Museum of Natural History, and at many other museums and universities in the western U.S. were established through the lethal taking of representative specimens of California's mammalian fauna. Such collections remain an important resource for scientific investigations of the phylogeny, evolution, taxonomy, diet, morphology, physiology of California's fauna (Pyke and Ehrlich 2010).

For long-lived/low fecundity species such as Townsend's big-eared bat, it is possible that repeated scientific collection may have a population impact. As documented by Brown et al. (1994), the Townsend's big-eared bat maternity colony at Prisoners Harbor (Santa Cruz Island) was subjected to three collecting episodes over a period of 25 years in which a total of 246 individuals were taken. The Santa Cruz Island colony, which apparently numbered "more than" 300 individuals (which probably included both adult females and their young) in 1939, has never recovered to its historical size, though other impacts, including roost loss and disturbance have been contributing factors.

Non-collecting scientific study may also impact Townsend's big-eared bat populations through disturbance of roosts. Before Townsend's big-eared bat's susceptibility to roost site disturbance was well documented, Pearson et al. (1952) conducted investigations of the basic ecology and reproductive biology of Townsend's big-eared bat in California. These studies included occasional entry into maternity and hibernation roosts at multiple sites around California to collect information and to place wing-bands on bats. In one case, the authors banded 75 young Townsend's big-eared bats during the early night while the adult females were foraging. By the next morning, the young had been carried by their mothers to another roost site, presumably in response to the disturbance at the original roost site

(Pearson et al. 1952). The authors did not document whether there was an impact in terms of growth or survival of the young from this disturbance event.

Placement of wing bands on bats is a long-standing method used to mark individual bats (Barclay and Bell 1988, Gannon et. al. 2007). Recapture of banded bats can provide information on movements, survival, and population size. Based on available information, it appears Townsend's big-eared bat does not handle wing-banding as well as other bat species. Ellison (2010) summarized results from her own and others' studies suggesting a relatively high proportion of banded Townsend's big-eared bat suffer from perforated wing membranes, scarring, tissue-swelling, infection, and irritation. Moreover, the banding activity may have disturbed some individuals sufficiently to cause them to move to different roost sites (Ellison 2010).

Because of the concerns related to over-collection, disturbance at roosts, and wing-banding, CDFW carefully controls the activities of scientific researchers working on Townsend's big-eared bat in California. All persons who may take[5] Townsend's big-eared bat for scientific or educational purposes are required to possess a current Scientific Collecting Permit and, while a candidate for listing, a CESA Memorandum of Understanding issued under the authority of Fish & G. Code § 2081(a). Among the standard conditions of research permits are: a prohibition on entry into known roost sites (unless specifically authorized for a particular study), immediate departure from sites discovered to be maternity roosts, and measures to minimize the risk of introducing the fungus that causes White Nose Syndrome to hibernacula. Wing-banding is not currently authorized for any researcher working on Townsend's big-eared bat. No collection of Townsend's big-eared bat specimens is currently authorized for any individual. Prior to Townsend's big-eared bat's designation as a Candidate for listing, Scientific Collecting Permits that authorized work with Townsend's big-eared bat had similar provisions for the protection of Townsend's big-eared bat individuals and populations.

Given the level of control exerted by CDFW on scientific researchers working with bats, overexploitation for scientific purposes is not considered to be a threat to the continued existence of Townsend's big-eared bat in California.

Habitat Essential for Continued Existence of the Species (FISH & G. CODE § 2074.6)

In 1952, after intensive study of Townsend's big-eared bat at several maternity and hibernation roosts at both coastal low elevation sites and interior high-elevation sites, Pearson and his co-authors considered factors that may be limiting Townsend's big-eared bat populations in California. They dismissed predation as a limiting factor, as they had never observed a predation event or evidence of such, nor were they aware of any important natural predators of Townsend's big-eared bat.[6] Disease was likewise

[5] "Take" is defined in Fish and G. Code §86 as "to hunt, pursue, catch, capture, or kill" or to attempt to do so.

[6] But see Fellers's 2000 report of black rats, *Rattus rattus*, preying upon non-volant young Townsend's big-eared bat at the Randall House maternity roost, as well as his description of the possible effect of owl presence on roost departure times of Townsend's big-eared bat at the same site (Fellers 2014).

discounted in importance due to lack of observation. Pearson et al. (1952) considered the availability of food and water as a possible limiting factor, but could not address this factor given a lack of data on prey availability. Regarding roost site availability, the authors noted that each maternity and hibernation roost site in their study seemed large enough to house many more Townsend's big-eared bat individuals than were observed. They reasoned that at the local scale food or water may be limiting, but on a regional scale appropriate roost sites may be limiting the total population size. Appropriate roost sites not only must have suitable size and other structural and microclimate characteristics, but also must be near suitable foraging habitat, including safe and accessible sources of open water for drinking.

Comment [PB30]: Many bats including TBEB are found in the middle of the desert away from any open water in commuting distance. Most desert bats get sufficient metabolic water from insect prey. Large maternity colonies of TBEB are usually found near riparian areas with increased insects, whether or not there is open water (i.e. not covered by vegetation).

With these considerations in mind, and with the apparent loss of historical roost sites documented by Pierson and Rainey (1998) and others, and the expected continued degradation and loss of old buildings suitable for use as roost sites (Fellers and Halstead 2015, G. Tatarian 2014 pers. comm.), CDFW considers any structure, or set of structures, used by Townsend's big-eared bat as a maternity or hibernation roost to be habitat essential for the continued existence of the species. The essential characteristics of these suitable roost sites extend to the nearby foraging, commuting, and night-roosting habitat and therefore these adjacent habitats are also considered essential.[7]

It may be possible on a case-specific basis to identify alternative or replacement roost structures, or set of structures (to allow for roost-switching), and adjacent habitat that would serve a local Townsend's big-eared bat population. The suitability of such alternative or replacement roost sites would need to be demonstrated (through comparable use by the local Townsend's big-eared bat population) prior to considering any occupied roost unnecessary for the population. CDFW is not aware of any replacement roost structure having been purpose-built for use by Townsend's big-eared bat, but this is a management action that should be explored on an experimental basis.

EXISTING MANAGEMENT, MONITORING, AND RESEARCH ACTIVITIES

CDFW

The California Department of Fish and Wildlife is the state trustee agency for fish, wildlife, and botanical resources. In addition to its current status as a Candidate for CESA listing, CDFW designates Townsend's big-eared bat as a Species of Special Concern (Williams 1986). The SSC designation does not confer any legal protection on the species, but rather is intended to ensure management, conservation, and research activities are implemented to prevent future declines and the need for listing under the California Endangered Species Act (Comrack et al. 2008). As an SSC, Townsend's big-eared bat is also

[7] In particular, as noted by Tatarian (2015 pers. comm.), structures used for roosting by single Townsend's big-eared bats in the vicinity of maternity roosts and hibernacula may be essential to allow population-level behaviors essential to reproduction. These behaviors include socialization between adult females and males in the fall leading to mating at mixed-sex overwintering roost sites, as well as fledging and dispersal of young at the end of the maternity season.

designated as a Species of Greatest Conservation Need (SGCN) in California's State Wildlife Action Plan (SWAP, CDFG 2007). This designation provides additional focus on the species by CDFW, as well as funding opportunities for research and conservation actions from the State Wildlife Grant program of the U.S. Fish and Wildlife Service.

As part of CDFW's general mission to monitor wildlife resources, known Townsend's big-eared bat roosts on CDFW lands (Wildlife Areas and Ecological Reserves) are monitored. This includes the maternity colony that occurs on the Chorro Creek Ecological Reserve in CDFW's Central Region. Through on-going monitoring, CDFW has documented the impact of human disturbance at this site and has implemented measures to reduce the threat of disturbance to the colony (R. Stafford 2014, 2015 pers. comms.).

Townsend's big-eared bat is currently a Candidate for listing as threatened or endangered under the California Endangered Species Act. As such, the prohibition on "take" of listed and candidate species of CESA applies to Townsend's big-eared bat. Regulatory programs of CDFW now review proposed CEQA, timber harvesting plans, and scientific research applications to ensure that no take of the species would occur, unless authorized by one of the statutory exemptions allowing such take, such as the Incidental Take Permit and Safe Harbor mechanisms of CESA, or through a Memorandum of Understanding for take for scientific or educational purposes. All such take may only be authorized if it is fully mitigated and would not jeopardize the continued existence of the species in California. As mentioned above, should the species not be listed then it would revert to the Species of Special Concern designation. SSCs typically receive some attention during CEQA review, but protection from take and population-level impacts is less certain. This applies not only to projects for which CDFW is the lead or responsible agency, but for CEQA projects for which other state agencies (such as CDPR and CalFire, see below) or counties or cities are the lead agency.

CDFW is currently implementing three projects relevant to Townsend's big-eared bat that are funded by the State Wildlife Grant (SWG) program. The California Bat Conservation Plan (CBCP) was initially funded by SWG in the mid-2000s and, after several years of development is now nearing completion, thanks in part to a new SWG to complete final edits. The CBCP addresses the management and conservation of all bat species occurring in California, including Townsend's big-eared bat, and will provide specific recommendations for the management, policy development, and research for all species, all ecoregions, and all the major conservation issues affecting bats in the state. Included in the CBCP is a relative ranking of the species for conservation concern – Townsend's big-eared bat consistently was rated by the authors as among the greatest concern bat species.

The second SWG-funded project directly addresses the current conservation status of Townsend's big-eared bat in California. Previously, the California Department of Fish and Game funded a statewide survey for Townsend's big-eared bat in the 1980s by Elizabeth Pierson and William Rainey (Pierson and Rainey 1998). The new statewide survey effort is being conducted over a two-year period and is targeting known and highly-suitable locations for maternity and hibernation roosts. This project is being contracted to researchers from Humboldt State University and Texas A&M University (Joe Szewczak and Michael Morrison) and should provide an updated snapshot of the species' distribution as of 2015-2017.

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SWG funding was also provided to CDFW to implement a project to expand bat monitoring in California according to the North American Bat Monitoring Program (Loeb et al. 2015). This project is initially focused on acoustic monitoring of bat activity around the state, which probably will not provide a lot of data on Townsend's big-eared bat due to its quiet echolocation calls. However, CDFW plans to increase efforts to monitor important roosts for this and other species in the future as the NABat program continues to develop.

CDPR

The California Department of Parks and Recreation manages state parks throughout California. As with other land management agencies, CDPR manages sensitive biological resources, such as Townsend's big-eared bat, both through review of proposed project impacts under the environmental review process, as well as through focused monitoring efforts at known roosts (such as at Hearst San Simeon State Historical Monument).

CalFire

The California Department of Forestry and Fire Protection (CalFire) is the lead agency in California for timber harvest projects on private and state forest lands. Timber harvest review is a CEQA-equivalent environmental review process and, as such, requires proposed timber management projects to assess and disclose potential impacts on the environment, including to biological resources. Since the designation of Townsend's big-eared bat as a candidate for listing under CESA, CalFire has been proactive in working with timber companies and registered professional foresters to ensure significant impacts to the species, as well as "take," are avoided.

NPS

The National Park Service lands in California include several known Townsend's big-eared bat roost sites, including the large number of caves at Lava Beds National Monument, the Randall House maternity colony at Point Reyes National Seashore, the hibernacula and maternity roosts at Pinnacles National Park, and the Scorpion Ranch maternity roost on Santa Cruz Island. In general, the NPS approach to sensitive biological resources, such as Townsend's big-eared bat and its habitat, is to survey, monitor, manage, and to conduct research on the species. However, on Santa Cruz Island, upper NPS management has considered the bats a "nuisance" as the main focus is preservation and interpretation of the historic buildings both at Prisoner' Harbor and Scorpion Landing. The bats have not been a conservation priority in the past. A listing by CDFW might encourage that TBEB management is considered.

In addition to the monitoring and management of the aforementioned sites, work by E.D. Pierson and others in Yosemite National Park (Pierson and Heady 1996, Pierson and Rainey 1997, and Pierson et al. 2006) provided baseline information on bat use of the Yosemite area, including on Townsend's big-eared bat (S. Stock 2014 pers. comm.).

BLM

The Bureau of Land Management designates Townsend's big-eared bat as a sensitive species. This designation requires land use plans to address the species and its habitat and to incorporate the species' needs in a manner to reduce potential conflicts with other multiple use activities. On BLM-administered lands, BLM manages a sensitive species and its habitat to minimize or eliminate threats affecting the status of the species or to improve the condition of the species' habitat. BLM assists, as funding allows, in determining distribution, abundance, and condition of the species, and to manage the habitat in such a manner to improve the conservation status of the species and ensure that BLM actions do not move the species towards needing to be listed (A. Fesnock 2015 pers. comm.).

However, BLM claimants conduct mining activities on BLM lands, and many of these claims include historic mines that shelter bats. The renewed mining activities, including entry into the mines, can disturb bats, especially Townsend's bi-eared bats. A paln of operation does not need to be filed on small mining claims. The BLM Washington and regional offices sends letters to claimants asking them to make the historic records safe and prevent human entry and reduce liability. These notices do not mention bats or other wildlife, nor do they recommend methods for mine safety closure (i.e. bat gates). Sometimes the mine portals are covered either temporarily or permanently without excluding bats (P. Brown pers. obs.)

Based on information gathered for this status review report (A. Fesnock 2015 pers. comm.), Townsend's big-eared bats are known to occur on BLM lands throughout much of California. As with other lands, most records for the species are from roost structures, including mostly abandoned mines. The BLM has an active survey and assessment program that evaluates abandoned mines for public safety hazards, wildlife and historical resources, and recommended closure methods. Evaluations of abandoned mines conducted over the past 15 years indicate many such mines are used by Townsend's big-eared bats. Few repeat visits or monitoring programs have been implemented, however, and therefore inferences about population status or trend cannot be made. Many of the BLM roost sites surveyed since 1999 are being re-visited as part of the current CDFW-funded statewide survey project.

All of the BLM field offices in California consider Townsend's big-eared bat roost sites (both hibernacula and maternity roosts) to be important resources to protect and manage. Many such sites have been gated in the past two decades to allow bats to use the sites without human disturbance (BLM unpublished data). The BLM expects to continue with gating abandoned mines to protect bat habitat and for public safety (A Fesnock 2015 pers. comm.). Hopefully the methods of mine closure will not include corrugated culverts.

USFS

The U.S. Forest Service in California lists Townsend's big-eared bat on its Regional Foresters Sensitive Species list. As such, the species is given almost as much protection as a species listed as threatened or endangered under the federal Endangered Species Act (L. Angerer 2015 pers. comm.). USFS projects and management actions are evaluated to ensure project effects do not put the species on a trend towards endangered or threatened status.

In particular, the USFS completes Biological Evaluations for all Sensitive Species prior to implementing projects and management actions. Each Biological Evaluation includes management recommendations for the Sensitive Species. In general, Townsend's big-eared bat colonies are protected. When a project is proposed that may impact a roost site (such as a mine closure or historical building removal) measures are implemented to replace the lost structure or to improve the use of the structure by bats after project completion.

Most known Townsend's big-eared bat roost sites on Forest Service lands are not consistently monitored (though with some exceptions, such as the Kentucky Mine colony in the Sierra National Forest). The overall strategy implemented by the USFS has been to protect and avoid impacts (L. Angerer 2015 pers. comm.). However, many of the mine closures use corrugated culverts since mine portal stability has been an issue on steep and wet hillsides. Without good pre and post closure surveys, the impact to theTownsend's bat populations is not known (P. Brown, pers. obs.).

SUMMARY OF LISTING FACTORS (14 California Code of Regulations 670.1)

CESA directs CDFW to prepare this report regarding the status of Townsend's big-eared bat based upon the best scientific information available to CDFW. CESA's implementing regulations identify key factors that are relevant to the CDFW's analyses. Specifically, a "species shall be listed as endangered or threatened ... if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors: (1) present or threatened modification or destruction of its habitat; (2) overexploitation; (3) predation; (4) competition; (5) disease; or (6) other natural occurrences or human-related activities." (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A)).

The definitions of endangered and threatened species in the Fish and G. Code provide key guidance to CDFW's scientific determination. An endangered species under CESA is one "which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease" (Fish & G. Code, § 2062). A threatened species under CESA is one "that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by [CESA]" (*Id.*, § 2067).

The following summarizes CDFW's determination regarding the factors to be considered by the Commission in making its decision on whether to list Townsend's big-eared bat. This summary is based on the best available scientific information, as presented in the foregoing sections of the report.

Present or threatened modification or destruction of its habitat

Disturbance, degradation, and loss of suitable roost sites is a recognized threat to Townsend's big-eared bat populations, both in natural roost sites such as large, old trees and caves, as well as in manmade roosts such as old buildings and mines. Although there are some recent examples of roost protection compared to the historical period, lacking the protections of CESA it is possible the species could be impacted at multiple roost sites in the future, which could lead to population-level impacts.

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Comment [PB31]: I'm not sure what this statement is based on as there are more human disturbances, especially as relates to mine entry for recreational purposes and the installation of culverts in known roosts.

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Additionally, although impacts to foraging habitat could also affect the species, there is no current indication that impacts to foraging habitat poses a significant threat at this time. Therefore, CDFW does not consider modification and destruction of habitat to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Comment [PB32]: What is this statement based on? Look at declines in mining areas on NPS, DOD, BLM , FS roosts.

Deleted: However, there is no current indication disturbance of roost sites is a significant threat at this time

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Comment [PB33]: Loss of foraging habitat due to wildfires, habitat conservation along the LCR, continues sub urbanization. etc. There have been no scientific studies to indicate that there is not modification and destruction of habitat

Comment [PB34]: I do not agree. Absence of evidence of impacts is not evidence of absence . It just means that the research has not been done .

Overexploitation

CDFW does not consider overexploitation to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Predation

CDFW does not consider predation to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Competition

CDFW does not consider competition to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Disease

White Nose Syndrome is an important potential threat to Townsend's big-eared bat in California. Monitoring and research to determine the species' susceptibility to the disease as well as its occurrence in western North American are needed to assess the actual level of this threat. As discussed above, however, this disease is not currently impacting Townsend's big-eared bat in California. Therefore, CDFW does not consider disease to be a significant threat to the continued existence of the Townsend's big-eared bat in California. However, with the recent case of WNS in Washington, mointoring TBEB hibernacula is important, since the Western subspecies may not be resistant to the fungus. Since throughout much of California, the hibernation sites for this species have not been identified (and may be in inaccessible areas in the mountains), monitoring population size at maternity colonies could be the most effective means of determining if the bats are being killed during hibernation.

Other Natural Events or Human-Related Activities

Mining (including renewed mining), agricultural development and pesticide use, restoration or demolition of old buildings and other anthropogenic structures used as roosts, forest management, and recreational caving and mine exploration all have the potential to impact Townsend's big-eared bat populations. State and federal environmental review programs typically include assessment and disclosure of potential impacts to the species in the CEQA/NEPA process. Adequate environmental review should prevent such activities from affecting Townsend's big-eared bat at the population or statewide level.

Climate change, especially more frequent and severe drought, has the potential impact Townsend's big-eared bat in California. Continued and increased monitoring of the species' abundance and distribution should help determine the actual impact of these threats to the species.

MANAGEMENT RECOMMENDATIONS

These recommendations were developed by CDFW in accordance with the requirements of Fish & G. Code, § 2074.6. This list includes some recommendations developed by other authors, including Johnston (2004), Ellison et al. (2003), Tigner and Stukel (2003), Hinman and Snow (2003), and Bradley et al. (2006). CDFW recommends these actions be implemented regardless of the Commission's decision on listing Townsend's big-eared bat as threatened or endangered. This list includes recommendations for actions that could be undertaken by CDFW as well as by other public agencies, non-governmental organizations, and private land owners.

Research and Monitoring Needs

- Complete statewide population assessment of Townsend's big-eared bat by 2017.
- Implement consistent long-term monitoring at representative Townsend's big-eared bat roost sites in California. Monitoring of maternity colonies may be the test way to determine declines due to WNS or human disturbance.
- Design and test manmade structures suitable for use by Townsend's big-eared bat during the maternity and hibernation seasons.
- Create standardized procedures for monitoring Townsend's big-eared bat populations. Ensure all such studies will not adversely impact the subject populations.
- Conduct additional analyses of the possible effects of climate change and drought on Townsend's big-eared bat and determine best approaches to address possible adverse effects.
- Conduct research on the role environmental contaminants play in the health of Townsend's big-eared bat populations.
- Develop methods to create basal hollows in suitable large old trees.
- Conduct genetic studies to determine the population genetic structure of Townsend's big-eared bat in California, with special attention to the degree of divergence and isolation of populations on Santa Cruz Island relative to the mainland and between coastal and interior populations.

CDFW Administrative Actions

- If results of current statewide Townsend's big-eared bat survey indicate a decline in the population status is occurring that may lead to endangerment, prepare a staff recommendation to list the species as Threatened or Endangered for consideration by the Fish and Game Commission.
- Working with partners at state and federal agencies, as well as private landowners, ensure that management of Townsend's big-eared bat roost sites is consistent with continued site occupancy at or above existing population levels.
- Attempt to secure new funding and position resources as a priority to establish a full-time permanent bat specialist position within the Nongame Wildlife Program of CDFW to address data assimilation and conservation of bats in California, including Townsend's big-eared bat.
- Support research on the design and effectiveness of manmade structures suitable for use by Townsend's big-eared bat during the maternity and hibernation seasons.

Comment [PB35]: This may not give data on population trends, just presence or absence.

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- Create interagency and other stakeholder cooperation in, and public support for, conservation efforts for Townsend's big-eared bat. Partner with non-governmental organizations such as Bat Conservation International, The Nature Conservancy, and local NGOs in such efforts.
- Develop greater awareness of Townsend's big-eared bat and other bat conservation and management issues within CDFW.
- Direct fiscal and position resources to complete the draft California Bat Conservation Plan.

Management of Known Roost Sites

- Prior to changing management of caves, mines, or buildings that could be used by Townsend's big-eared bat or other bat species, such sites should be evaluated and/or surveyed during appropriate seasons for their use by Townsend's big-eared bat.
- Existing roosts should be left undisturbed and occupied roosts should only be entered for management or research purposes.
- Bat-friendly gates should be installed at Townsend's big-eared bat roosts where other methods of controlling human entrance are not effective. Special consideration should be given to gate design to minimize risk of injury or unsuitability for Townsend's big-eared bat. Corrugated culverts should not be used.
- Abandoned mines suitable for use by Townsend's big-eared bat should not be collapsed or closed in a manner to prevent bat use. If renewed mining will close a mine, mitigation for replacement habitat should be in place. This mitigation should be tracked by the government agencies (CDFW, BLM, etc) toensure that it is carried out and effective.
- Effectiveness monitoring (use of data loggers to passively record bat use and human disturbance) should be implemented at gated roost sites and other roost sites actively managed for bat resources (as through signage, information for visitors, etc.).
- Ensure foraging habitat, including access to riparian habitat , within the vicinity of maternity roosts remains suitable for use by Townsend's big-eared bat. Analysis of habitat suitability should be made on a site-specific basis, but start with using the area within a 24-km radius of the roost site.
- Where a Townsend's big-eared bat or other bat roost site has a history of recreational use by humans, implement a management plan to ensure new impacts from human use do not occur. The Kentucky Mine Stamp Mill management plan (Tierney and Freeman 2007) is a good example of such a plan that appears to be successful. The CDFW should encourage the NPS on Santa Cruz Island to protect the colony at Scorpion Anchorage.

Landscape Management Practices

- Developed springs and other water sources should be kept available for in-flight drinking as outlined in various "wildlife-friendly" water facility publications.
- If protracted drought poses a threat to Townsend's big-eared bat, develop additional water sources for drinking in areas where open water limits population size.
- Restore or enhance riparian habitat.

Comment [PB36]: Bats don't necessarily need water for drinking, but riparian areas have better insect prey assemblages.

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Comment [PB37]: Other shapes may be needed after surveys are conducted, for example, Idionycteris (Brown and Berry 2004) traveled 40 km from roost in a fan-shaped pattern with roost at apex.

Comment [PB38]: There is no evidence that open water or the lack limits population size. The insect prey density and diversity is greatest in riparian systems, but often the water is not opened and is covered by vegetation, preventing access for drinking by bats.

- Implement basal hollow creation projects to increase opportunities for Townsend's big-eared bat to use tree roosts in coastal redwood forests (and possibly in interior forests where large tree species, such as giant sequoia, have the potential to serve as roost sites)

CEQA Review of Proposed Projects

- Ensure direct and cumulative impacts from projects proposed under CEQA and CEQA-equivalent regulatory programs are not likely to result in a substantial reduction in population or range of Townsend's big-eared bat and other bat species.

Public Education and Outreach

- Conduct and cooperate with other agencies on public outreach events about Townsend's big-eared bat and other bat species.
- Disseminate the California Bat Conservation Plan to the public, when complete.
- Encourage citizen participation, as appropriate, in bat monitoring projects.
- Promote bat-friendly exclusions where it is necessary to remove bats from buildings and other structures. Seasonal use of the roost needs to be considered in the timing of exclusions.

Health and Disease

- Continue and expand surveillance for WNS by state and federal agencies and researchers. This could include the monitoring of the size of hibernacula (Lava Tubes NP) and maternity colonies.
- Support research on the etiology and epidemiology of WNS on *Corynorhinus* species, including Townsend's big-eared bat.
- Continue and expand, if necessary, decontamination requirements for persons entering hibernacula for Townsend's big-eared bat and other hibernating bat species to minimize the risk of introducing the fungus that causes WNS. Fungal spores can also be carried into maternity colonies and picked up by bats at other seasons than winter.
- Work with other state and federal regulatory agencies to prevent the introduction of environmental contaminants that may affect the health of Townsend's big-eared bat and other bats. These may include aerial pesticide application and chemicals used in processing mined minerals.

LISTING RECOMMENDATION

CESA directs CDFW to prepare this report regarding the status of Townsend's big-eared bat in California based upon the best scientific information. CESA also directs CDFW based on its analysis to indicate in the status report whether the petitioned action is warranted. (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).) CDFW includes and makes its recommendation in its status report as submitted to the Commission in an advisory capacity based on the best available science. In consideration of the scientific information contained herein, CDFW has determined that the petitioned action is or is not warranted at this time.

PROTECTION AFFORDED BY LISTING

It is the policy of the State to conserve, protect, restore and enhance any endangered or any threatened species and its habitat (Fish & G. Code, § 2052.). If listed as an endangered or threatened species, unauthorized "take" of Townsend's big-eared bat will be prohibited, making the conservation, protection, and enhancement of the species and its habitat an issue of statewide concern. As noted earlier, CESA defines "take" as to hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill. (*Id.*, § 86.) Any person violating the take prohibition would be punishable under State law. As to authorized take, the Fish & G. Code provides CDFW with related authority under certain circumstances. (*Id.*, §§ 2081, 2081.1, 2086, 2087 and 2835.) In general and even as authorized, however, impacts of the taking on Townsend's big-eared bat caused by the activity must be minimized and fully mitigated according to State standards.

Additional protection of Townsend's big-eared bat following listing is also likely with required public agency environmental review under CEQA and its federal counterpart, the National Environmental Policy Act (NEPA). CEQA and NEPA both require affected public agencies to analyze and disclose project-related environmental effects, including potentially significant impacts on endangered, rare, and threatened special status species. Under CEQA's "substantive mandate," for example, state and local agencies in California must avoid or substantially lessen significant environmental effects to the extent feasible. With that mandate and CDFW's regulatory jurisdiction generally, CDFW expects related CEQA and NEPA review will likely result in increased information regarding the status of Townsend's big-eared bat in California as a result of, among other things, updated occurrence and abundance information for individual projects. Where significant impacts are identified under CEQA, CDFW expects required project-specific avoidance, minimization, and mitigation measures will also benefit the species. State listing, in this respect, and required consultation with CDFW during state and local agency environmental review under CEQA, would also be expected to benefit the species in terms of related impacts for individual project that might otherwise occur absent listing.

Listing Townsend's big-eared bat increases the likelihood that State and federal land and resource management agencies will allocate funds towards protection and recovery actions. Funding for species recovery and management is limited, however, and there is a growing list of threatened and endangered species.

ECONOMIC CONSIDERATIONS

CDFW is charged in an advisory capacity in the present context to provide a written report and a related recommendation to the Commission based on the best scientific information available regarding the status of Townsend's big-eared bat in California. The topic areas and related factors CDFW is required to address as part of that effort are biological and not economic. (See Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).)

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Townsend's big-eared bat CESA Status Review – Figures

Captions

1. Map showing geographic ranges of species and subspecies of North American long-eared bats as described by Handley (1959). Adapted from Piaggio and Perkins (2005, Figure 1).

2. COTO CWHR geographic range map, with occurrence locations.

3. COTO CWHR range map, with occurrence locations symbolized by time period.

4. Locations mentioned in the Population Trend section.

5. From Fellers and Halstead (2014, Figure 1). (A) Attempts to break into the Randall House, site of a *Corynorhinus townsendii* roost at Point Reyes National Seashore, California. (B) Annual number of adults (maximum count during May or June) and total *C. townsendii* (adults plus volant young; maximum count during July or August) emerging from roost at Point Reyes National Seashore.

6. COTO exit count data at Kentucky Mine maternity colony (Sierra County), 1996 - 2005. A. All counts. B. Early maternity season counts (before late July), without counts when the colony likely roosted elsewhere. C. Late maternity season counts (late July and later), without counts when the colony was likely roosting elsewhere. (source: Marilyn Tierney, unpublished data, and Freeman 2012).

7. From Weller et al. (2014, Figure 2). Estimated trend (solid line), upper and lower 95% prediction intervals (dotted lines), and number of Townsend's bigeared bats (*Corynorhinus townsendii*) counted (solid circles) during hibernacula surveys at 22 caves in Lava Beds National Monument, Siskiyou County, California, during 1991–2012. Caves are ordered top left to bottom right as largest to smallest observed counts.

8. From Weller et al. (2014, Figure 4). Estimates, with 95% prediction intervals, for the total number of Townsend's big-eared bats (*Corynorhinus townsendii*) hibernating in 52 caves at Lava Beds National Monument, Siskiyou County, California, during 1991–2012. The total number of caves surveyed each year is denoted as n on the x-axis.

9. Late summer (August – mid-September) exit counts for the COTO maternity colony site at Hearst San Simeon State Park, 2000 – 2014 (R. Orr, pers. comm.). For years with more than one count was conducted during the late summer season, the date with the highest count is depicted.

10. Average application of pesticides (kg/ha) for California counties, 2013, plotted with Townsend's big-eared bat occurrence locations.

11. Current and future projected climatically-suitable areas for Townsend's big-eared bat in California (J.Stewart, unpublished data) under four projections of future climate. Climatically-suitable areas were modelled using MaxEnt and existing occurrence records. For the period 2070-2099, areas shown in dark blue remain suitable, areas shown in red are suitable under current climate conditions but are projected to become unsuitable, and areas in light blue are modelled as currently unsuitable but would become suitable in the future.

12. California abandoned mines.

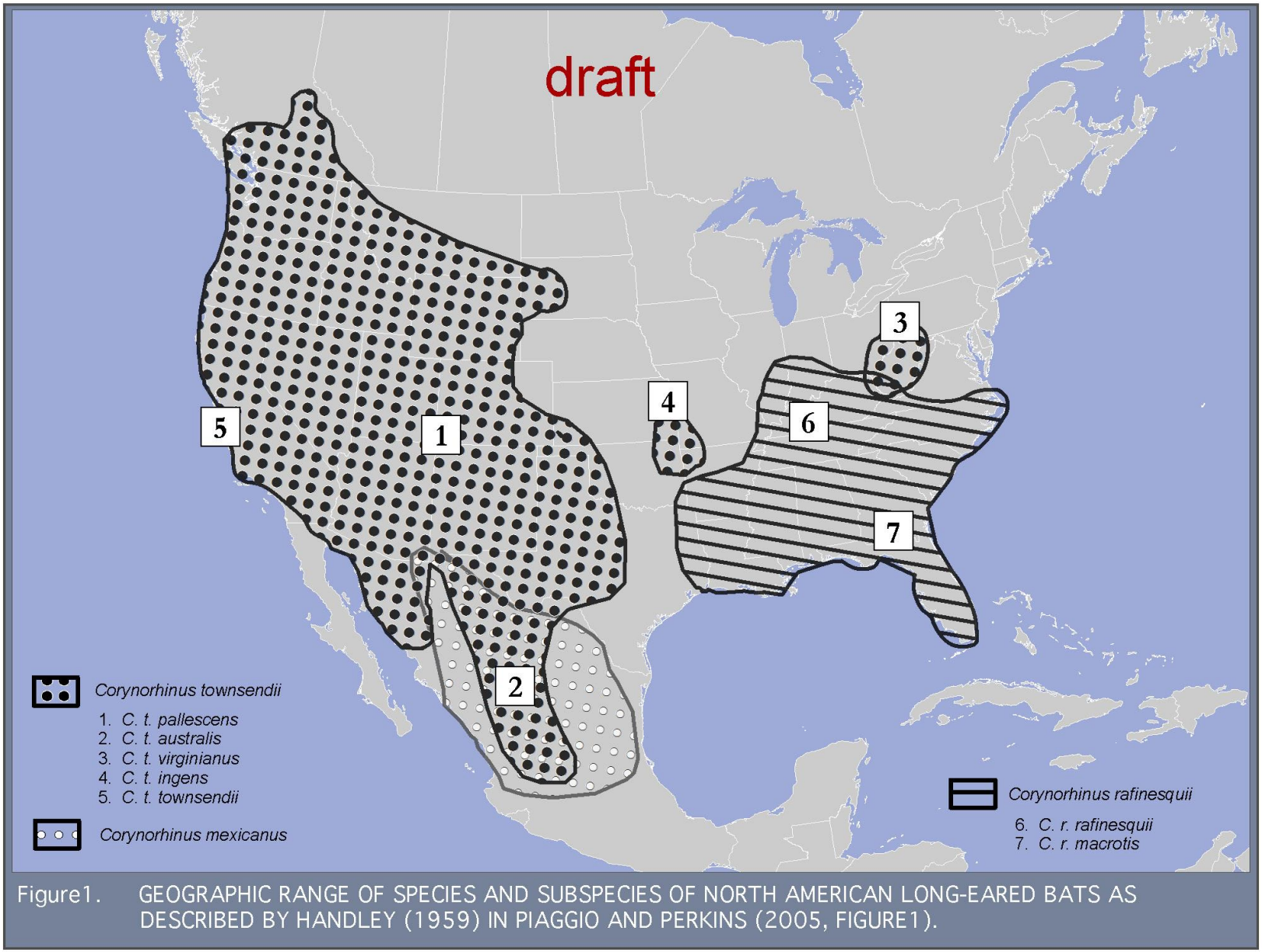


Figure1. GEOGRAPHIC RANGE OF SPECIES AND SUBSPECIES OF NORTH AMERICAN LONG-EARED BATS AS DESCRIBED BY HANDLEY (1959) IN PIAGGIO AND PERKINS (2005, FIGURE1).

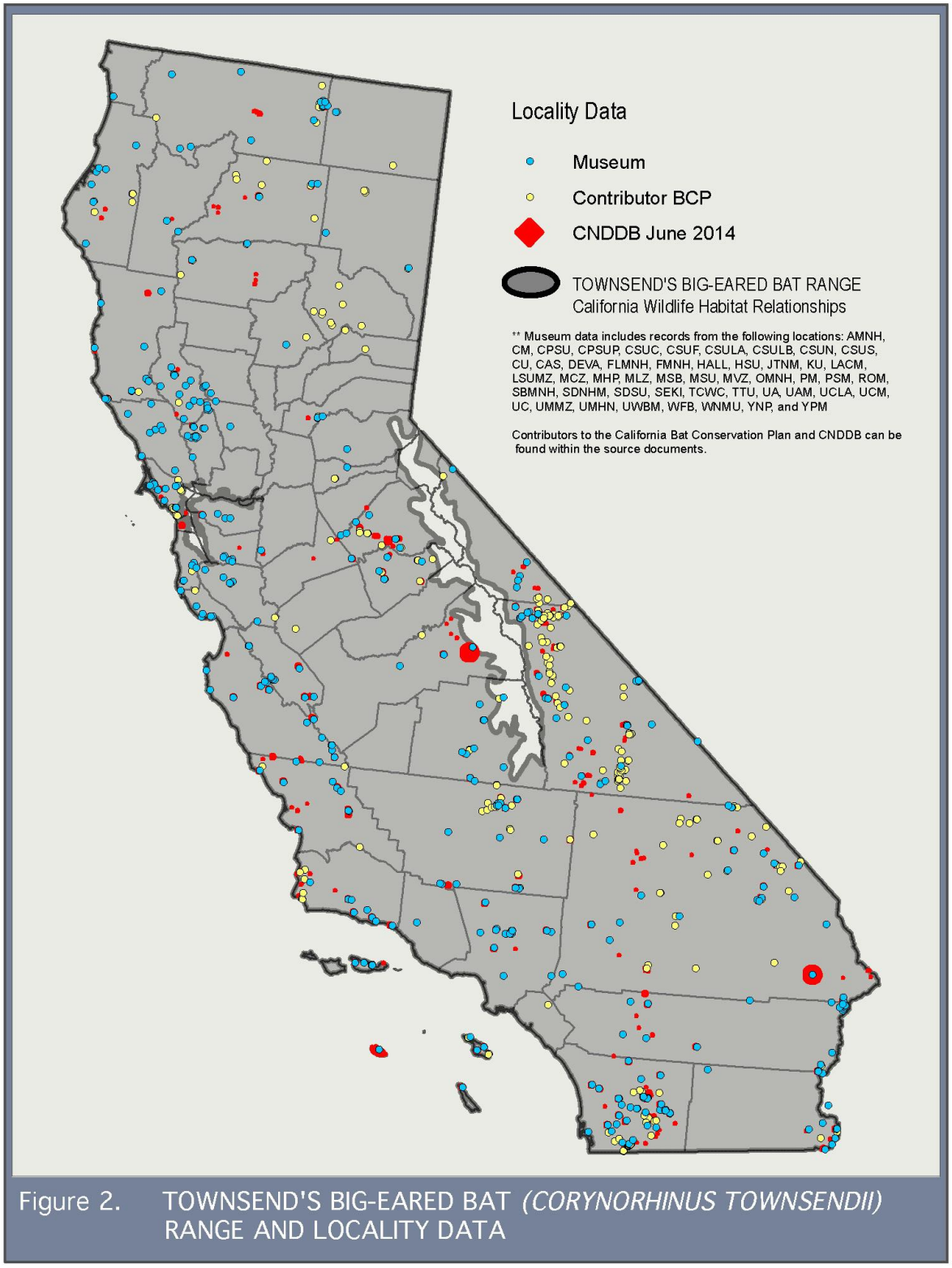


Figure 2. TOWNSEND'S BIG-EARED BAT *(CORYNORHINUS TOWNSENDII)* RANGE AND LOCALITY DATA

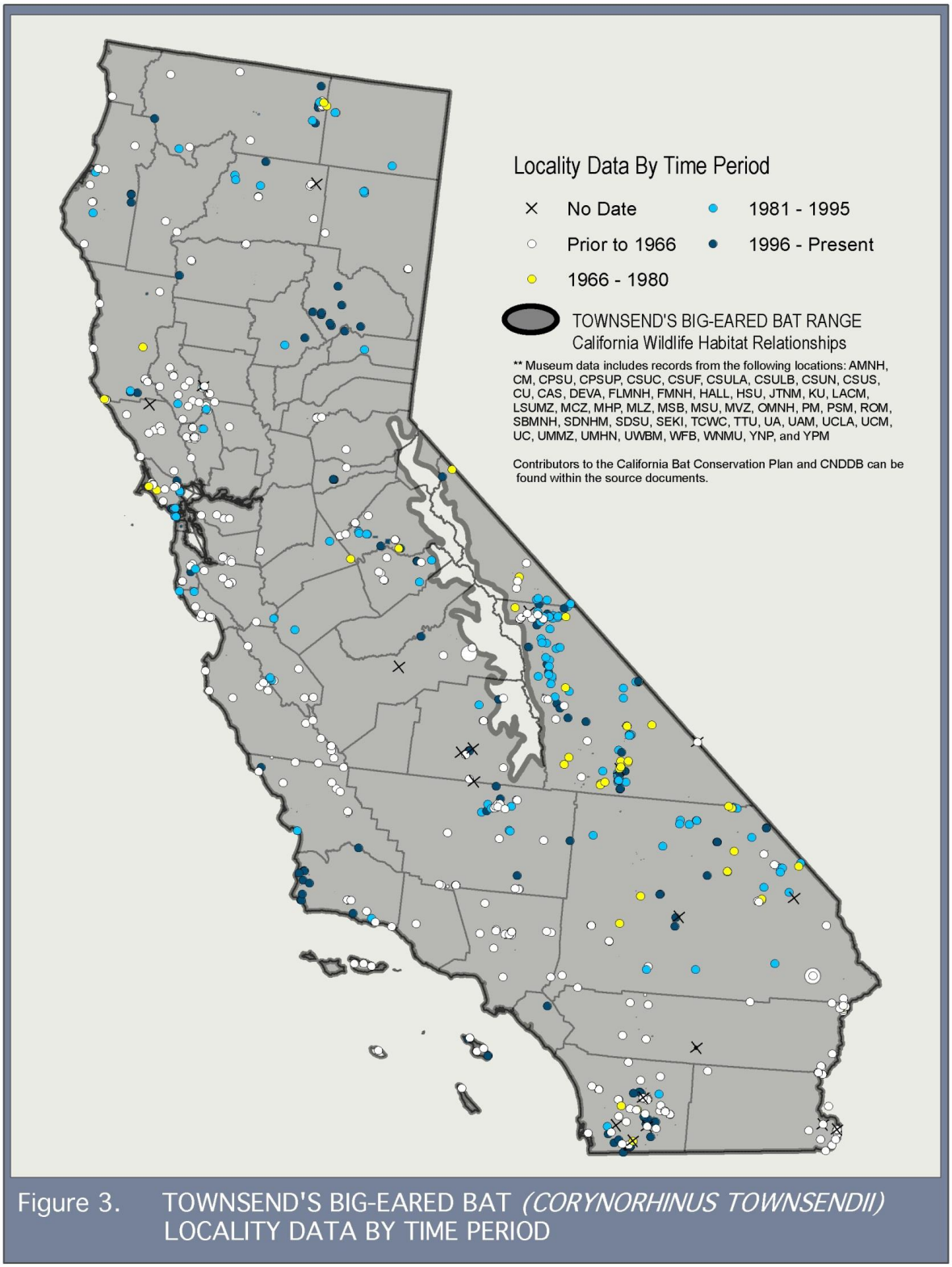


Figure 3. TOWNSEND'S BIG-EARED BAT *(CORYNORHINUS TOWNSENDII)* LOCALITY DATA BY TIME PERIOD

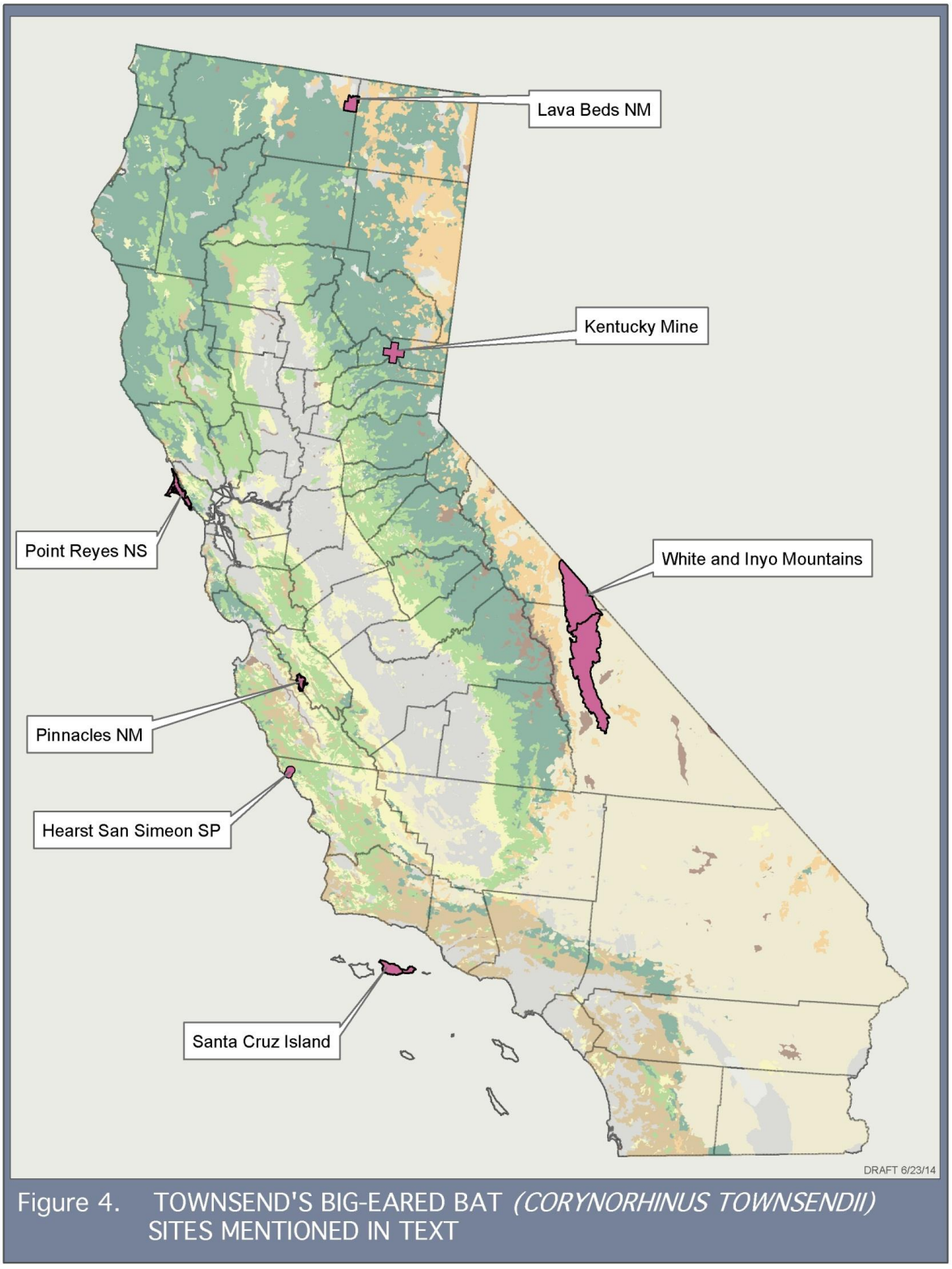
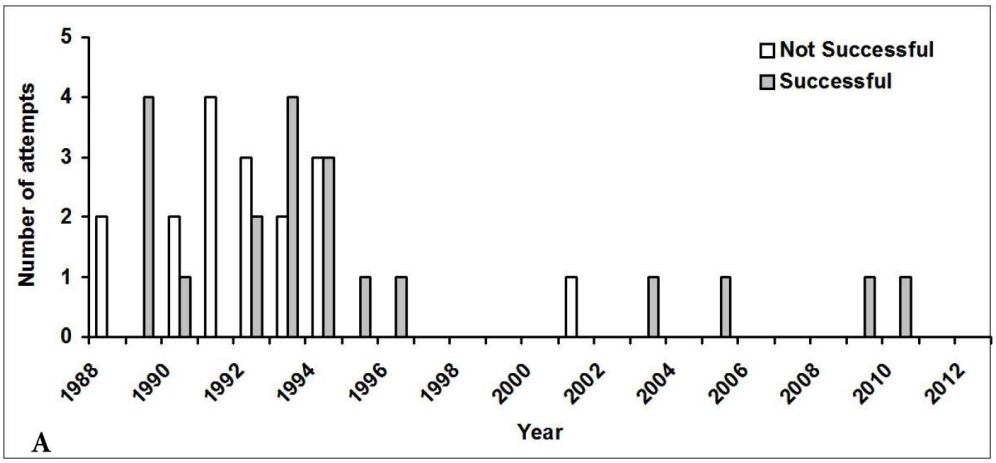


Figure 4. TOWNSEND'S BIG-EARED BAT *(CORYNORHINUS TOWNSENDII)* SITES MENTIONED IN TEXT

Figure 5.


Not Successful
Successful
Number of attempts
0
1
2
3
4
5
1988
1990
1992
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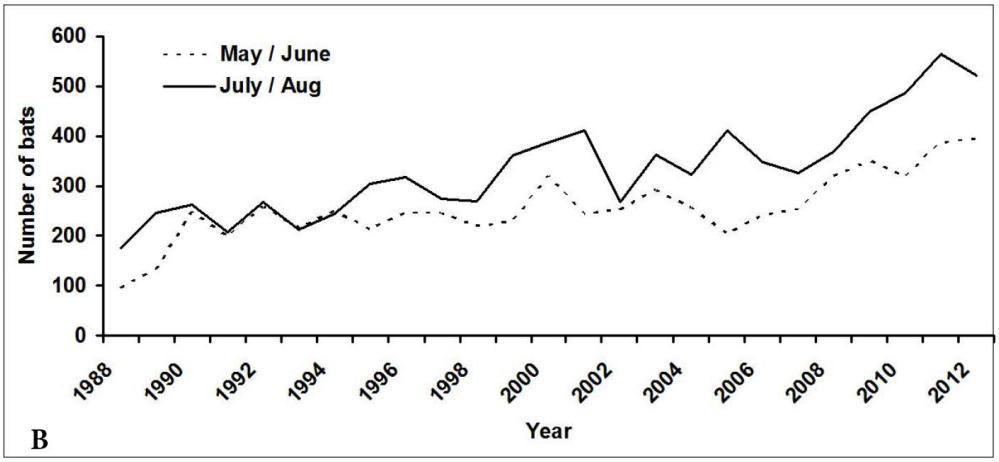
2010
2012
Year
A


May / June
July / Aug
Number of bats
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100
200
300
400
500
600
1988
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1994
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2006
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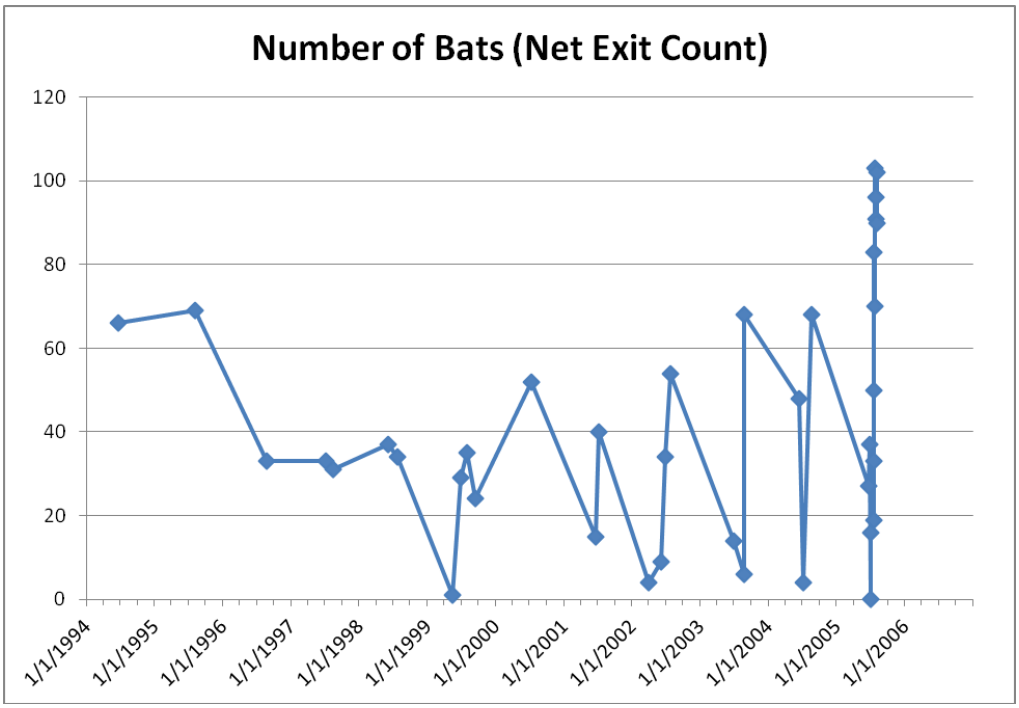
2010
2012
Year
B

Figure 6. (A)


Number of Bats (Net Exit Count)
120
100
80
60
40
20
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1/1/1994
1/1/1995
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1/1/1999
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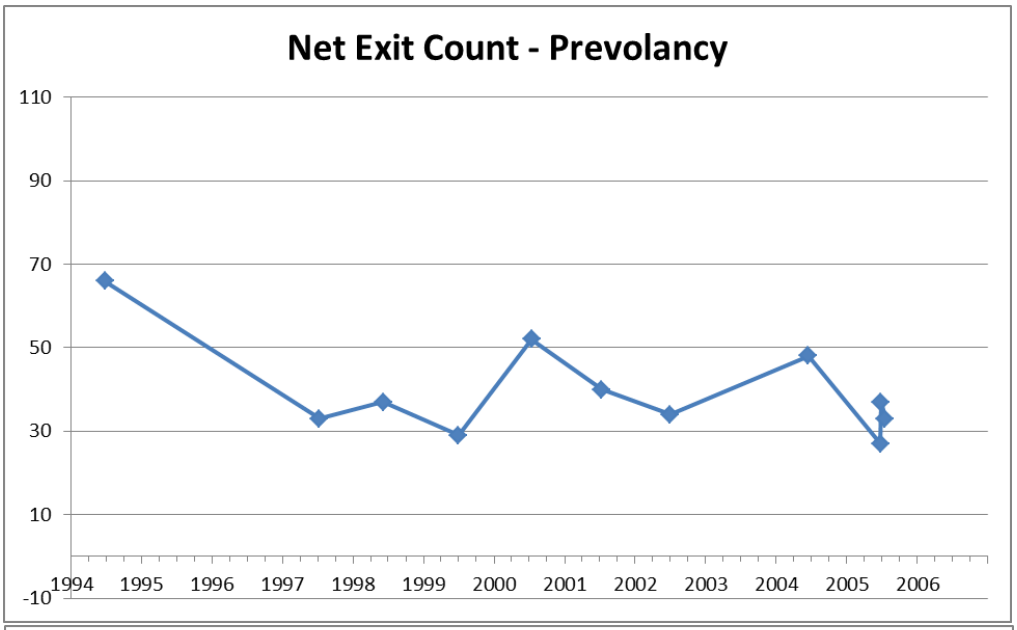
1/1/2002
1/1/2003
1/1/2004
1/1/2005
1/1/2006

Figure 6. (B, C)


Net Exit Count - Prevolancy
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30
10
-10
1994
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2003
2004
2005
2006

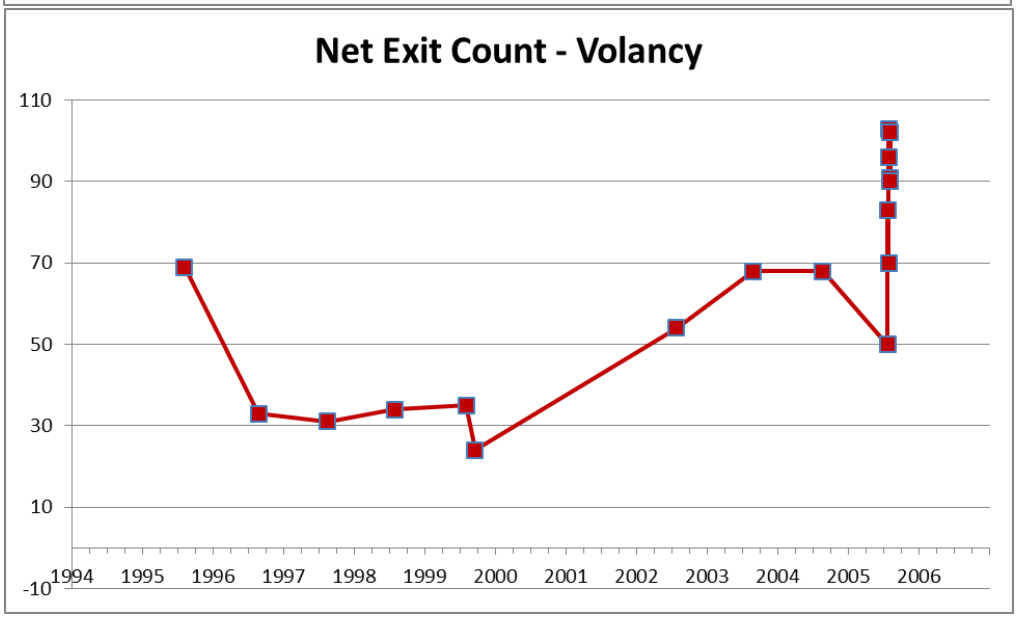
Net Exit Count - Volancy
110
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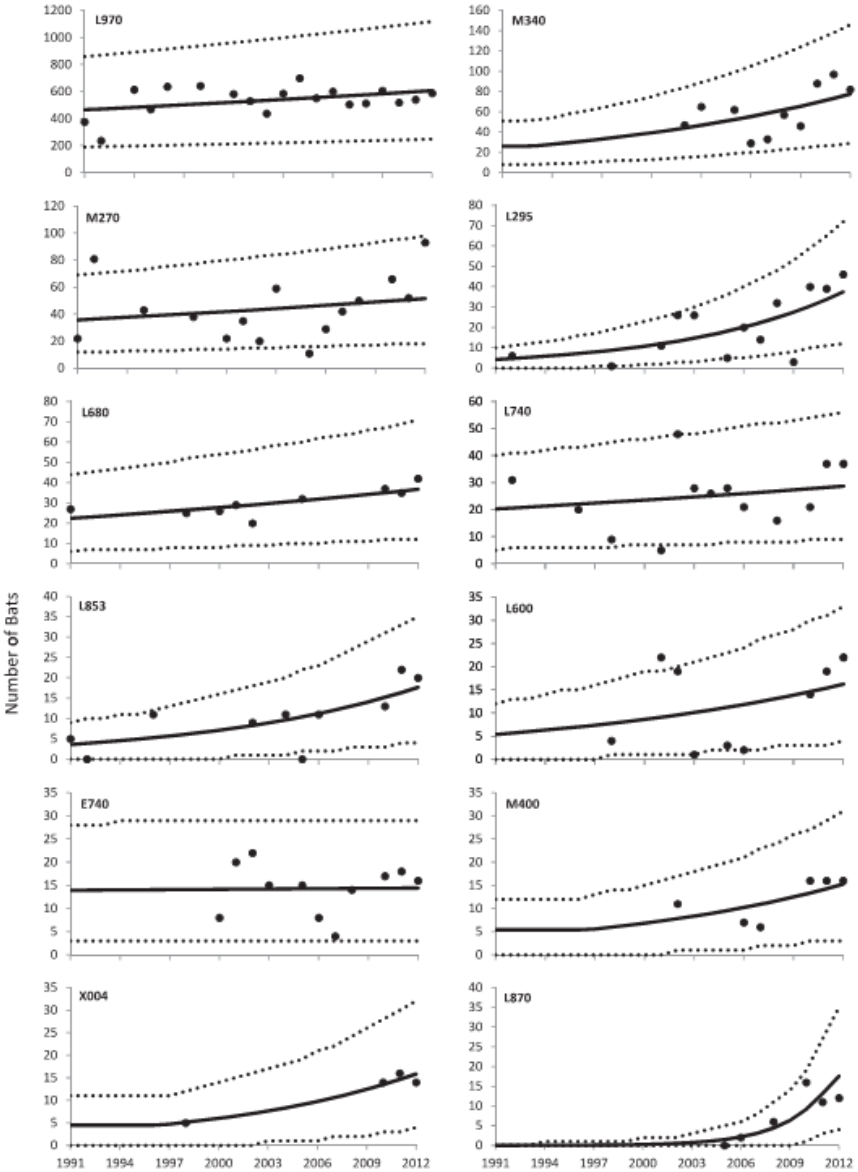
Figure 7.


L970
M340
M270
L295
L680
L740
L853
L600
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M400
X004
L870
Number of Bats
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1994
1997
2000
2003
2006
2009
2012

Figure 7 (continued).

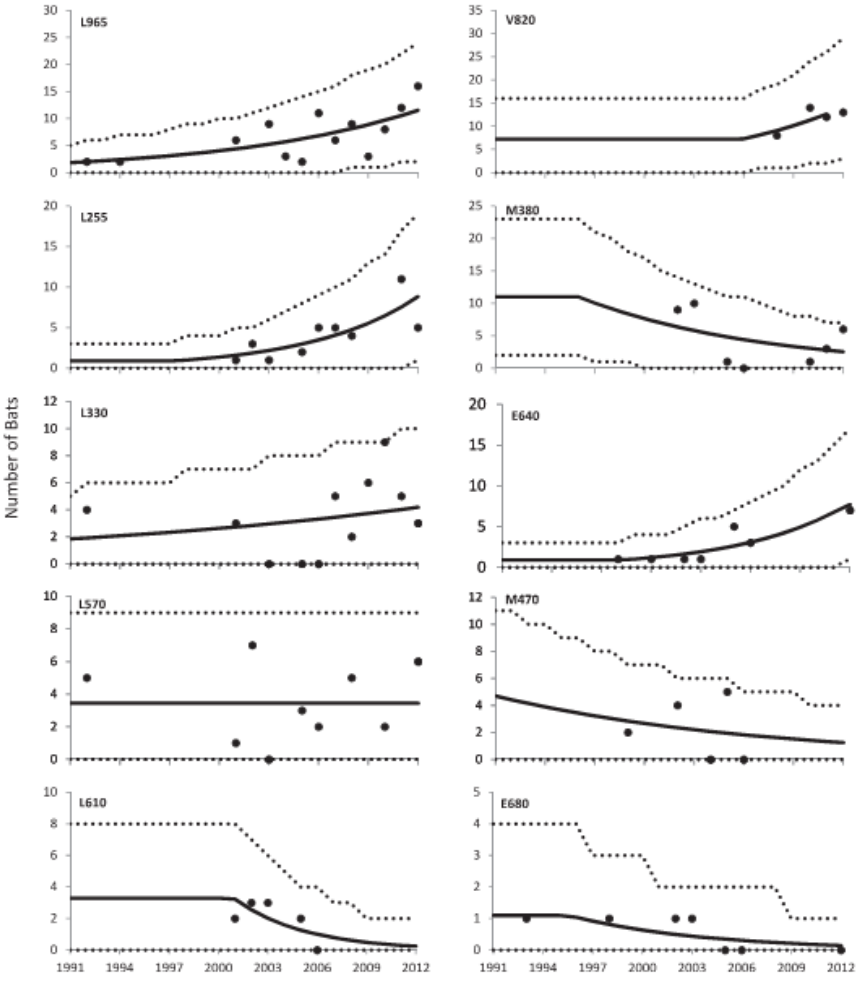
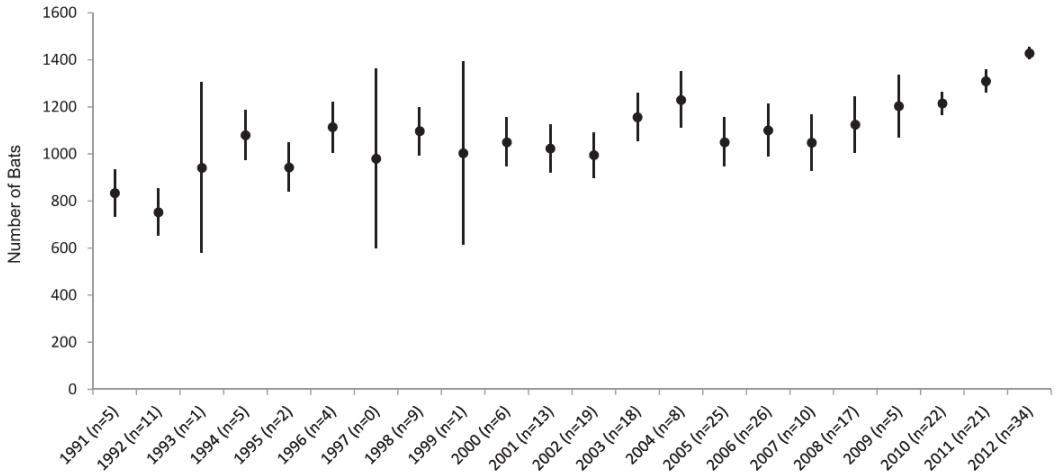


Figure 8.


Number of Bats
1600
1400
1200
1000
800
600
400
200
0
1991 (n=5)
1992 (n=11)
1993 (n=1)
1994 (n=5)
1995 (n=2)
1996 (n=4)
1997 (n=0)
1998 (n=9)
1999 (n=1)
2000 (n=6)
2001 (n=13)
2002 (n=19)
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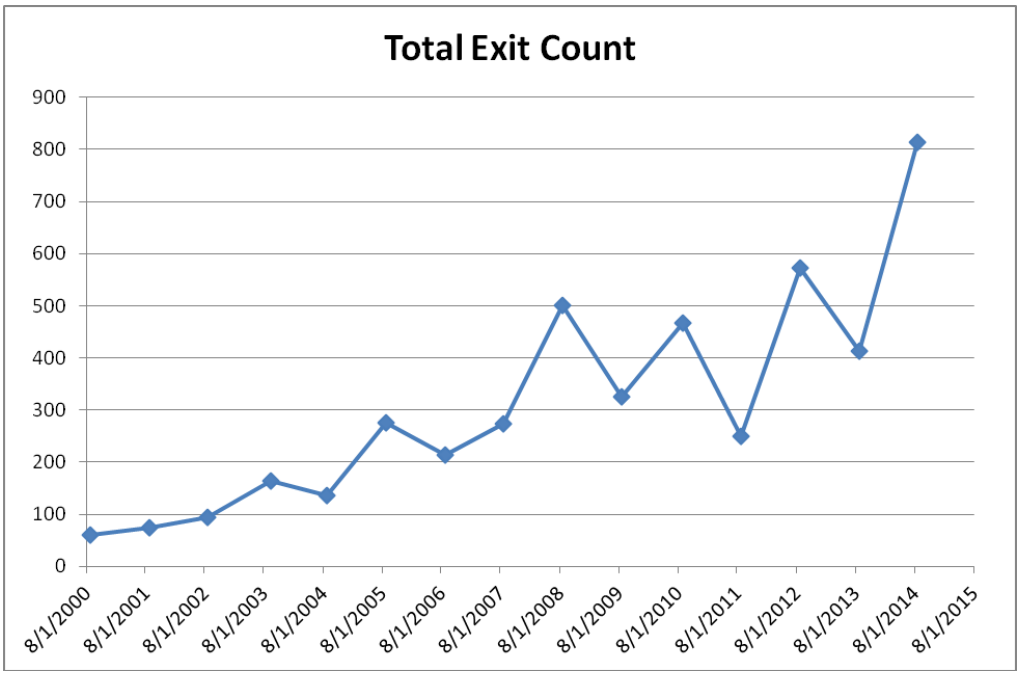
2004 (n=8)
2005 (n=25)
2006 (n=26)
2007 (n=10)
2008 (n=17)
2009 (n=5)
2010 (n=22)
2011 (n=21)
2012 (n=34)

Figure 9.


Total Exit Count
900
800
700
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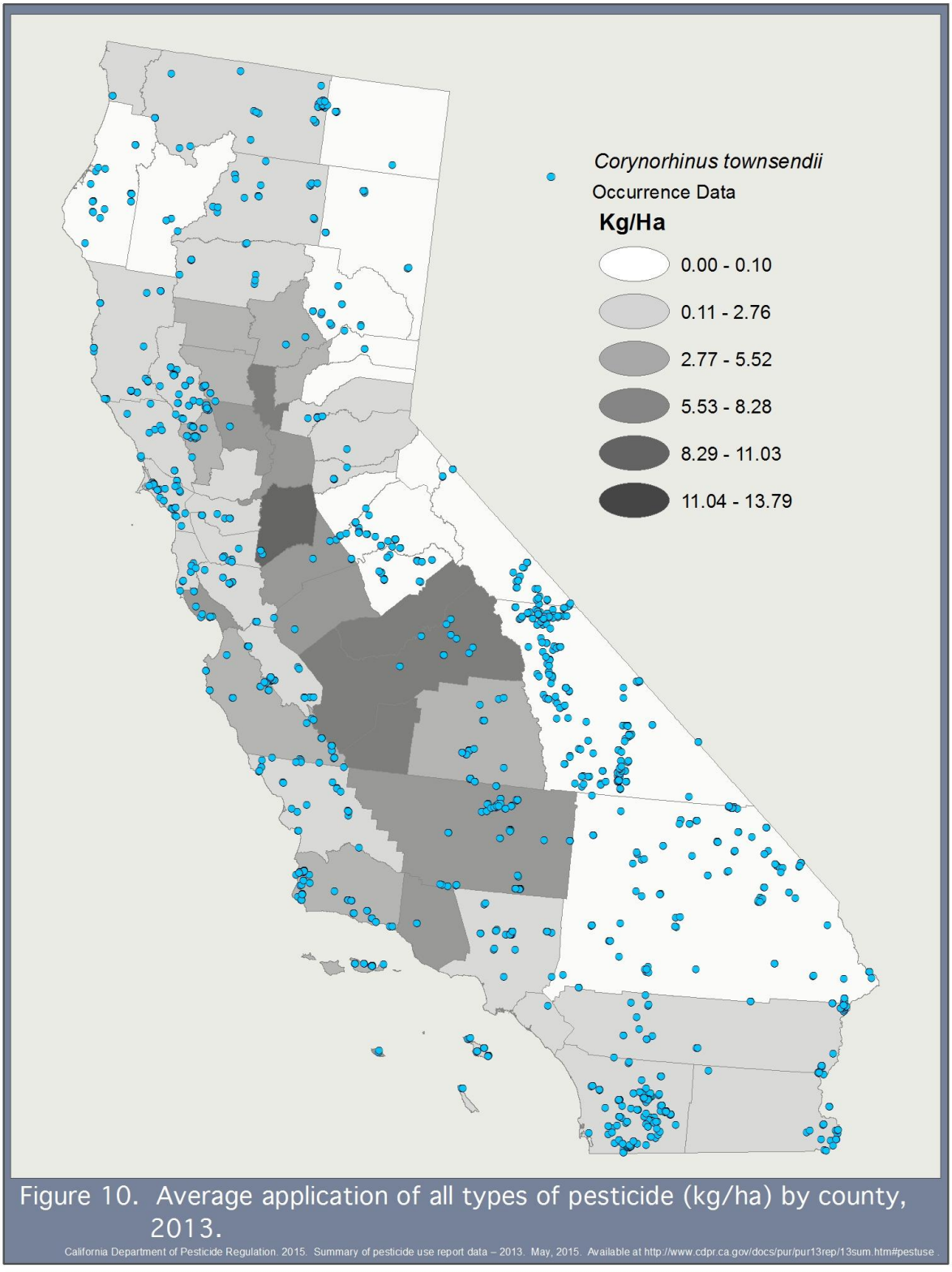

Figure 10. Average application of all types of pesticide (kg/ha) by county, 2013.

California Department of Pesticide Regulation. 2015. Summary of pesticide use report data – 2013. May, 2015. Available at http://www.cdpr.ca.gov/docs/pur/pur13rep/13sum.htm#pestuse .

Figure 11.

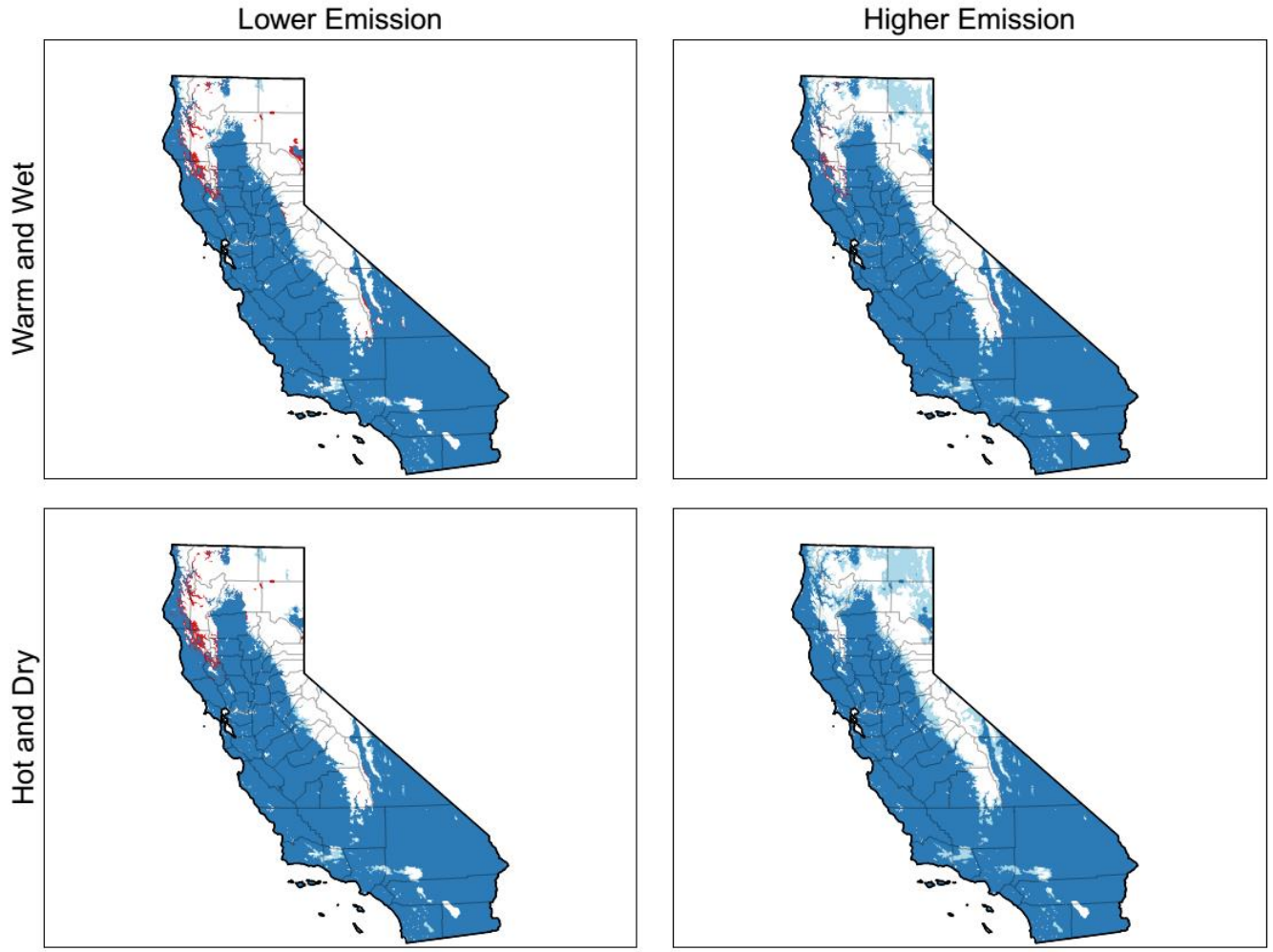

Figure 12.


EDMUND G. BROWN, JR., GOVERNOR, STATE OF CALIFORNIA
JOHN LAIRD, SECRETARY, NATURAL RESOURCES AGENCY
DAVID BUNN, DIRECTOR, DEPARTMENT OF CONSERVATION
OFFICE OF MINE RECLAMATION, ABANDONED MINE LANDS PROGRAM
CALIFORNIA ABANDONED MINES
POTENTIAL, INVENTORIED AND REMEDIATED
MINE FEATURE LOCATIONS
Physical Hazard Remediations*
* Remediations are AMLP data only.
Other agency closures exist, but are not shown on this map
USGS Mapped Mine Features*
*Based on USGS 7.5 minute topographical map mine symbols
AML Program Inventoried Features
Map produced by the Department of Conservation
Abandoned Mine Lands Program (AMLP), July 2015

Townsend's big-eared bat CESA Status Review – Tables

Captions

1. From Weller et al. (2014, Table 1). Number of caves searched and total number of Townsend's big-eared bats ( ) counted between November 15 and March 15 at Lava Beds National Monument, Siskiyou County, California, during the years 1991-2012. Cave L970 contained, by far, the largest number of hibernating bats in the monument.

2. Pinnacles National Park COTO maternity and hibernation roost count summary (NPS unpublished data). Visual counts made during one or more visits during the maternity and hibernation seasons. Where clusters of bats were observed, the number of bats were estimated from the area occupied, assuming between 100 and 150 COTO individuals per square-foot of ceiling area. In years when more than one survey was made in a season, the highest count is reported here. To avoid excessive disturbance to roosting bats in some years, presence only of the maternity colony was noted, or a minimum number of bats was estimated.

3. Summary of Townsend's big-eared bat monitoring studies referenced in the report.

Table 1.

Year	No. of Caves Surveyed	Cave L970 Count	Total Count
1991	5	376	438
1992	11	236	384
1993	1	—	1
1994	5	614	643
1995	2	469	512
1996	4	637	672
1997	0	—	—
1998	9	643	727
1999	1	—	2
2000	6	582	640
2001	13	530	665
2002	19	437	702
2003	18	586	811
2004	8	699	739
2005	25	551	733
2006	26	601	756
2007	10	505	620
2008	17	513	723
2009	5	607	665
2010	22	519	1,026
2011	21	541	1,117
2012	34	588	1,346

Table 2.

Year	Total Maternity*	Total Hibernacula
1997	150-200 (including pups)	60
1998	300-400 (including pups)	114
1999	320 (including pups)	254
2000	200-300	252
2001	300-600 (including pups)	282+
2002	Present	50++
2003	150+	364
2004	300-450	378
2005	100+	409
2006	600-1000 (4 clusters)	384
2007	Unknown/Not surveyed at peak of maternity season	261
2008	200-300	396
2009	125-160+	75
2010	240-290+	44
2011	Present	15
2012	225-235++	51
2013	Present	40
2014	~250+	43
2015	440-615	

Table 3.

Hibernation	
Lava Beds National Monument	Statistically significant population increase over 22 years
White-Inyo Mountains	No statistical inference possible; many repeat visits had lower counts than initial visits 10-plus years earlier
Pinnacles National Park	No inference possible based on uneven monitoring effort
Maternity	
Randall House	Statistically significant population increase over 25 years
Kentucky Mine	Statistical tests not conducted, but colony appears to be stable
Lava Beds National Monument	No inference possible
Pinnacles National Park	Statistical tests not conducted, but colony appears to be stable or increasing
Hearst Castle	Statistical tests not conducted, but colony appears to be stable or increasing
Santa Cruz Island	No statistical tests conducted, but colony has decreased from historical size

APPENDICES [to be completed for the final following external review]

1. **Public Comment Summary**
2. **List of Peer Reviewers and Invitation Letters**
3. **Peer Reviewer Comments**

STATE OF CALIFORNIA
NATURAL RESOURCES AGENCY
DEPARTMENT OF FISH AND WILDLIFE

EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE

REPORT TO THE FISH AND GAME COMMISSION

A STATUS REVIEW OF
TOWNSEND'S BIG-EARED BAT (*CORYNORHINUS TOWNSENDII*)
IN CALIFORNIA

CHARLTON H. BONHAM, DIRECTOR
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

Draft Date: January 7, 2016

Report to the Fish and Game Commission

A Status Review of Townsend's Big-Eared Bat in California

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FIGURES, TABLES, and APPENDICES follow text.

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Executive Summary

[To be completed following external review]

INTRODUCTION

Petition Evaluation Process

On November 1, 2012, the California Fish and Game Commission (Commission) received the "Petition to List the Townsends big-eared bat *(Corynorhinus townsendii*) as endangered under the California Endangered Species Act" (dated October 18, 2012; hereafter, the Petition), as submitted by the Center for Biological Diversity. Commission staff transmitted the Petition to the Department of Fish and Wildlife (CDFW) pursuant to Fish and Game Code (Fish & G. Code) section 2073 on November 9, 2012, and the Commission published formal notice of receipt of the Petition on November 30, 2012 (Cal. Reg. Notice Register 2012, No. 48-Z, p. 1747). After evaluating the Petition and other relevant information CDFW possessed or received, CDFW provided the Commission with the a report "Evaluation of the Petition from the Center for Biological Diversity to List Townsend's Big-Eared Bat (*Corynorhinus townsendii*) as Threatened or Endangered Under the California Endangered Species Act" (Evaluation). CDFW determined, pursuant to Fish & G. Code § 2073.5, subdivision (a), that sufficient scientific information exists to indicate that the petitioned action may be warranted and recommended the Commission accept the Petition (CDFG 2013). At its scheduled public meeting on June 26, 2013 in Sacramento, California, the Commission considered the Petition, CDFW's Evaluation and recommendation, and comments received. The Commission found that sufficient information existed to indicate the petitioned action may be warranted and accepted the Petition for Consideration. Upon publication of the Commission's notice of its findings, Townsend's big-eared bat was designated a candidate species on November 14, 2013 (Cal. Reg. Notice Register 2013, No. 52-Z, p. 2092).

Department Status Review

Following the Commission's action designating the Townsend big-eared bat as a candidate species, and pursuant to Fish & G. Code section 2074.4, CDFW solicited information from agencies, educational institutions, tribes, and the public to inform the review of the species' status using the best scientific information available. This report contains the results of CDFW's status review, including independent peer review of the draft report by scientists with expertise relevant to the Townsend big-eared bat. At its scheduled public meeting on December 3, 2014 in Van Nuys, California, the Commission granted CDFW a six-month extension to facilitate external peer review. The purpose of this status review is to fulfill the mandate as required by Fish & G. Code section 2074.6 and to provide the Commission with the most current, scientifically-based information available on the status of Townsend big-eared bat in California and to serve as the basis for CDFW's recommendation to the Commission.

BIOLOGY AND ECOLOGY[1]

Species Description

Townsend's big-eared bat is a medium sized (10-12 g) bat with an adult forearm length of 39-48 mm and ear length of 30-39 mm. Townsend's big-eared bat generally has buffy brown dorsal fur with somewhat paler underparts (Barbour and Davis 1969, Kunz and Martin 1982). Among western North American bats, Townsend's big-eared bat is unique with its combination of a two-pronged, horseshoe-shaped lump on the muzzle and large, long ears. Although other California bats have long ears, no other has both large ears and the two-pronged nose lump. The other large-eared bat species have other characteristics that readily distinguish them from Townsend's big-eared bat.

Townsend's big-eared bat has relatively broad and short wings, which provides a low body mass-to-wing area ratio (wing load) (Norberg and Rayner 1987). Low wing loading confers high maneuverability and good economy of power, and take-off at low speeds. It may also allow the species to take advantage of pulses in prey availability by ingesting a large mass of insects when they are available (Norberg and Rayner 1987).

Systematics

Townsend's big-eared bat (Class Mammalia, Order Chiroptera) is in the Microchiropteran family Vespertilionidae, which contains the most species of the four bat families in the United States. There are two other species of *Corynorhinus*: *Corynorhinus rafinesquii,* Rafinesque's big-eared bat, and *Corynorhinus mexicanus,* the Mexican big-eared bat. The North American genus of big-eared bats now known as *Corynorhinus* was for several decades known as *Plecotus*, and much of the older scientific literature used that name.

There are five currently recognized subspecies of Townsend's big-eared bat in the United States (Handley 1959, Piaggio and Perkins 2005)(see Figure 1). Two of the subspecies (*C. t. townsendii* and *C. t. pallescens*) occur throughout much of western North America (including California), two (the Ozark big-eared bat, *C. t. ingens,* and the Virginia big-eared bat, *C. t. virginianus*) occur in the eastern United States, and one (*C. t. australis*) is distributed primarily in Mexico, but also extends into Texas. Both of the eastern subspecies of Townsend's big-eared bat (the Ozark and Virginia big-eared bats) are listed by the U.S. Fish and Wildlife Service as Endangered.

This classification scheme follows the presumed evolutionary history of Townsend's big-eared bat and related bats species. Tumlison and Douglas (1992) used cladistic analysis of shared acquired

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[1] Much of the information presented here on the biology of Townsend's big-eared bat has been adapted from the draft species account prepared by E.D Pierson, W.E. Rainey, and L. Angerer for the California Bat Conservation Plan (CDFW in prep.). Personal communications and personal observations cited without a year reference are from the draft species account. All other personal communications were between the referenced person and Scott Osborn, CDFW Senior Environmental Scientist with the Wildlife Branch, Nongame Wildlife Program.

characteristics to determine that the New World *Corynorhinus* species comprise a distinct lineage from both the Old World *Plecotus* species (which they had formerly been grouped with under the genus name *Plecotus*) and two other big-eared bat genera (*Idionycteris* and *Euderma*).

Piaggio and Perkins (2005) examined the evolutionary relationships within *Corynorhinus* using both mitochondrial and nuclear DNA. Their results confirmed the status of the five Townsend's big-eared bat subspecies, suggested that *C. townsendii* and *C. mexicanus* are more closely related to each other than to *C. rafinesquii*, and that levels of genetic divergence among the Townsend's big-eared subspecies are relatively high (Piaggio and Perkins 2005).

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Within Townsend's big-eared bat itself, DNA analysis has shown the western-most subspecies, *C. townsendii townsendii*, may have diverged from the other Townsend's big-eared bat subspecies between 41,000 and 64,000 years ago, while *C. townsendii pallescens* diverged 12,000 to 23,000 years ago, and *C. townsendii australis* diverged between 6,000 and 20,000 years ago (Smith et al. 2008). The timings of divergence and geographic pattern of the subspecies' ranges today suggested to the authors that the subspecies developed during periods of extensive glaciation in western North America when Townsend's big-eared bat populations were isolated from each other. Other mitochondrial DNA evidence suggests an earlier divergence of the five Townsend's big-eared bat subspecies (possibly as earlier as 1 million years ago), with subsequent effects on distribution during the Pleistocene (Lack and Van Den Bussche 2009).

Geographic Range and Distribution

Townsend's big-eared bat ranges throughout much of the western United States and Canada (Figure 1). In California, its geographic range is generally considered to encompass the entire state, except for the highest elevations of the Sierra Nevada (Figure 2). Within the general range, there are areas of greater and lesser probability of occupancy by Townsend's big-eared bat. Populations are concentrated in areas offering caves (commonly limestone or basaltic lava) or mines as roosting habitat.

Conversely, a general lack of Townsend's big-eared bat records in the Central Valley and Imperial Valley (Figure 2), along with a paucity of suitable roost structures, suggests these areas are unlikely to harbor populations of resident Townsend's big-eared bat.

The species is found from sea level along the coast to 1,820 m (6,000 ft) in the Sierra Nevada (Dalquest 1947, Pearson et al. 1952, Pierson and Rainey 1998). In the White Mountains, summer records for males extend up to 2,410 m (7,900 ft), and hibernating groups have been found in mines as high as 3,188 m (10,460 ft) (Szewczak et al. 1998). Maternity colonies are more frequently found below 2,000 m (6,560 ft) (Pierson and Fellers 1998, Szewczak et al. 1998). Outside California, Townsend's big-eared bat has been found to 2,400 m (7,900 ft) (Jones 1965, Jones and Suttkus 1971) and 2,900 m (9,500 ft) (Findley and Negus 1953).

As for the two Townsend's big-eared bat subspecies that occur in California, *C. t. townsendii* occurs primarily in the western-most portion of the species' range in California, Oregon, Washington, Nevada, Idaho, and possibly southwestern Montana and northwestern Utah. *C. t. pallescens* occurs in all the

same states as *C. t. townsendii*, plus in more interior portions of the continent in Arizona, Colorado, New Mexico, Texas, and Wyoming (Handley 1959, Piaggio and Perkins 2005). Throughout much of their range in California, Idaho, Nevada, Oregon and Washington there are extensive zones of intergradation for the two subspecies and it is often not possible to assign individuals to one subspecies or the other.

Population Genetics

Genetic studies can inform our understanding of animal populations, including the amount of mixing between subpopulations and level of genetic variability among and between individuals or subpopulations. Smith (2001) demonstrated the Townsend's big-eared bat populations in Oklahoma show high movement (high gene flow) of males across her study area (nuclear microsatellite DNA results), but low movement of females (mitochondrial DNA results). This suggests high site fidelity of females to their natal roosts relative to males. The female subpopulations were highly differentiated from each other, but also highly variable within the subpopulations.

Miller's (2007) study of Townsend's big-eared bat population genetics in southeastern Idaho used nuclear DNA to show most individuals within hibernacula were not closely related to each other, contrary to an earlier suggestion by Pearson (1959) that Townsend's big-eared bats within a hibernaculum should be closely related, since Townsend's big-eared bat mate at their hibernacula and have high fidelity to these sites. Miller (2007) suggested that "juveniles may disperse from natal colonies before settling and becoming philopatric to a single [hibernation] site, which could create these communities of unrelated individuals." Alternatively, it is possible that Townsend's big-eared bats in her study area are either not loyal to a single hibernaculum or do not mate at the hibernacula in which they over winter. She also found that adult females in maternity colonies are more closely related to each other than are juveniles, which is consistent with males dispersing longer distances than females.

The study by Piaggio and others (2009) of populations structure, genetic diversity, and dispersal among three subspecies of Townsend's big-eared bat in the Rocky Mountains region (*townsendii*, *pallescens*), and in the southeastern U.S. (the endangered *virginianus* subspecies) used both nuclear and mitochondrial DNA analyses. Their study indicated significantly lower genetic diversity in *virginianus*, compared to the other two subspecies, which is expected due to the lower overall population size of *virginianus*. Their study also indicated relatively low levels of gene flow among populations of the *townsendii* and *pallescens* subspecies, which tend to be isolated. On the other hand, some gene flow can occur at distances of 310 km between roosts, which (with other recent data) suggests that Townsend's big-eared bat may move greater distances than typically thought. These genetic results are consistent with the observation that a simple geographic demarcation between the *pallescens* and *townsendii* subspecies is not sufficient to differentiate between individuals of the two subspecies.

Comment [WR1]: It is unclear whethgr this recent data is something referenced in the paper under discussion .

Comment [WR2]: It sems this sentence would be somewhat clearer if it said populations or colonies rather than individuals.

Reproduction and Development

Townsend's big-eared bat is a colonial species. Maternity colonies form between March and June, with the timing varying based on local climate, elevation, and latitude. Colony size ranges from a few dozen to several hundred individuals. Mating generally takes place in both migratory sites and hibernacula between September or October and February. "Swarming" – a behavior at non-maternity roost sites

where both sexes mix in autumn prior to moving to hibernacula – has been observed during the latter half of September in the Mojave Desert. Females are generally reproductive in their first year, whereas males do not reach sexual maturity until their second year. Gestation length varies with climatic conditions, but generally lasts from 56 to 100 days (Pearson et al. 1952). Some evidence indicates maternity colonies may have up to three different roost sites for given stages of reproduction – one each for pregnancy, birthing, and rearing (Sherwin et al. 2000).

Comment [WR3]: This is a very interesting observation if correct. With consequences for genetic patterns on the landscape. AFAIK it is not in the literature so some more support should be offered for this.

A single pup is born between May and July (Easterla 1973, Pearson et al. 1952, Twente 1955). Townsend's big-eared bat pups average 2.4 g at birth, nearly 25% of the mother's postpartum mass (Kunz and Martin 1982). While adult males are typically solitary during the maternity season, adult females and their pups cluster together in colonial roosts (Pearson et al. 1952). Aggregations in maternity roosts have typical densities of between 100 and 150 adults and young per square foot of roost surface area occupied. Such clustering minimizes heat loss and allows more energy to be used for milk production (adults) and growth (pups). Young bats are capable of flight at 2.5 to 3 weeks of age and are likely gradually weaned by 2 months (Pearson et al. 1952). Nursery colonies start to disperse in August about the time the young are weaned and break up altogether in September and October (Pearson et al. 1952, Tipton 1983).

Vital Rates (Reproduction, Survival)

Maximum fecundity per adult female is one pup per year. Pearson et al. (1952) estimated an average fecundity for the colonies in their study to be about 0.45 female pups per adult female per year. Examining exit count data from an undisturbed colony where counts were made both before and after young Townsend's big-eared bat became volant, it appears that the number of bats may increase by a factor of 1.5 to 2 (unpublished CDFW analysis of Kentucky Mine counts in 2005 and 2006). Assuming a 50:50 sex ratio of young, this would be equivalent to recruitment rates of 0.25 to 0.5 female young per adult female.

Pearson et al. (1952) estimated annual survival at about 50% for the first year of life and about 80% for adults. The authors determined these survival rates, combined with their estimates of fecundity, were "just sufficient" to maintain a stable population during the years these colonies were studied (Pearson et al. 1952). Ellison (2010) estimated winter survival in a Washington Townsend's big-eared bat population to range between 54% and 76%, with higher survival for females than for males. Band recoveries have yielded individual longevity records of 16 years, 5 months (Paradiso and Greenhall 1967) and 21 years, 2 months (Perkins 1994).

Behavior

Townsend's big-eared bat's susceptibility to disturbance at roost sites is usually cited as a key behavioral characteristic putting the species at conservation risk (Twente 1955, Barbour and Davis 1969, Humphrey 1969, Humphrey and Kunz 1976). As summarized by Pierson et al. (1991):

> Townsend's big-eared bats are so sensitive to human disturbance that simple entry into a nursery roost can be enough to induce the colony to abandon a site (Mohr 1972, Humphry and Kunz 1976). Activities as apparently harmless as recreational caving have

been shown to have negative impacts and have driven Townsend's big-eared bat from a number of their traditional roost sites in California (Graham 1966, Pierson, unpubl. data).

Pearson (1952) documented temporary abandonment of maternity roosts in California as a direct result of his research team entering the roost site to band young. Fellers and Halstead (2015) showed a strong negative relationship between attempted unlawful entries into the Randall House Townsend's big-eared bat maternity roost (coastal Marin County) and overall colony reproductive success on an annual basis.

Contrary to the general pattern of susceptibility to disturbance, one Townsend's big-eared bat maternity colony in California has demonstrated some tolerance to disturbance (Freeman 2012). The Kentucky Mine colony in Sierra County has persisted despite daily tours in the historic stamp mill building where the bats typically roost, though some impacts to the colony and changes in behavior (including temporary roost abandonment) have occurred there over the years (M. Tierney pers. comm. 2015). It should be noted the Kentucky Mine roost site is managed under guidance that emphasizes quiet, predictable disturbance events (tours) and minimizes other, novel types of disturbance. Clark et al. (1997) also noted one of the eastern Townsend's big-eared bat subspecies, the Ozark big-eared bat (*C. townsendii ingens*) did not abandon roosts or caves despite researcher entry and surmised this subspecies may tolerate more human activity than the western subspecies.

Once a roost site has been successfully colonized by Townsend's big-eared bat (whether for the active or hibernation season), it is likely to be used in subsequent years, so long as it remains suitable (Humphrey and Kunz 1976). However, it is not unusual for maternity colonies to switch roosts during the course of the season (Fellers and Pierson 2002, Sherwin et al. 2000, 2003). Disturbance events, as noted above, may trigger a temporary abandonment of the preferred roost. In some cases, different roosts may be used to provide more optimal conditions during different phases of the maternity season (early and late pregnancy, early and late pup-rearing).

Night roosts are used opportunistically during breaks from foraging. Such roosts probably allow the bats to rest and digest meals while minimizing predation risk. Townsend's big-eared bat appears not to show particularly high fidelity to night roosts (Fellers and Pierson 2002). During early-evening foraging bouts of six light-tagged Townsend's big-eared bat in Oklahoma, Caire et al. (1984) documented their study animals rested between bouts of foraging about 17% of the time under observation. It is likely the overall resting time between foraging bouts in a given night is greater.

Diet

Diet has not been examined in detail for any California population of Townsend's big-eared bat. It is likely that Townsend's big-eared bat here, as elsewhere, is a Jepidopteran specialist, feeding primarily on medium-sized moths, but with occasional captures of other insects, including flies, beetles, and aquatic insects (Ross 1967, Whitaker et al. 1977, 1981, Dalton et al. 1986, Sample and Whitmore 1993, Furford and Lacki 1998, Dodd and Lacki 2007).

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Comment [WR4]: Wrong subspecies name given. Examples of negative effects of disturbance on virginianus are numerous aswell as benefit from restriction on human access associated with endangered status.

Comment [WR5]: There are a number of observations from California that ill timed disturbance triggers abandonment of non-young by females with at least the loss of that year's reproductive output.

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Vocalizations

Townsend's big-eared bat produces ultrasonic calls that are used for navigating in the dark, and for locating and capturing prey, as well as for social communication. While cruising or searching for prey, a semi-regular pattern of calls is emitted at 10 to 20 calls per second (Kunz and Martin 1982). Search- and cruising calls are usually simple downward sweeps in frequency, typically starting at about 40 to 45 kHz and ending at about 19 to 23 kHz, with the maximum power (volume) produced at about 21 to 26 KHz (J.M. Szewczak, unpublished data 2011). Calls may include sounds produced at the harmonic frequencies at two- and three times the fundamental call frequencies – sometimes with more power applied to a harmonic than to the fundamental call. Townsend's big-eared bat is commonly known as a "whispering" bat, because of the relatively low power of its calls – typically about 40 to 50 dB quieter than those of *Myotis lucifugus* (Kunz and Martin 1982). The relatively low intensity of its echolocation calls makes Townsend's big-eared bat difficult to detect with acoustic equipment..

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Predation

Pearson et al. (1952) discounted predation as a factor limiting Townsend's big-eared bat populations, but individuals may be preyed upon by a variety of native and non-native predators, as has been documented for other bats. Hensley et al. (1995) listed several potential predators of Townsend's big-eared bat in the recovery plan for the endangered Ozark big-eared bat (*C. townsendii virginianus*), including raccoons (*Procyon lotor*), bobcats (*Lynx rufus*), house cats (*Felis catus*), skunks (*Mephitis*, *Spilogale*), and snakes. These and other generalist predators, such as ringtails (*Bassariscus astutus*) likely take Townsend's big-eared bat opportunistically in California.

Fellers and Halstead (2015) stated several owl species known to prey on bats may have influenced Townsend's big-eared bat emergence times at the Randall House maternity roost. These include great horned owls (*Bubo virginianus*), barn owls (*Tyto alba*), and spotted owls (*Strix occidentalis*). Townsend's big-eared bat's tendency to avoid foraging in open grassland and other areas of low vegetation cover has been hypothesized to be a mechanism for avoiding aerial predators such as owls (Pierson and Fellers 1999); however, this behavior may also be driven by the distribution of the bat's prey.

Fellers (2000) also reported that non-native black rats (*Rattus rattus*) preyed upon young Townsend's big-eared bats at the Randall House roost before measures were taken to prevent rat entry into the structure.

Movements

Migration. Townsend's big-eared bat is considered a relatively sedentary species, for which no long-distance migrations have been reported (Barbour and Davis 1969, Humphrey and Kunz 1976, Pearson et al. 1952). The longest movement known for this species in California is 32.2 km (20 mi) (Pearson et al. 1952). There is some evidence of local migration, perhaps along an elevation gradient.

Townsend's big-eared bats in Oregon appear to move from their hibernacula to active season (maternity) roosts over a period of several nights, using interim roosts before settling into the maternity

roost (Dobkin et al. 1995). This study recorded a maximum distance between hibernation site and foraging areas of 24 km (15 mi).

Feeding. Despite its reputation as a sedentary species, Townsend's big-eared bat may cover a lot of ground while foraging each night. As described in one species account for Townsend's big-eared bat (WBWG 2005), "these bats often travel large distances while foraging, including movements of over 150 kilometers during a single evening (R. Sherwin pers. comm.). Evidence of large foraging distances and large home ranges has also been documented in California (E.D. Pierson pers. comm.)."

Thermoregulation and Hibernation

Townsend's big-eared bat, like most mammals, maintains a high body temperature primarily through heat produced by its metabolism. High metabolic rate and elevated (and typically constant) body temperature allow mammals to maintain high aerobic activity levels, which in turn has allowed them to occupy ecological niches only available to highly energetic animals. Like many bat species inhabiting temperate regions, Townsend's big-eared bat uses torpor[2] as a physiological and behavioral strategy in winter to deal with diminished food resources and cool or cold ambient temperatures, which make it energetically costly to maintain normal high body temperature. By allowing body temperature to cool to near ambient, bats in torpor reduce their energy expenditure to a small fraction of what would be used to keep body temperature elevated. Despite the energy savings conferred by torpor, hibernating bats may lose more than 50% of their body mass during the hibernation season (Humphrey and Kunz 1976). Townsend's big-eared bat and other bats that use torpor have a suite of physiological adaptations to allow them to remain healthy during torpor and to arouse at the appropriate times.

An important behavioral trait of hibernators is the selection of suitable sites for the inactive period. Townsend's big-eared bat hibernation sites are generally caves or mines (Pearson et al. 1952, Barbour and Davis 1969), although animals are occasionally found in buildings (Dalquest 1947). Deep mine adits and shafts, , known to provide significant hibernating sites in New Mexico (Altenbach and Milford 1991), may also be important in California. Winter roosting is typically composed of mixed-sexed groups from a single individual to several hundred or several thousand individuals(in eastern subspecies); however, behavior varies with latitude. In areas with prolonged periods of non-freezing temperatures, Townsend's big-eared bat tends to form relatively small hibernating aggregations of single to several dozen individuals (Barbour and Davis 1969, Pierson et al. 1991, Pierson and Rainey 1998). Larger

[2] "Torpor" is a general term for reduced metabolic rate and body temperature. For animals adapted to use torpor as described, it can range from "shallow torpor" which occurs when winter temperatures are relatively mild and where the animal may only drop its body temperature a few degrees, to deep hibernation, which occurs in more extreme cold. In hibernation, ambient temperatures may be near or below freezing and the torpid animal may maintain its temperature just above freezing. Bats in hibernation may appear almost completely inanimate with no visible sign of breathing. Arousal from deep torpor may take many minutes to over an hour. Bats in shallow torpor may respond to handling or other stimuli by slowly moving and visibly breathing, and will often arouse in several minutes.

aggregations (75-460) are confined to areas that experience prolonged periods of freezing temperatures (Pierson and Rainey 1998).

Studies in the western U.S. have shown that Townsend's big-eared bat selects winter roosts with stable, cold temperatures, and moderate air flow (Humphrey and Kunz 1976, Kunz and Martin 1982). Individuals roost on walls or ceilings, often near entrances (Humphrey and Kunz 1976, Twente 1955). If undisturbed, individuals will frequently roost less than 3 m (10 ft) off the ground (Perkins et al. 1994), and have been found in air pockets under boulders on cave floors (E. Pierson pers. obs.). Temperature appears to be a limiting factor in roost selection. Recorded temperatures in Townsend's big-eared bat hibernacula range from -2.0°C to 13.0°C (28°F to 55°F) (Humphrey and Kunz 1976, Genter 1986, Pearson et al. 1952, Pierson et al. 1991, Twente 1955), with temperatures below 10°C (50°F) being preferred (Perkins et al. 1994, Pierson and Rainey 1998). Within a hibernaculum, Townsend's big-eared bat most frequently hibernates singly, but pairs and small clusters of torpid individuals are observed. In the White and Inyo mountains, larger groups were observed in sites where air temperature was around 5°C (41°F) while smaller groups occurred at locations with air temperatures that were colder (Szewczak et al. 1998). In the Mojave Desert in the winter, hibernating Townsend's big-eared bat have been found at temperatures of 15.5°C (60°F), as these might be the coolest temperatures available (P. Brown pers. obs.).

The period of hibernation is shorter at lower elevations and latitudes. Coastal populations of Townsend's big-eared bat, which experience particularly mild winters, may use shallow torpor on a daily basis and may be active at any time to take advantage of warm weather and prey availability (Pearson et al. 1952).

Thermoregulation is also an important aspect of the active season for Townsend's big-eared bat, especially for the energetically-demanding processes of pregnancy and lactation. Adult females form maternity colonies in the warmest available suitably-protected roost sites. Such warm locations minimize the energy lost as heat during pregnancy and help newborn and young pups conserve energy for growth. Clustering behavior of females and their young further enhances energy conservation and cluster size has been observed to increase and decrease based on the ambient temperature of the roost site (Betts 2010).

Habitat Utilization

Habitat associations for Townsend's big-eared bat in California include the inland deserts, cool, moist coastal redwood forests, oak woodlands of the inner Coast Ranges and Sierra Nevada foothills, and lower to mid-elevation mixed coniferous-deciduous forests. Townsend's big-eared bat has also been observed hibernating in the bristlecone-limber pine habitat (Szewczak et al. 1998) of the White Mountains (Inyo County). Distribution is patchy within these types and is strongly correlated with the availability of caves and cave-like roosting habitat, with population centers occurring in areas dominated by exposed, cavity forming rock and/or historic mining districts (Genter 1986, Graham 1966, Humphrey and Kunz 1976, Kunz and Martin 1982, Perkins et al. 1994, Pierson and Rainey 1998). The species' habit of roosting on open surfaces within roost sites makes it readily detectable and it is often the species

most frequently observed (but often in low numbers) in caves and abandoned mines throughout its range.

Roosting Habitat. Townsend's big-eared bat prefers open surfaces of caves or cave-like structures, such as mine adits and shafts (Barbour and Davis 1969, Graham 1966, Humphrey and Kunz 1976). It has also has been reported in such structures as buildings, bridges, and water diversion tunnels that offer a cave-like environment (Barbour and Davis 1969, Dalquest 1947, Howell 1920, Kunz and Martin 1982, Pearson et al. 1952, Perkins and Levesque 1987, Brown et al. 1994, Pierson and Rainey 1998). It has been found in rock crevices and, like a number of bat species (Gellman and Zielinski 1996), in large hollow trees (Fellers and Pierson 2002, Mazurek 2004). Roosting structures often contain multiple openings. The species seems to prefer dome-like areas, possibly where heat or cold is trapped (warm pockets for maternal roosting, cold pockets for hibernation).

Deleted: cavernous

Deleted: Zielinksi

Specific roosts may be used at only one time of year or may serve different functions throughout the year, such as for maternity roosts, hibernation, or other uses (Sherwin et al. 2000, 2003). Roosting surfaces often occur in locations with partial light during the day; however, some roost surfaces have been found very deep inside caves or mines. Of 54 maternity roost sites tabulated by Pierson and Fellers (1998), 43% were in caves, 39% were in mines, and 18% were in buildings.

Townsend's big-eared bat appears to have fairly restrictive roost requirements (Humphrey and Kunz 1976, Perkins et al. 1994, Pierson et al. 1991). Roost temperature appears to be critical (Lacki et al. 1994, Pearson et al. 1952, Pierson and Rainey 1998). Temperatures vary in maternity roosts throughout California from 19°C (66°F) in cooler regions to 30°C (86°F) in warmer southern regions (Pierson et al. 1991). Some colonies are known to change roosts during the maternity season, using cooler roosts earlier in the year (Pierson et al. 1991, P. Brown pers. comm., V. Dalton pers. comm.) and using warmer roosts while pup-rearing. Roost dimensions are also important. The majority of the roosts examined in California are fairly spacious, at least 30 m (100 ft) in length, with the roosting surface located at least 2 m (6.5 ft) above the ground, and a roost opening at least 15 cm by 62 cm (6 inches by 24 inches) (Pierson et al. 1991). Maternity clusters are always situated on open surfaces, often in roof pockets or along the walls just inside the roost entrance, within the twilight zone.

Night roosts include caves, rock shelters, open buildings, mines and bridges. They may be smaller than typical day roosts and are almost always singly occupied (Pierson and Fellers 1998).

Foraging Habitat. Foraging associations include edge habitats along streams and areas adjacent to and within a variety of wooded habitats (Brown et al. 1994, Fellers and Pierson 2002, Pierson et al. 2002). Radiotracking and light-tagging studies have found Townsend's big-eared bat foraging in a variety of habitats, including within collapsed lava tubes and trenches (Pierson and Fellers 1998). Brown et al. (1994) showed that on Santa Cruz Island in California, Townsend's big-eared bat avoided the lush introduced vegetation near their day roost, and traveled up to 5 km (3 mi) to feed in native oak and ironwood forest. P. Brown (pers. comm.) also documented Townsend's big-eared bat foraging in desert canyons with water on the west slopes of the Panamint Mountains (Inyo County).

Radiotracking and light-tagging studies in northern California have found Townsend's big-eared bat foraging within forested habitat, within the canopy of oaks (Pierson and Rainey unpubl. data), and along heavily vegetated stream corridors, avoiding open, grazed pasture land (Fellers and Pierson 2002). In Oklahoma, *C. townsendii ingens* more frequently used edge habitats (along intermittent streams) and open areas (pastures, agricultural fields, native grass) compared to wooded habitat (Clark et al. 1993), but also tended to focus foraging along canyon walls (Caire et al. 1984).

Light-tagging studies in West Virginia (V. Dalton pers. comm.) showed a bimodal foraging pattern for *C. t. virginianus*, with animals foraging over hayfields during the first part of the night, and within the forest later in the night, traveling up to 13 km (8 mi) from the day roost. They foraged as long as weather permitted in the fall, and were periodically active in winter (Pierson et al. 1991). Townsend's big-eared bats have been observed flying in a snowstorm (G. Tatarian pers. comm.).

CONSERVATION STATUS

Despite the long-standing designation of Townsend's big-eared bat as a Species of Special Concern in California (Williams 1986), there has not been a statewide effort to assess the conservation status of the species since Pierson and Rainey's work in the late 1980s and early 1990s (Pierson and Rainey 1998). CDFW is working with a contract team from Humboldt State University and Texas A & M University to survey maternity roosts and hibernacula over the next two years. This effort will serve as a comprehensive update to the Pierson and Rainey effort, but the results of this new project will not be available until 2017.

In the meantime, and in the interest of informing the Commission's decision on whether to list Townsend's big-eared bat according the statutory schedule required by CESA, CDFW offers the following summary of the conservation status of the species. This summary is based on a variety of recent and on-going efforts to study and monitor Townsend's big-eared bat in California and elsewhere.

Comment [WR6]: The design of the new study incorporates some level of sampling in semi-randomized sites for possible detection of the species in a set of habitat types where it has not previously been sampled. However, the data collected are on presence/absence. Thu s it primarily addresses distribution, but not abundance measures. Though there are regions of California where the species has essentially disappeared often in association with urbanization , a major feature of reasons for concern about this species has been repeated observation of marked declines in maternity colony size. Colony size can play a role in reproductive output and juvenile survival.

Regulatory Status

State, federal and non-governmental organizations designate "at risk" species (e.g., threatened and endangered species, Species of Special Concern, Species of Greatest Conservation Need, etc.) and assess and rank their conservation needs. Status designations for Townsend's big-eared bat are summarized below by jurisdiction or organization:

State of California Status. The Fish and Game Commission designated Townsend's big-eared bat a "candidate" for listing as endangered or threatened under CESA, effective December 27, 2013. With the notice of its candidacy for listing, the CESA prohibition against unauthorized "take" of Townsend's big-eared bat is currently in effect. (Fish & G. Code, §§ 2080, 2085). "Take" is defined in the Fish & G. Code as to hunt, pursue, catch, capture, or kill, or to attempt to engage in any of these activities. (*Id.*, § 86.) Take of species protected by CESA, including Townsend's big-eared bat, may be authorized under certain circumstances.

"Species of Special Concern" (SSC) is a Department administrative designation intended to alert biologists, land managers, and others to a species' declining status and to encourage additional management considerations for these species to ensure population viability and to preclude the need for listing. SSCs are defined as species, subspecies, or distinct populations of an animal native to California that currently satisfies one or more of the following (not necessarily mutually exclusive) criteria: extirpated from the State or, in the case of birds, in its primary seasonal or breeding role; listed under the federal Endangered Species Act (but not CESA) as threatened or endangered; meets the State definition of threatened or endangered but has not been formally listed; is experiencing, or formerly experienced, serious (noncyclical) population declines or range retractions (that have not been reversed) that, if continued or resumed, could qualify it for State threatened or endangered status; has naturally small populations exhibiting high susceptibility to risk from any factor(s), that if realized, could lead to declines that would qualify it for State threatened or endangered status (Comrack et al. 2008).

Townsend's big-eared bat has been designated as a Mammal Species of Special Concern (MSSC) since the list was established in 1986 (Williams 1986). The MSSC list is now undergoing a formal update and

revision using an objective, criterion-based method developed by CDFW (see Shuford and Gardali 2008 for a recent published example of the current method). As part of the update process, Townsend's big-eared bat has been evaluated, scored, and ranked using eight criteria along with all other terrestrial mammal taxa naturally occurring in California. Based on current information, it is likely Townsend's big-eared bat will be on the updated MSSC list (assuming it is not CESA-listed as threatened or endangered first).

Projects carried out on state and private lands that are funded or authorized by public agencies (such as highway construction, residential and commercial development, and energy development projects) are subject to the provisions of California Environmental Quality Act (California Public Resources Code, Division 13, section 21000 *et seq*. and Guidelines published under the California Code of Regulations, Title 14, section 150000 *et seq*.). CEQA requires that actions that may substantially reduce the habitat, decrease the number, or restrict the range of any species that can be considered rare, threatened, or endangered (regardless of status under state or federal law) must be identified, disclosed, considered, and mitigated or justified. (Cal. Code Regs., tit. 14, §§ 15065(1), 15380.) Impacts to species identified as SSCs should be carefully evaluated in CEQA planning documents.

In summary, as a Candidate for CESA listing, Townsend's big-eared bat enjoys a high-level of assessment and disclosure of potential impacts of proposed CEQA projects. The standard "no-take" requirement for projects helps ensure that population-level impacts do not occur when a project is implemented. Should the species not be listed, then the SSC designation should still ensure that proposed projects include assessment and disclosure of potential impacts, but protection from impacts is less certain and take of individuals may occur.

Federal Status. Townsend's big-eared bat is not currently listed as endangered or threatened nor is it a candidate for listing under the federal Endangered Species Act. However, several federal land management agencies (e.g., U.S .Forest Service, Bureau of Land Management) have special management designations for the species. See the EXISTING MANAGEMENT, MONITORING, AND RESEARCH ACTIVITIES section below for additional information on federal agency management of Townsend's big-eared bat.

Status in Surrounding States.

Oregon – The Oregon Department of Fish and Wildlife (ODFW) designates Townsend's big-eared bat as a Sensitive/Critical species.[3] Sensitive species are "naturally-reproducing fish and wildlife species, subspecies, or populations which are facing one or more threats to their populations and/or habitats. Implementation of appropriate conservation measures to address the threats may prevent them from declining to the point of qualifying for threatened or endangered status." The Critical designation indicates ODFW has determined that Townsend's big-eared bat is a species "imperiled with extirpation from a specific geographic area of the state because of small population sizes, habitat loss or

[3] http://www.dfw.state.or.us/wildlife/diversity/species/sensitive_species.asp

degradation, and/or immediate threats. Critical species may decline to point of qualifying for threatened or endangered status if conservation actions are not taken."

Nevada – The Nevada Department of Wildlife (NDOW) does not have a special status designation for Townsend's big-eared bat. However, the Nevada Bat Conservation Plan (Bradley et al. 2006), which was adopted by a variety of state agencies and federal agency offices in Nevada, including NDOW, designates the species as "Sensitive." The Nevada Bat Conservation Plan designates the conservation risk to Townsend's big-eared bat as "High" (Bradley et al. 2006). According to the plan, "A far more broad-scaled and complete monitoring effort is needed in Nevada to truly discern the status and trend of this species."

Arizona – The Arizona Game and Fish Department (AGFD) published the Arizona Bat Conservation Strategic Plan (AGFD 2003). The plan outlines the current status of all 28 bat species occurring in Arizona. For Townsend's big-eared bat, the plan states that population trends and conservation status of the species is unclear, though some losses of maternity roost sites are known to have occurred. AGDF published an update to its State Wildlife Action Plan (SWAP) in 2011 (AGFD 2011), in which it designates Townsend's big-eared bat as a Tier 1B Species of Greatest Conservation Need. That status is based primarily on AGDF's determination that the species is in a "demographically poor situation: Unusually low birth rates or high death rates combined with small or declining population size. Demographic rates are affected by known stressors likely causing a worsening situation in parts of Arizona." The Arizona SWAP also notes the species' vulnerability due to its concentration at certain points in its life cycle (colonial roosting habits) and an unknown population trend in the state.

Non-governmental Organization Designations. NatureServe, a non-profit conservation organization whose mission is to provide the scientific basis for effective conservation action through its network of natural heritage programs, ranks Townsend's big-eared bat as a whole and each of the two non-listed subspecies (*pallescens* and *townsendii*) as "G3G4/T3T4" throughout their respective geographic ranges. This designation indicates uncertainty regarding conservation status, which may be characterized as either Apparently Secure (G4/T4) or Vulnerable (G3/T3).

NatureServe defines "Vulnerable" as "at moderate risk of extinction or elimination due to a restricted range, relatively few populations, recent and widespread declines, or other factors" and "Apparently Secure" as "Uncommon but not rare; some cause for long-term concern due to declines or other factors." (http://explorer.natureserve.org/granks.htm).

International Union for the Conservation of Nature (IUCN). The current version of the IUCN Red List (http://www.iucnredlist.org/details/17598/0) designates Townsend's big-eared bat as a 'Least Concern' species based on the latest assessment of the species range-wide. The IUCN had previously designated the species in 1996 as 'Vulnerable.' The Least Concern designation is based on "its wide distribution, presumed large population, occurrence in a number of protected areas and because it is unlikely to be declining at nearly the rate required to qualify for listing in a threatened category."

The Western Bat Working Group (WBWG) is a consortium of agency biologists, consultants, academic researchers, and other interested persons throughout the western states and Canada working to ensure

a coordinated approach to bat conservation in western North America (http://wbwg.org/). Based on its initial assessment of the conservation status of western bat species in 1998, WBWG rated Townsend's big-eared bat as "high" priority (the highest conservation concern designation). According to the WBWG website, this designation "represents those species considered the highest priority for funding, planning, and conservation actions. Information about status and threats to most species could result in effective conservation actions being implemented should a commitment to management exist. These species are imperiled or are at high risk of imperilment."

Bat Conservation International (BCI) is a not-for-profit organization dedicated to the conservation of "the world's bats and their ecosystems to ensure a healthy planet." BCI does not have an assessment of the conservation status of Townsend's big-eared bat on its website, but has published articles related to the importance of proper mine and cave management to ensure successful roosting of this and other cave/mine-dwelling bat species.

Current Distribution

Based on recent records, Townsend's big-eared bat appears to be fairly well distributed throughout much of its historic range in California. Figure 3 displays Townsend's big-eared bat observations in California symbolized by time period of observation. The observations are from a number of sources, including museum specimens, observations submitted to the California Natural Diversity Database (CNDDB), and capture and acoustic records from biologists permitted by CDFW to study Townsend's big-eared bat. No obvious pattern of a reduction in distribution is apparent in Figure 3, though it is likely that occurrences are now rarer in the South Coast and Bay Area than before urbanization.

Population Trends

Summary of Pierson and Rainey (1998) Statewide Assessment and Other Information Cited in the Petition

To describe Townsend's big-eared bat population trend in California, the Petition relied heavily on the work conducted by Pierson and Rainey (1998) for the Department of Fish and Game. Pierson and Rainey conducted surveys of Townsend's big-eared bat maternity colonies and hibernacula throughout much of the species' range in California during the period 1987 to 1991. Their study focused primarily on maternity colonies to assess population status and reproductive capacity. In addition to visiting and counting the numbers of bats at all known large (> 30 females) Townsend's big-eared bat maternity colony roost sites in California, the authors also searched for additional or alternate roost sites within 15 km (9.3 mi) of the known sites. The authors also visited five known Townsend's big-eared bat hibernation sites in California and described the observations of other researchers at several other hibernation sites. The authors developed several measures of population status and trend in their study, including total estimated number of adult females at maternity colonies in the state, total number of colonies, average size of maternity colonies, and average and total size of hibernation colonies.

The work by Pierson and Rainey (1998) showed a marked decline in the population size of Townsend's big-eared bat over the period between the original surveys of the maternity colony roost sites and the

re-surveys conducted by the authors. Eighteen historically known maternity colonies with population counts were assessed in the study. The original dates of detection ranged from 1918 to 1974, with most of the original surveys conducted in the 1930s through 1960s. Six of the colonies appeared to have been extirpated, five had declined in number of females by more than 20%, four had remained relatively constant in numbers, and three colonies had increased by more than 20%. The authors lumped all 18 colonies' original population counts to get a historical-period population estimate of 3,004 adult females. Based on their counts during the 1987-1991 surveys, they estimated these colonies had declined by 55% to a total of 1,365 adult females.

The authors also found a decline in the total number of colonies known from the historical period to the resurveys. Of 46 historically-known maternity colonies (many without population counts), the authors could not find 24 (either at the original site or within 15 km (9.3 mi) of the original site), which represented a 52% decrease in the number of historically-known colonies.

Additional maternity colonies were located in the period after 1980, either by the authors or reliably reported to the authors by other researchers. These colonies were sufficiently distant from historically-known colonies for the authors to conclude they were not part of the historical set. Although no conclusion about population trend could be made based on the inclusion of the additional colonies, Pierson and Rainey's (1998) point estimate for the total known adult female Townsend's big-eared bat population size in California was 4,252 individuals, which distributed among 39 maternity colonies. The authors cited reliable reports of four other colonies of unknown size. The Petition cites reports and personal communications of an additional four maternity colonies known as of 2003, as well as observations of lactating females in areas without known colonies, suggesting there are additional maternity colonies not yet discovered.

Pierson and Rainey (1998) also compared the average size of the 18 historically-known maternity colonies to the 38 colonies with population estimates known at the time of their study. They found average number of adult females in the historical colonies to be 164, while the currently-known colonies averaged 112 females. Thus, the recent colony size was 32% smaller than the historical colony size.

Pierson and Rainey (1998) also assessed the size of five historically-known hibernation colonies in California. One of the colonies (at Lava Beds National Monument) had remained stable at approximately 30 individuals. The other four, which had original counts of between 55 and 177 bats, showed dramatic declines of between 70% and 94%. These sites were in Shasta, Lake, and Napa counties.

The Petition also cited observations by Williams (1986), who was an active researcher of the conservation status of mammals in California in the latter half of the 20th century. As mentioned in the Petition, Williams (1986) stated his impression that Townsend's big-eared bat had been common in central California through the 1960s, but had dramatically declined by the early 1970s. Williams (1986) mentioned that he had only captured one individual Townsend's big-eared bat during his 14 years of work in central California in the 1970s and 1980s. Townsend's big-eared bat has been recently observed in the central coast area of California, on Department lands and Vandenberg Air Force Base (R. Stafford

Comment [WR7]: While recent data from Vandenberg and other sites is valuable, it seems puzzling that this is highlighted as a novel observation for that locality given Pierson et al.2002 included capture and other data for C. t.t. in a fairly extensive survey of bats at VAFB. The locality data were provided to DFG several times and the report though 'grey' literature is reasonably widely cited.
Pierson, E.D., et al.2002. Final report on the distribution, status and habitat associations of bat species on Vandenberg Air Force Base, Santa Barbara County, California. Santa Barbara Museum of Natural History, Santa Barbara CA. Technical Rept. 1. i-xii, 1-135.

2014, 2015 pers. comm.; R. Evans 2014 pers. comm.). These observations, which included a maternity roost site for both of the jurisdictions, as well as a large extant maternity colony at Hearst San Simeon State Historical Monument, indicate the species continues to occur in the region, although no information on population or range trend is available for this area.

Other published observations of declines in Townsend's big-eared bat colonies in the Sierra Nevada and lower Colorado River area (Graham 1966, Stager 1939) were mentioned in the Petition.

In summary, the best quantitative information on the population status of Townsend's big-eared bat cited in the Petition is Pierson and Rainey's (1998) statewide assessment, which showed that, of the 18 historically-known maternity roost sites with population counts, six of the colonies had been extirpated by the time the authors conducted their work. Another six colonies showed a decline in the number of adult female Townsend's big-eared bat present. Although five colonies had increased in size (and one remained stable at 50 females), the overall decline in numbers from the historical period appeared to be substantial.

These comparisons between historical and recent colony numbers, colony size, and total population counts suggested that, as of the early 1990s, there had been a decline in the total population of Townsend's big-eared bat in California since the early 20th century. This decline may have been substantial, but the historical data set was limited and therefore the magnitude of the population decline could not be exactly determined. In combination with other aspects of the species' biology and observations of human disturbance at Townsend's big-eared bat roost sites, the trend information collated by Pierson and Rainey (1998) led to the inference that the California Townsend's big-eared bat population had declined over the several decades before their study.

CDFW is aware of ongoing efforts to monitor or revisit several important Townsend's big-eared bat maternity and hibernation roosts in California. These efforts include monitoring at both hibernation and maternity colonies at Lava Beds National Monument (S. Thomas 2013 pers. comm.), revisiting known Townsend's big-eared bat hibernacula in the White and Inyo mountains (Szewczak et al. 1999, M. Morrison 2013 pers. comm.), long-term annual counts of a maternity colony in a historical building in Sierra County (W. Copren 2013 pers. comm.), as well as at other sites. The following section summarizes recent results from these ongoing monitoring efforts.

Townsend's Big-Eared Bat Roost Site Monitoring Case Studies

To assess Townsend's big-eared bat population trends since Pierson and Rainey's (1998) work, CDFW has compiled information from a number of maternity and hibernation roost sites from around California. The following is a summary of studies that assess the population trend at specific sites. While this summary does not comprise a statistically valid estimate of the Townsend's big-eared bat population size or trend statewide, it does illustrate how population status varies around the state, as well as how management of roost sites directly affects the population status in an area. Locations referenced here are depicted in Figure 4.

Randall House Maternity Roost (Marin County). Fellers and Halstead (2015) reported results from 25 years of monitoring the Randall House maternity roost site in Marin County. The Randall House is a two-story late 19th Century ranch house situated in a valley at Point Reyes National Seashore. It was last used by humans in the 1970s and in 1987 was discovered to be the site of a Townsend's big-eared bat maternity colony. At that time, the colony numbered 95 adult females. The site had been subject to repeated break-ins by local teenagers prior to 1987, but, upon discovery of the Townsend's big-eared bat colony, the National Park Service fortified the house against unauthorized entry and has since maintained the house for use by the bats.

Using night-vision equipment, Fellers and his collaborators conducted 178 exit counts of Townsend's big-eared bat during the maternity season between 1988 and 2012. In addition to information on the number of adult females and young present at the site, this long-term monitoring study also yielded important information on the effects of human disturbance on colony status, effects of season and environmental factors on emergence time from the roost, and other natural history aspects of the species.

Over the course of the 25-year study, the Randall House Townsend's big-eared bat maternity colony increased in size (see Figure 5B). Adult female maximum number recorded increased from 95 in 1988 to 395 in 2012. The maximum recorded number of adult females plus volant young increased from 176 to 512. The annual rate of increase was estimated to be 8.7% for adult females and 5.3% for volant young.

Attempted and successful break-ins to the roost building occurred occasionally during the study period, despite increased security at the site. These disturbance events were documented and the authors found a significant negative correlation between disturbance events and subsequent numbers of adult females and volant young (compare Figures 5A and 5B). In other words, there were fewer Townsend's big-eared bat adults and young at the roost site in years with human disturbance events.

The authors note the Randall House is one of the most important remaining Townsend's big-eared bat maternity roost sites in coastal California. Because of the NPS commitment to maintaining the Randall House for Townsend's big-eared bat use, it is one of the few maternity roosts classified by Pierson and Rainey (1998) as "secure." Prior to its discovery in 1987, two other nearby historical roost sites (the Olema Inn and an old barn near Inverness) had already been lost. Fellers and Halstead (2015) note that only one other Townsend's big-eared bat maternity roost is known in the area and, although also located on NPS land, it is structurally dilapidated and its long-term suitability for Townsend's big-eared bat use is questionable. Like other old wooden buildings used by Townsend's big-eared bat around the state, these structures are vulnerable to degradation and loss over time. Replacement structures tend to be made of materials and use designs less suitable for bats.

Comment [WR8]: A major is sue not yet mentioned is use intensification. Typically restablishment of active human occupation of structures comes with the view that bat colonies inside the structure cannot be tolerated. This has contributed to the removal of P.t.t. and other colonies in historic structures on state parks lands. NPS protection of the Randall House colony and the following example contrast with typical experience elsewhere with State or local jurisdiction parks and NPS in that historic structure staff view bats as structure degrading vermin and managers want to exclude them based on health risks.

Nevertheless, the Randall House is an example of how management of a roost structure may allow Townsend's big-eared bat to continue to occupy an area and even expand in numbers over time.

Kentucky Mine Maternity Roost (Sierra County). The Kentucky Mine Historic Park and Museum is located in Sierra City, Sierra County, at an elevation of 1340 m (4400 ft). The Kentucky Mine Townsend's

big-eared bat maternity colony was not known at the time of Pierson and Rainey's 1980s and early 1990s statewide assessment. The colony primarily roosts in a historical mine building (a stamp mill used to crush ore excavated from the nearby mine), but the bats appear to also use the nearby mine itself as an alternate roost site (M. Tierney 2015 pers. comm.).

As described by Freeman (2012), unlike most Townsend's big-eared bat maternity colonies, "this colony has acclimated to a level of disturbance typically considered intolerable for *C. townsendii*. The Sierra County Historical Society leads tours twice a day through the stamp mill throughout the maternity period. During these tours, guides wind up a massive iron stamp and let it pound down to demonstrate how it crushes rocks to remove the gold. This noisy activity frequently occurs directly beneath the roosting bats and causes the entire building to quiver. The grounds surrounding the stamp mill permit daily public use. On weekends, human disturbance continues into the night. An outdoor amphitheater located less than 50 meters from the colony is used for concerts during the nursery season. This colony persists despite these disturbances."

The U.S. Forest Service prepared a management plan for the colony in 2007 (Tierney and Freeman 2007) and the Sierra County Historical Society, which operates the park and museum, cooperates with the U.S. Forest Service to manage the risk of disturbance to the colony by following the recommendations of the plan (W. Copren 2012 pers. comm.; M. Tierney 2015 pers. comm.). Among the plan's guidelines are measures to make the on-going human activities at the roost site consistent and predictable to allow the bats to acclimate to disturbance.

Exit counts from the stamp mill during the maternity season have been conducted by the U.S. Forest Service and others since 1994, along with occasional roost counts within the stamp mill and exit counts from the shafts of the mine itself. Data are available for the period 1994 through 2005 (Tierney, unpublished data). Depending on year, the counts at the stamp mill were conducted at various times during the maternity season (and therefore may include either adult females only or adult females and their young). The counts were sometimes conducted on nights when the colony was apparently roosting at an alternative site. The exit count data at first glance is irregular (Figure 6A).

Removing exit counts at the stamp mill roost with anomalously low numbers suggesting the bats were roosting at an alternative site (counts with fewer than 20 bats in years with other counts of 40 or more bats) and by separating the counts into the pre-volancy and volancy periods of the young (before mid-July and after the third week of July), a clearer pattern develops (Figures 6A and 6B).

Early season counts (consisting of adult females only) at the Kentucky Mine have generally been in the range of 30 to 50 bats since the first count of 66 bats was made in late June 1994. After young achieve flight starting around the last week of July, counts have varied between lows of around 35 in the late 1990s to between 50 and about 100 in the early 2000s (Figure 6A). Exit count data at the mine shaft roost site in late August and early September 2003 totaled 140 and 168 bats, but it is possible these very late counts included adult males as well as females and young of the year (Figure 6B).

CDFW does not have access to more recent exit count data from Kentucky Mill, but the U.S. Forest Service's estimate from data collected subsequent to 2005 is that the colony size has been fairly stable at or near 100 adult females (M. Tierney 2015 pers. comm.; K. Freeman 2015 pers. comm.).

Lava Beds National Monument Maternity Roosts (Siskiyou and Modoc counties). Lava Beds National Monument (LBNM) is located in northeastern California. The monument contains the largest concentration of lava caves in the contiguous United States; LBNM staff had identified more than 750 caves by 2013. The extensive network of caves at Lava Beds National Monument in Siskiyou and Modoc counties is considered a major population center for California's Townsend's big-eared bat population (Pierson and Rainey 1998). During the last statewide assessment of the species, it was estimated that a quarter of the state's breeding female population occurred at LBNM (Pierson and Rainey 1998). These caves have been monitored for Townsend's big-eared bat presence during the maternity season over the past couple of decades, but because of Townsend's big-eared bat's known sensitivity to disturbance, most surveys during the active season have been limited to quick checks for presence or absence of bats (T. Weller 2014 pers. comm.). Counts of bats were infrequently made during these surveys and only rough estimates of bat numbers are available. In accordance with cave resource management guidelines, caves where Townsend's big-eared bats were observed during the active season were then subsequently closed to recreational access.

Efforts to monitor the Townsend's big-eared bat population at LBNM during the maternity season take a light-touch approach to minimize the risk of disturbance at the roost sites. Three Townsend's big-eared bat maternity colonies are monitored for presence/absence and to collect cave microclimate data (temperature and relative humidity). Depending on staff availability, the monitoring occurs on a variable schedule of between once per week to once per month (Katrina Smith 2015 pers. comm.). Exit counts have also been conducted, but conditions are not conducive to accurate counts (Katrina Smith 2015 pers. comm.).

As part of his analysis of recent (1990s and later) Townsend's big-eared bat monitoring data from LBNM, Weller attempted to discern patterns of occupancy by date and location during the active season (T. Weller 2014 pers. comm.). Apart from very general conclusions about the timing of the maternity season, no pattern of occupancy in particular caves at particular dates, nor trend in bat population size, may be discerned from these data (T. Weller 2014 pers. comm.). Weller concluded the known roost-switching behavior of Townsend's big-eared bat during the maternity season and the opportunistic and infrequent attempts to monitor Townsend's big-eared bat at LBNM during the active season preclude inferences about active season population trends using existing data. He advocated instead the use of Townsend's big-eared bat counts at hibernacula, where individual bats may reliably be counted during the inactive season (and without undue disturbance of the bats) as the preferred method to estimate population size and trend. See below for a summary of results of LBNM hibernaculum monitoring (Weller et al. 2014).

Lava Beds National Monument Hibernacula (Modoc and Siskiyou counties). The Lava Beds area of northern California is home to one of the most important populations of Townsend's big-eared bat in California (Pierson and Rainey 1996). The National Park Service at Lava Beds National Monument

(LBNM) has monitored winter bat use of the lava tubes and caves for many years (Weller et al. 2014). Townsend's big-eared bat are the most commonly encountered bat species in winter because of their habit of roosting in the open, but Myotis bats (*Myotis* sp.) and big brown bats (*Eptesicus fuscus*) are also occasionally observed (Katrina Smith 2015 pers. comm.).

NPS considers the period from November 15 to March 15 to encompass the Townsend's big-eared bat hibernation season at LBNM. Any bat survey completed in caves during this period is included in the LBNM bat database and is considered hibernacula monitoring data. In recent years, a focused effort to monitor the hibernating bat population at LBNM has been conducted, with one entire week in mid-winter devoted to completing as many bat hibernacula surveys as possible. NPS staff and collaborators use a stratified random sampling method to select caves for survey based on the number of bats seen there in previous years. This allows collection of annual data on large known hibernacula and also to survey sites that have never been visited in winter. Using this method, in the past few years NPS has discovered four new hibernation sites with more than 30 bats, plus several sites with smaller numbers of Townsend's big-eared bat.

Winter bat surveys at LBNM use headlamps and other caving gear to enter caves to tally all visually observed hibernating bats. Townsend's big-eared bats typically hibernate singly or in small groups, generally consisting of fewer than 20 individuals, though larger clusters are occasionally observed. Along with counts of bats by species and location within the caves, cave microclimate data (air temperature, ceiling temperature, and relative humidity) are also recorded (Katrina Smith 2015 pers. comm.).

Weller et al. (2014) analyzed the results of NPS Townsend's big-eared bat hibernacula monitoring data from a 22-year period (1991-2012) at LBNM to determine if a trend in the number of Townsend's big-eared bat hibernating could be discerned. Over this period, bats were counted in a total of 52 caves. Although a concerted effort was made by NPS to monitor hibernating bats each year, the number of caves visited and number of surveys conducted varied based on staff availability. These analyses were also used to design a flexible yet statistically robust monitoring program in future years.

Weller et al. (2014) used regression analysis to model the changes and trend in Townsend's big-eared bat numbers at each cave that had at least four surveys conducted from 1991 and 2012, and for which at least half of the surveys had at least one bat recorded. Using these models, the authors generated predicted numbers of Townsend's big-eared bat for each cave in non-survey years, as well as for 2012. The 2012 predictions were compared to the actual counts for that year. They also estimated the total number of Townsend's big-eared bat hibernating in all the caves each year by combining actual counts and estimated numbers.

Seventeen of the 22 caves monitored during at least four years had a positive trend in the number of hibernating Townsend's big-eared bat during the 22-year study period (Figure 6), although not all of these were statistically significant. Most of these caves had large numbers of hibernating Townsend's big-eared bat. The decreasing trends for the other five caves were not statistically significant, nor did any of these caves ever have more than 10 Townsend's big-eared bat observed in a count.

The authors estimated the number of hibernating bats in the 52 surveyed caves increased from 834 bats in 1991 to 1,427 bats in 2012 (Figure 7). The estimated cumulative annual growth rate for the 52 caves over the period 1991–2012 was about 1.8% (Figure 8). The estimated annual population growth rate for the caves surveyed most often was about 4%. Estimates based on data from 1991 to 2011 generally predicted the 2012 counts well; however, the actual bats counted in most caves exceeded the predicted numbers in 2012. Seven caves had their highest count in 2012 and another three equaled their previous high count.

Although 52 caves among the 97 surveyed during the 22-year study period were observed to have hibernating Townsend's big-eared bats during one or more years, Cave L970 stands out as an especially important site. In 1990, 376 bats were counted there and it has consistently held the majority of bats counted each year (see Table 1 from Weller et al. 2014).

Although the authors list a number of caveats regarding their results, they are "confident that the number of bats in the 52 surveyed caves has increased or, at the least, remained stable." They state "the increasing number of hibernating individuals reaffirms LBNM as a population stronghold for Townsend's big-eared bats in a state (Pierson and Rainey 1998) and region (Pierson et al. 1999) where it is considered imperiled. Potential ecological explanations for the increase in hibernating bats are unclear but could be related to changes in management policy at LBNM. Beginning in 1991, approximately 10 caves were closed during the maternity period to limit disturbance of maternity colonies by visitors. Lava Beds National Monument also closed winter hibernation sites to visitors, starting with a few sites in the 1990s and increasing to nearly 20 caves by 2012."

Pinnacles National Park Maternity and Hibernation Roosts (San Benito County). Pinnacles National Park, located about 65 km (40 mi) east of Monterey, encompasses approximately 9,700 ha (24,000 acres). Pinnacles National Monument (later Park) was established to protect and allow public use of the unique talus cave systems found there, which are formed from the remnants of a 23-million-year-old volcano. The Townsend's big-eared bat maternity colony that occurs in the cave system at Pinnacles National Park was not known at the time of Pierson and Rainey's statewide survey in the 1980s and early 1990s. Following its discovery in 1997, NPS closed the cave to the public for 4 years to allow the bats undisturbed use of the cave and to determine how best to manage the site (NPS 2002). The Pinnacles roost site is used by the local Townsend's big-eared bat population both for hibernation and for the maternity season. Portions of the cave are warm enough during the maternity season for gestation and pup-rearing, while other sections are cool enough in the winter to provide a suitable environment for hibernation. After the period of study, NPS adopted a management policy for the site that allows park visitors to seasonally access the portions of the caves not in use by the bats (NPS 2002, Paul Johnson 2015 pers. comm.).

NPS conducts annual monitoring of the Townsend's big-eared bat population, usually during both the maternity and hibernation seasons, to determine the effectiveness of this management strategy as well as to verify the dates for shifting visitor access. Because of the porous nature of the talus caves at Pinnacles, it is not possible to conduct exit counts at one or a few entrances to the roosts. Instead, NPS staff attempt to conduct visual counts of the maternity colony and hibernating bats within the roosts.

Precise counts are not always possible due to limited access by humans to areas used by the bats, as well as the importance of minimizing disturbance to the roosting bats.

Over the period from 1997 to 2014, the total maternity colony size (sometimes including pups) has ranged from about 150 to possibly as high as 1000 individuals; though in most years the total maternity colony size ranges between 200 and 400 individuals (Table 2). The hibernaculum counts are generally lower than the maternity roost counts (possibly due to dispersed winter roosting habits), ranging from about 15 to 400 individuals, with many years having counts of around 200 individuals (Table 2). The annual count data shows an early increase in the total numbers of Townsend's big-eared bat individuals counted in both the maternity and hibernation seasons. This apparent increase in colony size may be attributed to the public cave closure from 1997 to 2002, followed by the adoption of the current management strategy of seasonal public access to the caves. Additional factors affecting the data are the intensity and frequency of survey effort in a given year. According to the NPS staff familiar with the surveys, the later years reported here had fewer survey visits to the roost site, which made it less likely that peak numbers would be detected in a given year (Paul Johnson 2015 pers. comm.). Despite the apparent decline in colony size since 2005-2006, NPS considers the Pinnacles Townsend's big-eared bat population to be relatively stable (Paul Johnson 2015 pers. comm.).

Hearst Castle Maternity Roost (San Luis Obispo County). The Townsend's big-eared bat maternity colony at Hearst San Simeon State Historical Monument was not known at the time of Pierson and Rainey's (1998) statewide survey. The Townsend's big-eared bat roost site was discovered during an assessment by Department of Parks and Recreation (DPR) of the bats occurring at Hearst Castle in 2000 (K. Miner 2015 pers. comm.). The maternity roost site is located in a cavernous space within the reinforced concrete stair and landing structure at the main entrance to the complex of mansions that comprise Hearst Castle. Prior to the survey, the space was regular inspected for structure integrity and used for closed-space rescue training by park staff during the maternity season, who reported that bats were disturbed by their presence. Once discovered that it was being used by Townsend's big-eared bats, DPR limited entry during the maternity season to only necessary safety inspections. Prior to 2003, Townsend's big-eared bats entered and exited the roost space through a narrow space below a screened door, forcing the bats to crawl on the ground. In 2003, the site was modified by adding two openings to the roost at more typical locations above the ground and sized to accommodate flying Townsend's big-eared bats accessing the site (R. Orr 2015 pers. comm.). DPR also developed management guidance to ensure maintenance and repair activities at the site have minimal impact on roosting bats, including Townsend's big-eared bat (DPR 2003).

Exit counts conducted by DPR staff since 2000 suggest the management of the site has enabled the colony to thrive. Most of the exit counts at the Townsend's big-eared bat roost have been conducted during late August, at which time the counts would likely include both adult females and their volant young and possibly adult males, as well. Late summer exit counts ranged from 60 to 95 total individuals prior to the roost entrance modification work. Since the modification and adoption of the bat protection policy in 2003, total counts of Townsend's big-eared bat during the late summer have

increased fairly steadily through the years (Figure 9). Over the period 2012-2014, late summer counts ranged from 413 to 813 total Townsend's big-eared bat individuals at the site.

Comment [WR9]: Includingadults plus young of the year. Pre-parturition counts are highly desirabke

Santa Cruz Island Maternity Colony (Channel Islands National Park). Santa Cruz Island is the largest and most habitat-diverse of California's Channel Islands and it is the only Channel Island known to harbor a reproductive colony of Townsend's big-eared bat (Brown et al. 1994). Because of its distance to the mainland, it is thought that the Santa Cruz Island Townsend's big-eared bat population may be isolated from other Townsend's big-eared bat populations. If so, it is possible the island population may have unique genetic characteristics. The Santa Cruz Island colony was first described in 1939 as roosting in a 2-story ranch house at Prisoners Harbor on the north-central side of the island. At that time, it was estimated to number more than 300 individuals, which were likely both adult females and their volant young (Brown et al. 1994). A total of 246 individuals were collected for scientific collections during this and two subsequent collection trips in 1949 and 1964 (Brown et al. 1994). Pierson and Rainey (1998) cited Museum of Vertebrate Zoology records as stating the colony in 1948 numbered 150 adult females.

At some point between the mid-1960s and 1974, the Prisoners Harbor ranch house was demolished. Despite extensive searches, Townsend's big-eared bat roosting in substantial numbers on Santa Cruz Island were not observed again until 1991, when they were reported to Pat Brown as occurring in the Bakery in an old adobe building at Scorpion Ranch on the northeast end of the island (Brown et al. 1994). It is not clear whether the Scorpion Ranch site was colonized by Townsend's big-eared bat displaced from Prisoners Harbor or if it was already in use prior to the loss of the Prisoners Harbor site. The National Park Service has since then assumed management of the entire island, including the Scorpion Ranch buildings, as part of the Channel Islands National Park.

NPS and others have conducted regular exit counts at the maternity roost site during the spring (adult females only) and late summer (adult females and their young). Exit count data available to CDFW suggest the number of Townsend's big-eared bats at Scorpion Ranch have never been as high as at the Prisoners Harbor roost site. Spring counts in the early 2000s ranged from about 50 to 105 adult females, while fall counts ranged from about 75 to 165 adult females and their young.

Work was conducted in 2009 to renovate and reoccupy other portions of the old adobe building. Exit counts by NPS personnel at the bakery roost site continued during maternity season during this time (T. Coonan 2014 pers. comm.). During the 4-year period from 2010 to 2013, the bakery roost site was abandoned, either temporarily (2010 and 2011) or for the remainder of the maternity season (2012 and 2013). The latter abandonment events resulted in the known death of pups at the caves to which the adult females had moved. Early season counts suggest between 60 and 90 adult females arrived at the roost site each year. The cause(s) and exact dates of abandonment are not known, but could include public visitor entrance over the half-door into the roost site or other activity in and around the building, including use of other rooms within the building by NPS personnel.

Proposals have been made to increase monitoring activity at the maternity roost site to more closely track human activity and bat numbers (T. Coonan 2014 pers. comm.), as well as to exclude human

entrance into the roost site with a bat-friendly gate. These proposals have not been implemented due to lack of funding (T. Coonan 2014 pers. comm.).

In summary, the Santa Cruz Island Townsend's big-eared bat population has fared relatively poorly since it was first described in 1939. Repeated collections for scientific purposes, demolition or reconfiguration of roost sites, and disturbance have all impacted the population, which had its highest recorded number (more than 300) reported when it was first counted. Although the failed or reduced recruitment that occurred during 2010 through 2013 may not yet have significantly reduced the population size of this long-lived species, repeated reproductive failures will impact the age structure of the population. If reproductive failure of this colony continues, it is possible the Santa Cruz Island Townsend's big-eared bat population may become extirpated.

White-Inyo Mountains Hibernacula (Tulare and Mono counties). Szewczak et al. (1998) conducted an extensive survey program for bats in the White and Inyo Mountains from 1990 through 1996. As part of that survey effort, many observations of Townsend's big-eared bat were made, along with counts of Townsend's big-eared bat in individual hibernacula, which typically were in caves and abandoned mines. The authors have revisited many of the hibernation roosts since the original study was completed (M. Morrison 2014 pers. comm.). Some hibernation sites were repeatedly surveyed over multiple years while others were surveyed only once.

Morrison and Szewczak conducted 92 surveys of 47 sites within 28 different mines and caves in the study area from 1991 to 2014 (M. Morrison 2014 pers. comm.). Counts of hibernating Townsend's big-eared bat ranged from 0 to 80 individuals per site. The median count per site for all Townsend's big-eared bat surveys was 4 individuals. Of the 47 sites, 33 were surveyed more than once. Of these, 62% of the sites had a decrease in the number of hibernating Townsend's big-eared bat, 19% showed an increase in numbers, 16% showed an initial increase but then decreased in recent years, and 3% showed an initial decrease and then increase in recent years. A mean decrease of 3 individuals per site was recorded among the revisited sites.

These data from Townsend's big-eared bat hibernacula in the White and Inyo mountains are preliminary and do not lend themselves to strong conclusions. However, the preliminary data suggest that, unlike the situation at Lava Beds National Monument, the Townsend's big-eared bat population in the southeastern part of the state may be decreasing.

Summary of Population Monitoring Studies. Table 3 summarizes the results of monitoring of Townsend's big-eared bat hibernation and maternity colonies at the aforementioned sites. Two of the sites (one hibernation and one maternity) had statistically significant increases in total population size over two-plus decades of monitoring. At the other sites, no statistical conclusions could be made about population trend.

Because the total current Townsend's big-eared bat population size and the status of many roost sites in California are unknown, CDFW applied for and received a State Wildlife Grant from the U.S. Fish and Wildlife Service to conduct a two-year study to address this information need. This study, which is being

conducted in collaboration with researchers from Humboldt State University and Texas A&M University, will provide a current snapshot of the species' population size relative to the estimates made by Pierson and Rainey (1998) for the historical period (pre-1980) as well as the estimates made by Pierson and Rainey based on their own survey work in the 1980s and 1990s. It is hoped that the current study will provide CDFW and the Fish and Game Commission a much clearer picture of the species' status in California than do the isolated case studies summarized here. The results of the two-year study are expected to be available by June 2017

Comment [WR10]: As noted earlier, this study is taking presence absence data at multiple sites so the information on population size is limited by design. Counts of colonies are not being made so clonypopulation trends (other than absence) are not being addressed. Is a puzzling decision given the effort in rteaching multiple sites.

Threats

CDFW has identified the following factors as potential threats to the continued existence of Townsend's big-eared bat in California: loss, degradation, and disturbance at roost sites; loss and degradation of foraging habitat; disease; mining; environmental contaminants; climate change and drought; and overexploitation. Each of these topics is addressed below. Competition for resources (such as prey, water, and cover habitat) with other native or introduced species was considered as a potential threat but eliminated from further consideration due to lack of evidence that it may pose a threat to the continued existence of the species.

Roosting Site Loss, Structural Degradation, and Disturbance.

The availability of suitable roosting habitat is often posited as a limiting factor for western bat populations. For example, Pierson (1998) stated "considerable evidence suggests that roosts are limiting for many bat species." Hayes (2003) cites several authors that "hypothesized [roosts] to be the primary factor" limiting bat populations. That roosts may limit bat populations, including Townsend's big-eared bat, is a reasonable conclusion, given bats may use multiple roost sites with different characteristics during the year; that roost site suitability may be based on a narrow range of suitable temperatures, relative humidity, physical dimensions, and so on; and that such sites may occur in low numbers on the landscape.

Impacts to roost sites are an important threat to Townsend's big-eared bat. Such impacts include both physical loss/modification of the roost site as well as disturbance of bats at the roost site.

Within the North Coast region of California, the loss of old-growth conifers with large, cavernous basal hollows during late 19th and early to mid-20th century industrial-scale logging is presented as a likely explanation for the apparent decline of Townsend's big-eared bat populations in the coastal forest of northern and central California (Pierson and Rainey 1998). The association of Townsend's big-eared bat with large basal hollows has been demonstrated by the work of Pierson and Fellers (1998) and Mazurek (2004).

Comment [WR11]: When suitable roost tree habitat is maintained in parks or other restricted use lands (e.g., watersheds) intensifying recreational use and greater ease of access with growth of nearby road networks means more frequenct disturbance of extant tree hollows and a decline in suitability of these sites particularly for maternity roosts.

More recent and ongoing forestry practices that could impact Townsend's big-eared bat include harvest of remnant old-growth trees with suitable roosting cavities, as well as disturbance associated with timber operations, increased access to roost sites by human visitors, loss of oak woodlands (which may provide roost sites and certainly provide foraging habitat), conversion of forest to agriculture such as vineyards, and application of chemicals.

New and renewed mining operations have the potential to impact Townsend's big-eared bat roosting in old shaft/adit mines, either through disturbance of roosting bats or by destroying the old mine by conversion to open pit-style mining, or through natural collapse of abandoned mines. Four examples of the destruction or loss of Townsend's big-eared bat roost sites are described in the Petition.

Dam construction or modification can result in the inundation of Townsend's big-eared bat roost sites. The Petition mentions one large colony that was displaced by construction of the New Melones Dam on the Stanislaus River. As stated in the Petition, much of the dam-building, reconstruction, and license renewal in California occurs at the same elevations in the foothills of the Sierra Nevada and Klamath and Trinity mountains that are optimal for Townsend's big-eared bat roost sites.

Although generally considered a cave/mine roosting bat, Townsend's big-eared bat also roosts in large spaces in old buildings and in cavernous spaces in bridges and dams. Bats in such sites are subject to disturbance when humans enter for inspections or other activities. The roost sites themselves are subject to eventual deterioration or demolition. Pierson and Rainey (1998) documented the loss of several Townsend's big-eared bat roost sites found in buildings.

There is an ongoing interest among recreational explorers in caves and abandoned mines. There is also a collectible market for mining artifacts. People entering mines can disturb bats during the critical maternity and hibernation seasons. Townsend's big-eared bat appears to be particularly susceptible to such disturbance. Recreationists and homeless persons may also enter old buildings used as roosts and disturb bats. A house at the CDFW Chorro Creek Wildlife Area has provided a roost site for a Townsend's big-eared bat maternity colony off and on for several years. The site has been repeatedly abandoned by the bats after break-ins followed by subsequent re-occupancy after the house is resealed (R. Stafford 2014 pers. comm.). The same pattern of partial or complete abandonment has been observed at the Randall House maternity roost site (Fellers and Halstead 2015) and other sites.

While it is certainly true that natural roosting habitat for Townsend's big-eared bat has been impacted by humans over the past 150 years, it is important to consider that historical mining and building construction also added to the total available roost habitat in the state in the late 1800s and early 1900s. Assuming roost habitat is a limiting factor for Townsend's big-eared bat, it is likely that the carrying capacity for the species actually increased in the historical mining districts of California with the advent of historical mining and construction of buildings. It is unknown, however, to what degree the documented populations losses at natural roost sites of caves and large old trees with basal hollows have been offset by presumed historical population increases at man-made roost sites. Many of these old buildings and mines themselves have been subsequently impacted, and in many cases lost, since the historical period. Moreover, with the documented loss of approximately 95% of old-growth coastal redwood forest on California's North Coast (Fox 1989), it is likely that this region has suffered a substantial decrease in roost site availability during the historical period.

In summary, CDFW considers loss, degradation, and disturbance at roost sites to be an important threat to Townsend's big-eared bat in California. Given the species' known susceptibility to disturbance, its reliance on roost sites with a relatively narrow range of suitability, and the colonial nature of the

Comment [WR12]: List of impacts shuld mention underground mine closure without excluding bats.

Comment [WR13]: Particularly along the coast , in the Sieera foothills and on the suburbanizing margins of Los Angeles and other cities, intensification of human density and use includes restoration and reoccupation or repurposing of older structures which accommodate bats.

Comment [WR14]: And not infrequently kill bats

Comment [WR15]: Recrational disturbance effects on cave populations is not a new issue. Declines in Sierra foothill colonies in both karst and volcanic rock areas were show by the colony counts of the Stanford grotto priort to 1970.

Deleted: "artificial"

Comment [WR16]: This summary of habitat reduction should include the era of major reservoir contstruction. Flooding of caves at New Melones in a karst area was mentioned earlier but other mines and caves on the lower reaches predominantly of Sierra foothill rivers have also been inundated permanently. Planned expansion of existing reservoir storage will almost certainly continue to remove roosting habitat.

species, especially during the maternity season, it is possible that population-level or even statewide impacts could occur to the species from the loss or disturbance at relatively few roost sites.

Loss of Foraging Habitat (including water)

Loss of suitable foraging habitat has previously been identified as a threat to Townsend's big-eared bat (Pierson and Rainey 1998, Pierson and Fellers 1998). Ideal habitat for foraging likely includes a mix of edge and continuous vegetation cover. Land management practices that create large openings of low shrub or grass cover in forest and woodland areas, such as agricultural development and extensive clear-cutting reduce foraging habitat suitability for the species. Likewise, residential and urban development reduce available foraging habitat. This is especially true in the extensive, highly-developed regions along California's South Coast and Bay Area. Although individual Townsend's big-eared bats may still make forays into these areas, it is unlikely that populations could be supported in urbanized areas.

It has been estimated that 95 percent of California's riparian habitat, which is important for foraging Townsend's big-eared bats, has been lost to vegetation clearing or conversion and inundation behind dams (Katibah 1984). Climate change, including the effects of protracted or severe drought, may also negatively affect foraging habitat suitability and insect prey availability, both through vegetation changes and reductions in free surface water availability.

In summary, CDFW considers loss of foraging habitat to be a potential threat to Townsend's big-eared bat in California.

White Nose Syndrome and other Disease

White Nose Syndrome (WNS) is a disease that has killed more than 6 million bats in eastern North America (USFWS 2012). It is caused by *Pseudogymnoascus destructans* (Pd), a cold-loving fungus that is thought to have been introduced into northeastern North America from Europe sometime in the early 2000s. The fungus grows in the skin and other tissues of hibernating bats and may affect multiple physiological systems of the bats during the winter period. The most obvious effect on hibernating bats is that infected individuals arouse from deep torpor much more frequently and for longer periods than non-infected bats, which drastically reduces the fat reserves needed to sustain the bats until insect prey is available in the spring. Most affected bats die of starvation, with mortality rates for some species (e.g., *Myotis lucifugus*, the little brown bat) approaching 100% in some eastern hibernacula[4].

WNS has not yet been detected in western North America west of Nebraska. Surveillance studies to sample for the Pd fungus have yet to detect it California (W. Frick 2012 pers. comm.). Pd has been detected from swabs taken from the fur of Townsend's big-eared bats in WNS-affected areas in the eastern United States, but so far WNS (the disease) has not been observed to manifest in this species (A. Ballmann 2015 pers. comm.).

Comment [WR17]: It seems nonsensical to use 'prbably' in this location with reference to the consequences for this species, known to hunt moths in tree canopies when considering for example the replacement of the extensive riparian forest of the lower Colorado river with row crops (now largely alfalfa and cotton. Replacement of oakwoodland with vineyards is analogous.

Deleted: probably

[4] https://www.whitenosesyndrome.org/

Little is known about the occurrence of other diseases, such as rabies, in Townsend's big-eared bat. Based on recent submissions of bats to state and county public health test labs, there is nothing to suggest Townsend's big-eared bat populations in California have been subject to recent disease outbreaks (CDPH unpublished data 2015).

CDFW considers WNS an important potential threat to California populations of Townsend's big-eared bat. Based on observations in the eastern U.S., the species' susceptibility to the disease is unclear. Continued monitoring of hibernating bats (as at Lava Beds National Monument), surveillance for the fungal agent of WNS, and incorporation of measures to reduce the risk of introducing or transmitting the fungus to hibernation sites in California are all important measures to reduce the risk of WNS to California populations. CDFW does not consider other diseases such as rabies to be a threat to the Townsend's big-eared bat in California.

Environmental Contaminants

Environmental contaminants include both naturally occurring and human-generated toxins that may affect the health of plants or animals. Naturally occurring toxins, such as heavy metal minerals, sulfur oxides, ammonia, and carbon dioxide, generally do not naturally occur in sufficient concentrations to impact Townsend's big-eared bat populations and will not be addressed here. Human-produced toxins may be released or applied to the environment in many forms. Of greatest potential impact to Townsend's big-eared bat are toxins used for control of agricultural and other pests (pesticides), byproducts of mining and ore processing, and air quality contaminants.

Pesticides. The California Department of Pesticide Regulation publishes an annual Pesticide Use Report for California (available at www.cdpr.gov). These reports provide information on the types, amounts, and general location of pesticides used each year in the state. According to the 2013 annual report (CDPR 2015), a total of about 88 million kg of all types of pesticides were applied in California. Figure 10 (based on data provided in CDPR 2015, Table 1), depicts the 2013 average application (kg/ha) of all pesticides for each county in California. Pesticide use appears to be greatest in the San Joaquin Valley, an area with relatively few recorded observations of Townsend's big-eared bat. However, as noted in the Petition, drift of agricultural pesticides is known to occur – for example, pesticide chemicals applied in the Central Valley have been detected in frogs living in the Sierra Nevada (Sparling et al. 2001).

The most recent Pesticide Use Report (PUR-2013, CDPR 2015), which reports annual pesticide use for many classes of pesticides, states "regression analyses on use from 1996 to 2013 do not indicate a significant trend of either increase or decrease in total pesticide use." However, inspection of the report's figures suggests that total use of certain classes of pesticides has decreased over the period 1995-2013, while others have remained roughly the same or increased. In particular, the most heavily used classes of pesticides (Fungicide/Insecticide, Insecticide) have shown a fairly marked decrease over the period (see Figure 1 of the PUR-2013). CDPR also tracks use of various pesticide chemical classes, including "reproductive toxicity" chemicals, carcinogens, cholinesterase-inhibiting chemicals (organophosphates and carbamates), groundwater-impacting chemicals, toxic air contaminants, fumigants, and biopesticides (microorganisms and naturally-occurring chemicals used in lieu of synthetic chemicals). Some classes, such as the "reproductive toxic" chemicals, cholinesterase-inhibiting

chemicals, and groundwater-impacting chemicals, have clearly decreased in usage (see Figures 6, 7, and 8 of PUR-2013). Others, such as carcinogens (PUR Figure 6), air contaminants (PUR Figure 9), and Fumigants (PUR Figure 10) have varied somewhat over the years but do not show a trend in use. Biopesticides (PUR Figure 12) have shown a steady increase in use over the report period.

The extent pesticide use in California impacts Townsend's big-eared bat populations is unknown; however, it is likely that some Townsend's big-eared bat individuals, at least, are impacted where these toxins are concentrated, either by ingestion of prey (including the potential for bioaccumulation within prey or bat) or water contaminated by pesticides, or by absorption through the skin after contact with pesticides in the air or on surfaces. These impacts may result from both lethal and sub-lethal exposure effects on survival and reproduction. While it is encouraging that use of some of the most environmentally damaging pesticides has decreased over the past two decades, it is unknown what level of threat the current and future levels of application pose to Townsend's big-eared bat populations.

Mine Toxins. Mineral extraction can result in pools of water contaminated with toxic chemicals. Such toxic pools have long been recognized as a threat to wildlife, including bats that may drink from them (Clark and Hothem 1991). The rising price of gold in the 1980s led to the renewal of mining using cyanide leaching as an extraction method in gold fields previously considered depleted. See the section on Mining for more information on renewed mining). The research and publicizing of the threat to wildlife of open cyanide ponds resulted in greater attention to this problem by federal and state regulators (S. Reeves 2015 pers. comm.), as well as industry-led measures to reduce the environmental hazards associated with cyanide leach fields (SME 2014).

The "International Cyanide Management Code for the Manufacture, Transport, and Use of Cyanide In the Production of Gold" is an industry voluntary program for gold mining companies. It is intended to provide for the safe management of cyanide and cyanidation mill tailings and leach solutions. Companies that adopt the code must have their mining operations that use cyanide to recover gold audited by an independent third party to determine the status of code implementation. Those operations that meet the code requirements can be certified. The code was developed by a multi-stakeholder steering committee under the guidance of the United Nations Environmental Program and the International Council on Metals and the Environment (http://www.cyanidecode.org/about-cyanide-code#sthash.4jbDJ744.dpuf).

According to available information, the largest gold mines in California are certified under the code (S. Reeves 2015 pers. comm.). Although toxic leach fields and ponds remain a potential threat to Townsend's big-eared bat, CDFW believes that oversight of the mining industry by BLM, regional Water Quality Control Boards, and the California Geological Survey minimize the risks associated with mine toxins to an acceptably low level.

Air Quality. As described in the Petition, poor air quality on a local or regional basis may result from human transportation, energy production and manufacturing activities, ground disturbance, and erosion and loss of native vegetation cover. Although it is reasonable to conclude that Townsend's big-eared bat (and bats in general) may be affected by poor air quality due to their high metabolic rate when

active, CDFW is not aware of any research indicating an impact of air pollutants in bat populations in California.

Climate Change

As described in CDFW's document outlining the agency's plans to address climate change (CDFG 2011), "a growing body of scientific research indicates California's remarkable diversity of habitats and wildlife is threatened by climate change. Ecological changes, including changes in species' distributions, timing of life cycles, and abundance, have already occurred in California over the past century in concert with increases in average temperature and changes in precipitation patterns (California Natural Resources Agency 2009). Existing stressors such as human population growth and associated land use changes, water management conflicts, invasive species, and other widespread stressors will be exacerbated by climate change, and could increase negative impacts to ecosystems beyond the effects of individual stressors."

To assess the potential for future climate change to affect the distribution of Townsend's big-eared bat, Stewart (J. Stewart, unpublished data) conducted MaxEnt modeling using climatic variables to model the current and possible future distribution of the species under several projections of future climate during the period 2070 to the end of the 21st Century. This method uses the concept of a "climate envelope", the geographic area with a climate suitable for a species' survival. Such "envelopes" are generally expected to move up in elevation and north in latitude in the future with a warming climate.

The best predictors of Townsend's big-eared bat distribution in California were temperature and snowpack, with average amount of snowpack providing the most parsimonious model – that is, the species is less likely to occur in areas with greater snowpack (J. Stewart 2015 pers. comm.). Under four different future climate change projections (generally described as Warm-Wet and Hot-Dry) and two greenhouse gas emission scenarios (High and Low), Townsend's big-eared bat is projected to fare reasonably well, in terms of availability of climatically suitable habitat in California (see Figure 11). Although under some scenarios the species' suitable range is projected to retract in some areas (red areas in the figure), most of the currently-suitable modeled habitat is projected to remain suitable. Some areas, notably in the northern and higher elevations areas of the state, are projected to increase in suitability in the future. Under the worst-case scenario for Townsend's big-eared bat, 88% of current known locations for the species are projected to remain suitable. Other scenarios indicated 90% to 95% of current locations would remain suitable.

Stewart (2015 pers. comm.) suggests these results are not surprising, given the generally wide distribution of Townsend's big-eared bat in California, as well as its broad distribution in North America, including south through much of Mexico to the edge of the tropics. While such modeling may not accurately or precisely predict future habitat suitability for a species, and additional work is needed to ensure that future climate does not substantially impact Townsend's big-eared bat (for example, though loss of surface water and suitable foraging habitat, or de-coupling of suitable roost site structures from suitable climate areas), at this time CDFW has determined that climate change does not pose a significant threat to the species.

Mining

California has a long history of mining due to its variety of mineral and geologic resources. California ranks second nationwide in production of minerals other than fossil fuels (Department of Conservation 2000). Starting even before the Gold Rush era of the mid-1800s, tens of thousands of mines have been excavated in the state. The Abandoned Mine Lands Unit (AMLU) of the California Department of Conservation (Department of Conservation 2009) estimates that there are approximately 47,000 abandoned mine sites in California. Although mines exist throughout the state, the majority of these mines are concentrated in the desert regions and western Sierra Nevada foothills (see Figure 12). Approximately two-thirds of abandoned mine sites are on federal land, 31% are on private land, and 2% are on state and local government land.

Mines provide important shelter for Townsend's big-eared bat and other bat species that evolved to roost in natural caves and crevices. Historic mining has created habitat for bats and other wildlife. Eighty percent of the mines in the western U.S. show some evidence of bat activity (Tuttle and Taylor 1998). Mines may be used by Townsend's big-eared bat year round for their roosting needs. These include critically important maternity and hibernation seasons. Large, structurally diverse mines may provide both warm roosts for maternity colonies and the cool or cold temperatures during hibernation (Pierson and Fellers 1998, Pierson and Rainey 1991, 1998; Pierson et al. 1999).

Mines may also offer prey such as moths and other insects and open water for drinking in chambers that intercept ground water. Such water resources are especially important in desert regions where surface water may be uncommon.

Because of the importance of historical and abandoned mines to Townsend's big-eared bats, several management issues related to mines and mining may pose a threat to the species. These include: closure of mines, renewed mining, environmental contamination, and human disturbance at mine roosts. The latter two topics are discussed elsewhere in the Threats section of this report.

Abandoned Mine Lands (AML) programs are tasked with the closure of open mines hazardous to human safety. To determine the appropriate closure method at a mine, it is necessary to determine through surveys what species may be using the mine. Permanent abandoned mine closure methods have resulted in the destruction of roosting habitat and have also caused direct mortality of bats by trapping them within the closed mine without exclusion at the appropriate season (Brown 1995b; Altenbach and Pierson 1995). Bat conservationists have advocated for assessment and planning for the appropriate mine closure method (fences, bat gates, cupolas, large grates) that allow bats to pass through openings too small for humans, while maintaining air flow patterns crucial for internal habitat conditions (Sherwin *et al.* 2009).

California's Department of Conservation has an AML unit that is actively engaged in reducing the hazards associated with open mines. It works with state and private mine owners to ensure that wildlife-compatible closure methods are implemented. It also coordinates with federal land management agencies for closures on BLM and other federal lands. See

http://www.conservation.ca.gov/omr/abandoned_mine_lands for more information on AML issues in California.

Modern methods of mineral extraction have allowed mining companies to renew mining in historical areas previously abandoned. For example, the use of chemical extraction methods for gold from open pit mines often occurs directly in areas with abandoned shaft mines. Renewed mining in historical mine districts has the potential to impact Townsend's big-eared bat and other bat species where the modern mine obliterates the previous underground mine (Pierson et al. 1991). In addition, renewed mining may impact native vegetation and water sources used for foraging around the mine, and may introduce chemical contaminants used for mineral extraction to the environment. See the section on Environmental Contaminants for more information on this aspect of mining impacts to bats.

In summary, CDFW considers the impacts associated with mine closures and renewed mining to be important potential threats to Townsend's big-eared bats. Active AML programs at the state and federal level should minimize the threat of mine closures to sensitive species. Environmental review of proposed mining projects through CEQA and NEPA should ensure adequate assessment and disclosure of potential impacts to Townsend's big-eared bat of such projects. Provided such programs are adequately funded by state and federal agencies, it is likely that population-level impacts associated with legacy mines and renewed mining would not occur. However, there is less certainty that important roost sites and Townsend's big-eared bat populations would be adequately protected in the absence of a listing of the species as threatened or endangered.

Overexploitation (for Scientific Use)

As a nongame mammal (defined in Fish and Game Code section 4150), Townsend's big-eared bat is not harvested or collected for commercial or personal use. Collection of Townsend's big-eared bat does occur in California on a limited basis for bona fide scientific and educational purposes. Such collection is regulated according to Fish and Game Code (sections 1002 *et seq*.), which is administered by CDFW.

In the past, scientific collections were made on a much greater scale than occurs today. The mammal collections at the Museum of Vertebrate Zoology, Los Angeles County Museum of Natural History, and at many other museums and universities in the western U.S. were established through the lethal taking of representative specimens of California's mammalian fauna. Such collections remain an important resource for scientific investigations of the phylogeny, evolution, taxonomy, diet, morphology, physiology of California's fauna (Pyke and Ehrlich 2010).

For long-lived/low fecundity species such as Townsend's big-eared bat, it is possible that repeated scientific collection may have a population impact. As documented by Brown et al. (1994), the Townsend's big-eared bat maternity colony at Prisoners Harbor (Santa Cruz Island) was subjected to three collecting episodes over a period of 25 years in which a total of 246 individuals were taken. The Santa Cruz Island colony, which apparently numbered "more than" 300 individuals (which probably included both adult females and their young) in 1939, has never recovered to its historical size, though other impacts, including roost loss and disturbance have been contributing factors.

Non-collecting scientific study may also impact Townsend's big-eared bat populations through disturbance of roosts. Before Townsend's big-eared bat's susceptibility to roost site disturbance was well documented, Pearson et al. (1952) conducted investigations of the basic ecology and reproductive biology of Townsend's big-eared bat in California. These studies included occasional entry into maternity and hibernation roosts at multiple sites around California to collect information and to place wing-bands on bats. In one case, the authors banded 75 young Townsend's big-eared bats during the early night while the adult females were foraging. By the next morning, the young had been carried by their mothers to another roost site, presumably in response to the disturbance at the original roost site (Pearson et al. 1952). The authors did not document whether there was an impact in terms of growth or survival of the young from this disturbance event.

Placement of wing bands on bats is a long-standing method used to mark individual bats (Barclay and Bell 1988, Gannon et. al. 2007). Recapture of banded bats can provide information on movements, survival, and population size. Based on available information, it appears Townsend's big-eared bat does not handle wing-banding as well as other bat species. Ellison (2010) summarized results from her own and others' studies suggesting a relatively high proportion of banded Townsend's big-eared bat suffer from perforated wing membranes, scarring, tissue-swelling, infection, and irritation. Moreover, the banding activity may have disturbed some individuals sufficiently to cause them to move to different roost sites (Ellison 2010).

Because of the concerns related to over-collection, disturbance at roosts, and wing-banding, CDFW carefully controls the activities of scientific researchers working on Townsend's big-eared bat in California. All persons who may take[5] Townsend's big-eared bat for scientific or educational purposes are required to possess a current Scientific Collecting Permit and, while a candidate for listing, a CESA Memorandum of Understanding issued under the authority of Fish & G. Code § 2081(a). Among the standard conditions of research permits are: a prohibition on entry into known roost sites (unless specifically authorized for a particular study), immediate departure from sites discovered to be maternity roosts, and measures to minimize the risk of introducing the fungus that causes White Nose Syndrome to hibernacula. Wing-banding is not currently authorized for any researcher working on Townsend's big-eared bat. No collection of Townsend's big-eared bat specimens is currently authorized for any individual. Prior to Townsend's big-eared bat's designation as a Candidate for listing, Scientific Collecting Permits that authorized work with Townsend's big-eared bat had similar provisions for the protection of Townsend's big-eared bat individuals and populations.

Given the level of control exerted by CDFW on scientific researchers working with bats, overexploitation for scientific purposes is not considered to be a threat to the continued existence of Townsend's big-eared bat in California.

[5] "Take" is defined in Fish and G. Code §86 as "to hunt, pursue, catch, capture, or kill" or to attempt to do so.

Habitat Essential for Continued Existence of the Species (FISH & G. CODE § 2074.6)

In 1952, after intensive study of Townsend's big-eared bat at several maternity and hibernation roosts at both coastal low elevation sites and interior high-elevation sites, Pearson and his co-authors considered factors that may be limiting Townsend's big-eared bat populations in California. They dismissed predation as a limiting factor, as they had never observed a predation event or evidence of such, nor were they aware of any important natural predators of Townsend's big-eared bat.[6] Disease was likewise discounted in importance due to lack of observation. Pearson et al. (1952) considered the availability of food and water as a possible limiting factor, but could not address this factor given a lack of data on prey availability. Regarding roost site availability, the authors noted that each maternity and hibernation roost site in their study seemed large enough to house many more Townsend's big-eared bat individuals than were observed. They reasoned that at the local scale food or water may be limiting, but on a regional scale appropriate roost sites may be limiting the total population size. Appropriate roost sites not only must have suitable size and other structural and microclimate characteristics, but also must be near suitable foraging habitat, including safe and accessible sources of open water for drinking.

With these considerations in mind, and with the apparent loss of historical roost sites documented by Pierson and Rainey (1998) and others, and the expected continued degradation and loss of old buildings suitable for use as roost sites (Fellers and Halstead 2015, G. Tatarian 2014 pers. comm.), CDFW considers any structure, or set of structures, used by Townsend's big-eared bat as a maternity or hibernation roost to be habitat essential for the continued existence of the species. The essential characteristics of these suitable roost sites extend to the nearby foraging, commuting, and night-roosting habitat and therefore these adjacent habitats are also considered essential.[7]

It may be possible on a case-specific basis to identify alternative or replacement roost structures, or set of structures (to allow for roost-switching), and adjacent habitat that would serve a local Townsend's big-eared bat population. The suitability of such alternative or replacement roost sites would need to be demonstrated (through comparable use by the local Townsend's big-eared bat population) prior to considering any occupied roost unnecessary for the population. CDFW is not aware of any replacement roost structure having been purpose-built for use by Townsend's big-eared bat, but this is a management action that should be explored on an experimental basis.

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[6] But see Fellers's 2000 report of black rats, *Rattus rattus*, preying upon non-volant young Townsend's big-eared bat at the Randall House maternity roost, as well as his description of the possible effect of owl presence on roost departure times of Townsend's big-eared bat at the same site (Fellers 2014).

[7] In particular, as noted by Tatarian (2015 pers. comm.), structures used for roosting by single Townsend's big-eared bats in the vicinity of maternity roosts and hibernacula may be essential to allow population-level behaviors essential to reproduction. These behaviors include socialization between adult females and males in the fall leading to mating at mixed-sex overwintering roost sites, as well as fledging and dispersal of young at the end of the maternity season.

EXISTING MANAGEMENT, MONITORING, AND RESEARCH ACTIVITIES

CDFW

The California Department of Fish and Wildlife is the state trustee agency for fish, wildlife, and botanical resources. In addition to its current status as a Candidate for CESA listing, CDFW designates Townsend's big-eared bat as a Species of Special Concern (Williams 1986). The SSC designation does not confer any legal protection on the species, but rather is intended to ensure management, conservation, and research activities are implemented to prevent future declines and the need for listing under the California Endangered Species Act (Comrack et al. 2008). As an SSC, Townsend's big-eared bat is also designated as a Species of Greatest Conservation Need (SGCN) in California's State Wildlife Action Plan (SWAP, CDFG 2007). This designation provides additional focus on the species by CDFW, as well as funding opportunities for research and conservation actions from the State Wildlife Grant program of the U.S. Fish and Wildlife Service.

As part of CDFW's general mission to monitor wildlife resources, known Townsend's big-eared bat roosts on CDFW lands (Wildlife Areas and Ecological Reserves) are monitored. This includes the maternity colony that occurs on the Chorro Creek Ecological Reserve in CDFW's Central Region. Through on-going monitoring, CDFW has documented the impact of human disturbance at this site and has implemented measures to reduce the threat of disturbance to the colony (R. Stafford 2014, 2015 pers. comms.).

Townsend's big-eared bat is currently a Candidate for listing as threatened or endangered under the California Endangered Species Act. As such, the prohibition on "take" of listed and candidate species of CESA applies to Townsend's big-eared bat. Regulatory programs of CDFW now review proposed CEQA, timber harvesting plans, and scientific research applications to ensure that no take of the species would occur, unless authorized by one of the statutory exemptions allowing such take, such as the Incidental Take Permit and Safe Harbor mechanisms of CESA, or through a Memorandum of Understanding for take for scientific or educational purposes. All such take may only be authorized if it is fully mitigated and would not jeopardize the continued existence of the species in California. As mentioned above, should the species not be listed then it would revert to the Species of Special Concern designation. SSCs typically receive some attention during CEQA review, but protection from take and population-level impacts is less certain. This applies not only to projects for which CDFW is the lead or responsible agency, but for CEQA projects for which other state agencies (such as CDPR and CalFire, see below) or counties or cities are the lead agency.

CDFW is currently implementing three projects relevant to Townsend's big-eared bat that are funded by the State Wildlife Grant (SWG) program. The California Bat Conservation Plan (CBCP) was initially funded by SWG in the mid-2000s and, after several years of development is now nearing completion, thanks in part to a new SWG to complete final edits. The CBCP addresses the management and conservation of all bat species occurring in California, including Townsend's big-eared bat, and will provide specific recommendations for the management, policy development, and research for all species, all ecoregions, and all the major conservation issues affecting bats in the state. Included in the

CBCP is a relative ranking of the species for conservation concern – Townsend's big-eared bat consistently was rated by the authors as among the greatest concern bat species.

The second SWG-funded project directly addresses the current conservation status of Townsend's big-eared bat in California. Previously, the California Department of Fish and Game funded a statewide survey for Townsend's big-eared bat in the 1980s by Elizabeth Pierson and William Rainey (Pierson and Rainey 1998). The new statewide survey effort is being conducted over a two-year period and is targeting known and highly-suitable locations for maternity and hibernation roosts. This project is being contracted to researchers from Humboldt State University and Texas A&M University (Joe Szewczak and Michael Morrison) and should provide an updated snapshot of the species' status as of 2015-2017.

SWG funding was also provided to CDFW to implement a project to expand bat monitoring in California according to the North American Bat Monitoring Program (Loeb et al. 2015). This project is initially focused on acoustic monitoring of bat activity around the state, which probably will not provide a lot of data on Townsend's big-eared bat due to its quiet echolocation calls. However, CDFW plans to increase efforts to monitor important roosts for this and other species in the future as the NABat program continues to develop.

CDPR

The California Department of Parks and Recreation manages state parks throughout California. As with other land management agencies, CDPR manages sensitive biological resources, such as Townsend's big-eared bat, both through review of proposed project impacts under the environmental review process, as well as through focused monitoring efforts at known roosts (such as at Hearst San Simeon State Historical Monument).

CalFire

The California Department of Forestry and Fire Protection (CalFire) is the lead agency in California for timber harvest projects on private and state forest lands. Timber harvest review is a CEQA-equivalent environmental review process and, as such, requires proposed timber management projects to assess and disclose potential impacts on the environment, including to biological resources. Since the designation of Townsend's big-eared bat as a candidate for listing under CESA, CalFire has been proactive in working with timber companies and registered professional foresters to ensure significant impacts to the species, as well as "take," are avoided.

NPS

The National Park Service lands in California include several known Townsend's big-eared bat roost sites, including the large number of caves at Lava Beds National Monument, the Randall House maternity colony at Point Reyes National Seashore, the hibernacula and maternity roosts at Pinnacles National Park, and the Scorpion Ranch maternity roost on Santa Cruz Island. In general, the NPS approach to sensitive biological resources, such as Townsend's big-eared bat and its habitat, is to survey, monitor, manage, and to conduct research on the species.

In addition to the monitoring and management of the aforementioned sites, work by E.D. Pierson and others in Yosemite National Park (Pierson and Heady 1996, Pierson and Rainey 1997, and Pierson et al. 2006) provided baseline information on bat use of the Yosemite area, including on Townsend's big-eared bat (S. Stock 2014 pers. comm.).

BLM

The Bureau of Land Management designates Townsend's big-eared bat as a sensitive species. This designation requires land use plans to address the species and its habitat and to incorporate the species' needs in a manner to reduce potential conflicts with other multiple use activities. On BLM-administered lands, BLM manages a sensitive species and its habitat to minimize or eliminate threats affecting the status of the species or to improve the condition of the species' habitat. BLM assists, as funding allows, in determining distribution, abundance, and condition of the species, and to manage the habitat in such a manner to improve the conservation status of the species and ensure that BLM actions do not move the species towards needing to be listed (A. Fesnock 2015 pers. comm.).

Based on information gathered for this status review report (A. Fesnock 2015 pers. comm.), Townsend's big-eared bats are known to occur on BLM lands throughout much of California. As with other lands, most records for the species are from roost structures, including mostly abandoned mines. The BLM has an active survey and assessment program that evaluates abandoned mines for public safety hazards, wildlife and historical resources, and recommended closure methods. Evaluations of abandoned mines conducted over the past 15 years indicate many such mines are used by Townsend's big-eared bats. Few repeat visits or monitoring programs have been implemented, however, and therefore inferences about population status or trend cannot be made. Many of the BLM roost sites surveyed since 1999 are being re-visited as part of the current CDFW-funded statewide survey project.

All of the BLM field offices in California consider Townsend's big-eared bat roost sites (both hibernacula and maternity roosts) to be important resources to protect and manage. Many such sites have been gated in the past two decades to allow bats to use the sites without human disturbance (BLM unpublished data). The BLM expects to continue with gating abandoned mines to protect bat habitat and for public safety (A Fesnock 2015 pers. comm.).

USFS

The U.S. Forest Service in California lists Townsend's big-eared bat on its Regional Foresters Sensitive Species list. As such, the species is given almost as much protection as a species listed as threatened or endangered under the federal Endangered Species Act (L. Angerer 2015 pers. comm.). USFS projects and management actions are evaluated to ensure project effects do not put the species on a trend towards endangered or threatened status.

In particular, the USFS completes Biological Evaluations for all Sensitive Species prior to implementing projects and management actions. Each Biological Evaluation includes management recommendations for the Sensitive Species. In general, Townsend's big-eared bat colonies are protected. When a project is proposed that may impact a roost site (such as a mine closure or historical building removal) measures

are implemented to replace the lost structure or to improve the use of the structure by bats after project completion.

Most known Townsend's big-eared bat roost sites on Forest Service lands are not consistently monitored (though with some exceptions, such as the Kentucky Mine colony in the Sierra National Forest). The overall strategy implemented by the USFS has been to protect and avoid impacts (L. Angerer 2015 pers. comm.).

SUMMARY OF LISTING FACTORS (14 California Code of Regulations 670.1)

CESA directs CDFW to prepare this report regarding the status of Townsend's big-eared bat based upon the best scientific information available to CDFW. CESA's implementing regulations identify key factors that are relevant to the CDFW's analyses. Specifically, a "species shall be listed as endangered or threatened ... if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors: (1) present or threatened modification or destruction of its habitat; (2) overexploitation; (3) predation; (4) competition; (5) disease; or (6) other natural occurrences or human-related activities." (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A)).

The definitions of endangered and threatened species in the Fish and G. Code provide key guidance to CDFW's scientific determination. An endangered species under CESA is one "which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease" (Fish & G. Code, § 2062). A threatened species under CESA is one "that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by [CESA]" (*Id.*, § 2067).

The following summarizes CDFW's determination regarding the factors to be considered by the Commission in making its decision on whether to list Townsend's big-eared bat. This summary is based on the best available scientific information, as presented in the foregoing sections of the report.

Present or threatened modification or destruction of its habitat

Disturbance, degradation, and loss of suitable roost sites is a recognized threat to Townsend's big-eared bat populations, both in natural roost sites such as large, old trees and caves, as well as in artificial roosts such as old buildings and mines. Although recent examples of disturbance at roost sites are relatively rare compared to such events in the historical period, lacking the protections of CESA it is possible the species could be impacted at multiple roost sites in the future, which could lead to population-level impacts. However, there is no current indication disturbance of roost sites is a significant threat at this time. Additionally, although impacts to foraging habitat could also affect the species, there is no current indication that impacts to foraging habitat poses a significant threat at this time. Therefore, CDFW does not consider modification and destruction of habitat to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Overexploitation

CDFW does not consider overexploitation to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Predation

CDFW does not consider predation to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Competition

CDFW does not consider competition to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Disease

White Nose Syndrome is an important potential threat to Townsend's big-eared bat in California. Monitoring and research to determine the species' susceptibility to the disease as well as its occurrence in western North American are needed to assess the actual level of this threat. As discussed above, however, this disease is not currently impacting Townsend's big-eared bat in California. Therefore, CDFW does not consider disease to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Other Natural Events or Human-Related Activities

Mining (including renewed mining), agricultural development and pesticide use, restoration or demolition of old buildings and other anthropogenic structures used as roosts, forest management, and recreational caving and mine exploration all have the potential to impact Townsend's big-eared bat populations. State and federal environmental review programs typically include assessment and disclosure of potential impacts to the species in the CEQA/NEPA process. Adequate environmental review should prevent such activities from affecting Townsend's big-eared bat at the population or statewide level.

Climate change, especially more frequent and severe drought, has the potential impact Townsend's big-eared bat in California. Continued and increased monitoring of the species' abundance and distribution should help determine the actual impact of these threats to the species.

MANAGEMENT RECOMMENDATIONS

These recommendations were developed by CDFW in accordance with the requirements of Fish & G. Code, § 2074.6. This list includes some recommendations developed by other authors, including Johnston (2004), Ellison et al. (2003), Tigner and Stukel (2003), Hinman and Snow (2003), and Bradley et al. (2006). CDFW recommends these actions be implemented regardless of the Commission's decision on listing Townsend's big-eared bat as threatened or endangered. This list includes recommendations for actions that could be undertaken by CDFW as well as by other public agencies, non-governmental organizations, and private land owners.

Research and Monitoring Needs

- Complete comprehensive statewide population assessment of Townsend's big-eared bat by 2017.
- Implement consistent long-term monitoring at representative Townsend's big-eared bat roost sites in California.
- Design and test artificial structures suitable for use by Townsend's big-eared bat during the maternity and hibernation seasons.
- Create standardized procedures for monitoring Townsend's big-eared bat populations. Ensure all such studies will not adversely impact the subject populations.
- Conduct additional analyses of the possible effects of climate change and drought on Townsend's big-eared bat and determine best approaches to address possible adverse effects.
- Conduct research on the role environmental contaminants play in the health of Townsend's big-eared bat populations.
- Develop methods to create basal hollows in suitable large old trees.
- Conduct genetic studies to determine the population genetic structure of Townsend's big-eared bat in California, with special attention to the degree of divergence and isolation of populations on Santa Cruz Island relative to the mainland and between coastal and interior populations.

CDFW Administrative Actions

- If results of current statewide Townsend's big-eared bat survey indicate a decline in the population status is occurring that may lead to endangerment, prepare a staff recommendation to list the species as Threatened or Endangered for consideration by the Fish and Game Commission.
- Working with partners at state and federal agencies, as well as private landowners, ensure that management of Townsend's big-eared bat roost sites is consistent with continued site occupancy at or above existing population levels.
- Attempt to secure new funding and position resources as a priority to establish a full-time permanent bat specialist position within the Nongame Wildlife Program of CDFW to address data assimilation and conservation of bats in California, including Townsend's big-eared bat.
- Support research on the design and effectiveness of artificial structures suitable for use by Townsend's big-eared bat during the maternity and hibernation seasons.
- Create interagency and other stakeholder cooperation in, and public support for, conservation efforts for Townsend's big-eared bat. Partner with non-governmental organizations such as Bat Conservation International, The Nature Conservancy, and local NGOs in such efforts.
- Develop greater awareness of Townsend's big-eared bat and other bat conservation and management issues within CDFW.
- Direct fiscal and position resources to complete the draft California Bat Conservation Plan.

Management of Known Roost Sites

- Prior to changing management of caves, mines, or buildings that could be used by Townsend's big-eared bat or other bat species, such sites should be evaluated and/or surveyed during appropriate seasons for their use by Townsend's big-eared bat.
- Existing roosts should be left undisturbed and occupied roosts should only be entered for management or research purposes.
- Bat-friendly gates should be installed at Townsend's big-eared bat roosts where other methods of controlling human entrance are not effective. Special consideration should be given to gate design to minimize risk of injury or unsuitability for Townsend's big-eared bat.
- Abandoned mines suitable for use by Townsend's big-eared bat should not be collapsed or closed in a manner to prevent bat use.
- Effectiveness monitoring (use of data loggers to passively record bat use and human disturbance) should be implemented at gated roost sites and other roost sites actively managed for bat resources (as through signage, information for visitors, etc.).
- Ensure foraging habitat, including access to open water, within the vicinity of maternity roosts remains suitable for use by Townsend's big-eared bat. Analysis of habitat suitability should be made on a site-specific basis, but start with using the area within a 24-km radius of the roost site.
- Where a Townsend's big-eared bat or other bat roost site has a history of recreational use by humans, implement a management plan to ensure new impacts from human use do not occur. The Kentucky Mine Stamp Mill management plan (Tierney and Freeman 2007) is a good example of such a plan that appears to be successful.

Landscape Management Practices

- Developed springs and other water sources should be kept available for in-flight drinking as outlined in various "wildlife-friendly" water facility publications.
- If protracted drought poses a threat to Townsend's big-eared bat, develop additional water sources for drinking in areas where open water limits population size.
- Restore or enhance riparian habitat.
- Implement basal hollow creation projects to increase opportunities for Townsend's big-eared bat to use tree roosts in coastal redwood forests (and possibly in interior forests where large tree species, such as giant sequoia, have the potential to serve as roost sites)

CEQA Review of Proposed Projects

- Ensure direct and cumulative impacts from projects proposed under CEQA and CEQA-equivalent regulatory programs are not likely to result in a substantial reduction in population or range of Townsend's big-eared bat and other bat species.

Public Education and Outreach

- Conduct and cooperate with other agencies on public outreach events about Townsend's big-eared bat and other bat species.
- Disseminate the California Bat Conservation Plan to the public, when complete.

- Encourage citizen participation, as appropriate, in bat monitoring projects.
- Promote bat-friendly exclusions where it is necessary to remove bats from buildings and other structures.

Health and Disease

- Continue and expand surveillance for WNS by state and federal agencies and researchers.
- Support research on the etiology and epidemiology of WNS on *Corynorhinus* species, including Townsend's big-eared bat.
- Continue and expand, if necessary, decontamination requirements for persons entering hibernacula for Townsend's big-eared bat and other hibernating bat species to minimize the risk of introducing the fungus that causes WNS.
- Work with other state and federal regulatory agencies to prevent the introduction of environmental contaminants that may affect the health of Townsend's big-eared bat and other bats. These may include aerial pesticide application and chemicals used in processing mined minerals.

LISTING RECOMMENDATION

CESA directs CDFW to prepare this report regarding the status of Townsend's big-eared bat in California based upon the best scientific information. CESA also directs CDFW based on its analysis to indicate in the status report whether the petitioned action is warranted. (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).) CDFW includes and makes its recommendation in its status report as submitted to the Commission in an advisory capacity based on the best available science. In consideration of the scientific information contained herein, CDFW has determined that the petitioned action is or is not warranted at this time.

PROTECTION AFFORDED BY LISTING

It is the policy of the State to conserve, protect, restore and enhance any endangered or any threatened species and its habitat (Fish & G. Code, § 2052.). If listed as an endangered or threatened species, unauthorized "take" of Townsend's big-eared bat will be prohibited, making the conservation, protection, and enhancement of the species and its habitat an issue of statewide concern. As noted earlier, CESA defines "take" as to hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill. (*Id.*, § 86.) Any person violating the take prohibition would be punishable under State law. As to authorized take, the Fish & G. Code provides CDFW with related authority under certain circumstances. (*Id.*, §§ 2081, 2081.1, 2086, 2087 and 2835.) In general and even as authorized, however, impacts of the taking on Townsend's big-eared bat caused by the activity must be minimized and fully mitigated according to State standards.

Additional protection of Townsend's big-eared bat following listing is also likely with required public agency environmental review under CEQA and its federal counterpart, the National Environmental Policy Act (NEPA). CEQA and NEPA both require affected public agencies to analyze and disclose project-related environmental effects, including potentially significant impacts on endangered, rare, and

threatened special status species. Under CEQA's "substantive mandate," for example, state and local agencies in California must avoid or substantially lessen significant environmental effects to the extent feasible. With that mandate and CDFW's regulatory jurisdiction generally, CDFW expects related CEQA and NEPA review will likely result in increased information regarding the status of Townsend's big-eared bat in California as a result of, among other things, updated occurrence and abundance information for individual projects. Where significant impacts are identified under CEQA, CDFW expects required project-specific avoidance, minimization, and mitigation measures will also benefit the species. State listing, in this respect, and required consultation with CDFW during state and local agency environmental review under CEQA, would also be expected to benefit the species in terms of related impacts for individual project that might otherwise occur absent listing.

Listing Townsend's big-eared bat increases the likelihood that State and federal land and resource management agencies will allocate funds towards protection and recovery actions. Funding for species recovery and management is limited, however, and there is a growing list of threatened and endangered species.

ECONOMIC CONSIDERATIONS

CDFW is charged in an advisory capacity in the present context to provide a written report and a related recommendation to the Commission based on the best scientific information available regarding the status of Townsend's big-eared bat in California. The topic areas and related factors CDFW is required to address as part of that effort are biological and not economic. (See Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).)

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Townsend's big-eared bat CESA Status Review – Figures

Captions

1. Map showing geographic ranges of species and subspecies of North American long-eared bats as described by Handley (1959). Adapted from Piaggio and Perkins (2005, Figure 1).

2. COTO CWHR geographic range map, with occurrence locations.

3. COTO CWHR range map, with occurrence locations symbolized by time period.

4. Locations mentioned in the Population Trend section.

5. From Fellers and Halstead (2014, Figure 1). (A) Attempts to break into the Randall House, site of a *Corynorhinus townsendii* roost at Point Reyes National Seashore, California. (B) Annual number of adults (maximum count during May or June) and total *C. townsendii* (adults plus volant young; maximum count during July or August) emerging from roost at Point Reyes National Seashore.

6. COTO exit count data at Kentucky Mine maternity colony (Sierra County), 1996 - 2005. A. All counts. B. Early maternity season counts (before late July), without counts when the colony likely roosted elsewhere. C. Late maternity season counts (late July and later), without counts when the colony was likely roosting elsewhere. (source: Marilyn Tierney, unpublished data, and Freeman 2012).

7. From Weller et al. (2014, Figure 2). Estimated trend (solid line), upper and lower 95% prediction intervals (dotted lines), and number of Townsend's bigeared bats (*Corynorhinus townsendii*) counted (solid circles) during hibernacula surveys at 22 caves in Lava Beds National Monument, Siskiyou County, California, during 1991–2012. Caves are ordered top left to bottom right as largest to smallest observed counts.

8. From Weller et al. (2014, Figure 4). Estimates, with 95% prediction intervals, for the total number of Townsend's big-eared bats (*Corynorhinus townsendii*) hibernating in 52 caves at Lava Beds National Monument, Siskiyou County, California, during 1991–2012. The total number of caves surveyed each year is denoted as n on the x-axis.

9. Late summer (August – mid-September) exit counts for the COTO maternity colony site at Hearst San Simeon State Park, 2000 – 2014 (R. Orr, pers. comm.). For years with more than one count was conducted during the late summer season, the date with the highest count is depicted.

10. Average application of pesticides (kg/ha) for California counties, 2013, plotted with Townsend's big-eared bat occurrence locations.

11. Current and future projected climatically-suitable areas for Townsend's big-eared bat in California (J.Stewart, unpublished data) under four projections of future climate. Climatically-suitable areas were modelled using MaxEnt and existing occurrence records. For the period 2070-2099, areas shown in dark blue remain suitable, areas shown in red are suitable under current climate conditions but are projected to become unsuitable, and areas in light blue are modelled as currently unsuitable but would become suitable in the future.

12. California abandoned mines.

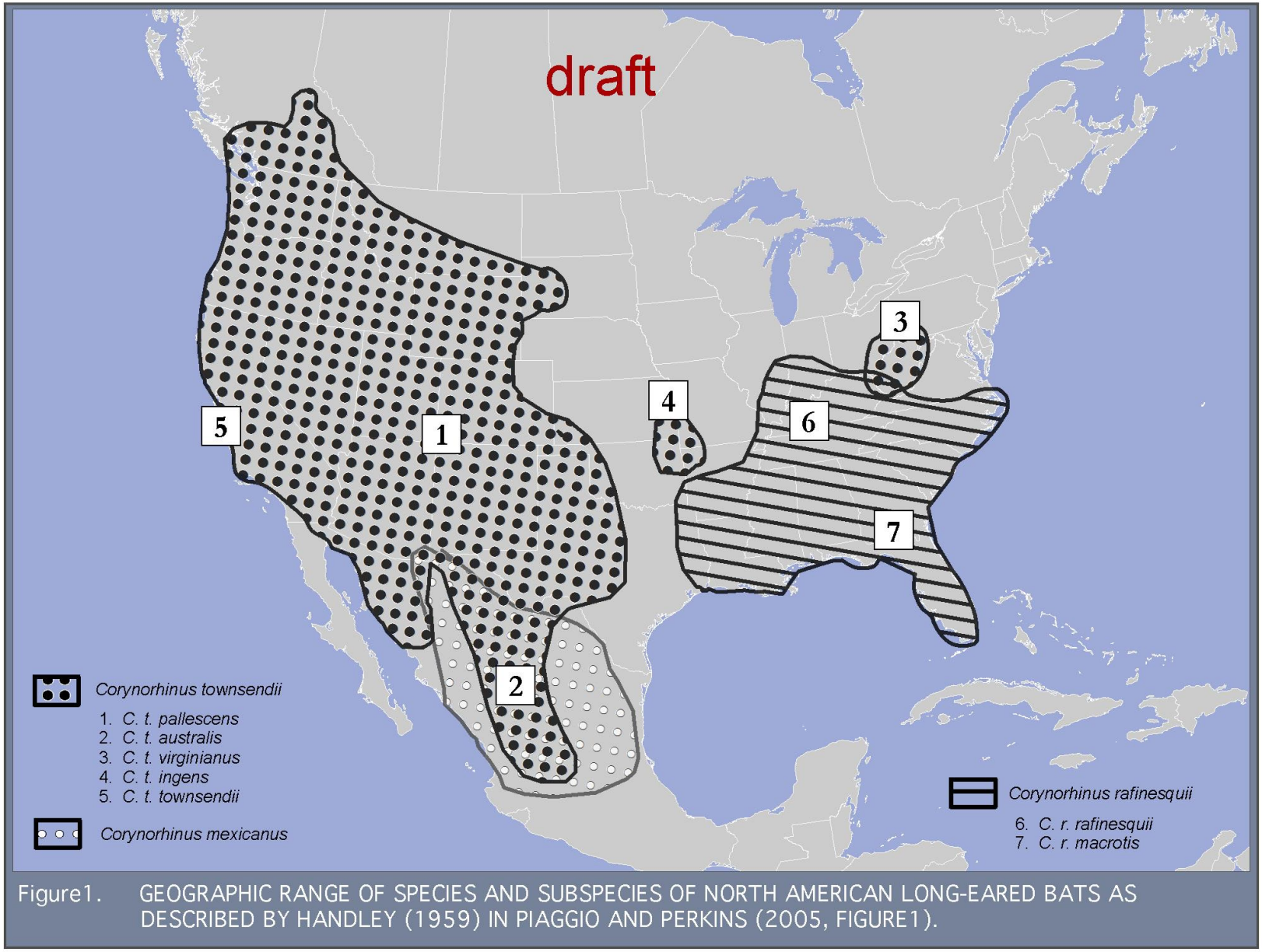


Figure1. GEOGRAPHIC RANGE OF SPECIES AND SUBSPECIES OF NORTH AMERICAN LONG-EARED BATS AS DESCRIBED BY HANDLEY (1959) IN PIAGGIO AND PERKINS (2005, FIGURE1).

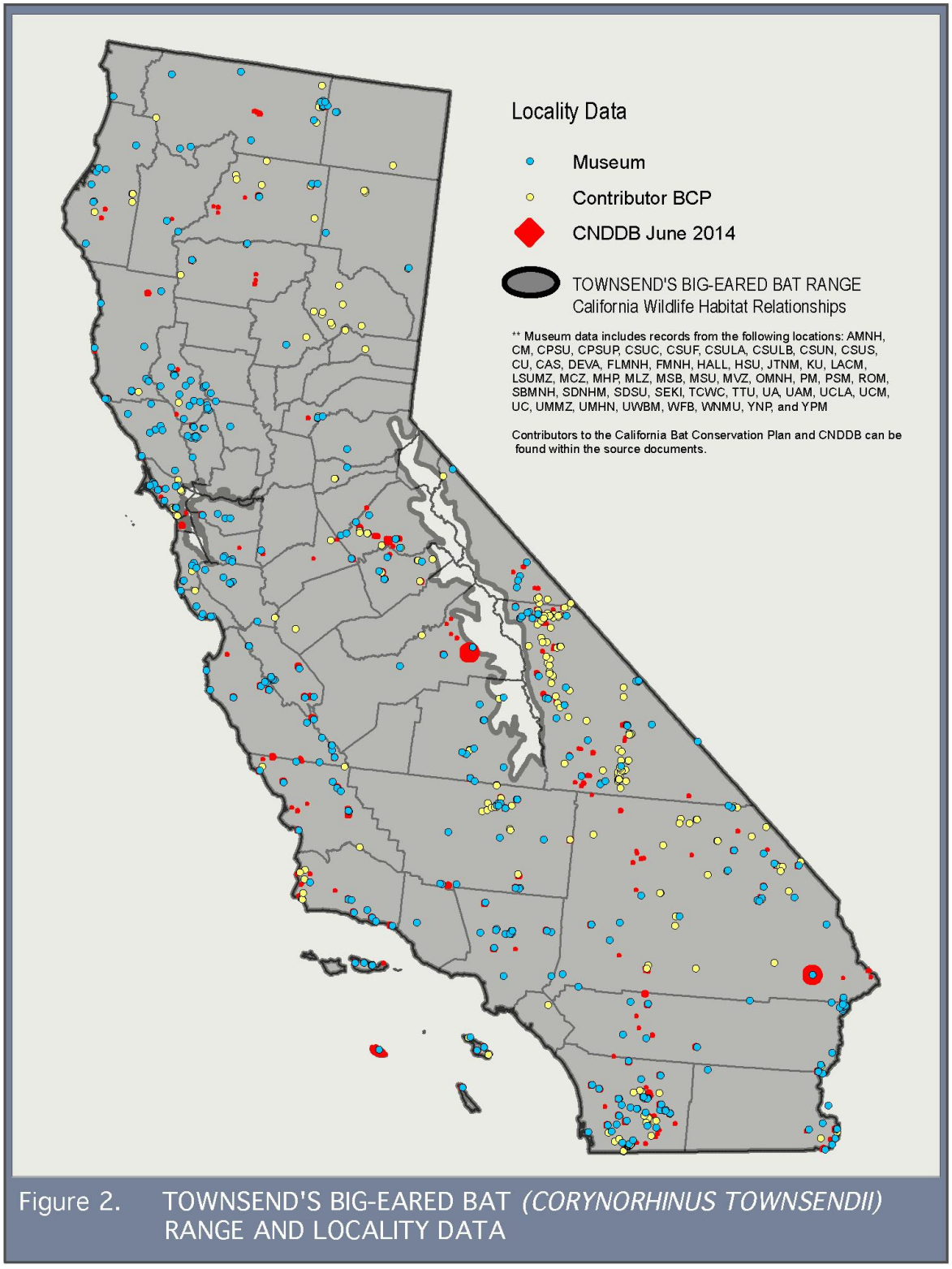


Figure 2. TOWNSEND'S BIG-EARED BAT *(CORYNORHINUS TOWNSENDII)* RANGE AND LOCALITY DATA

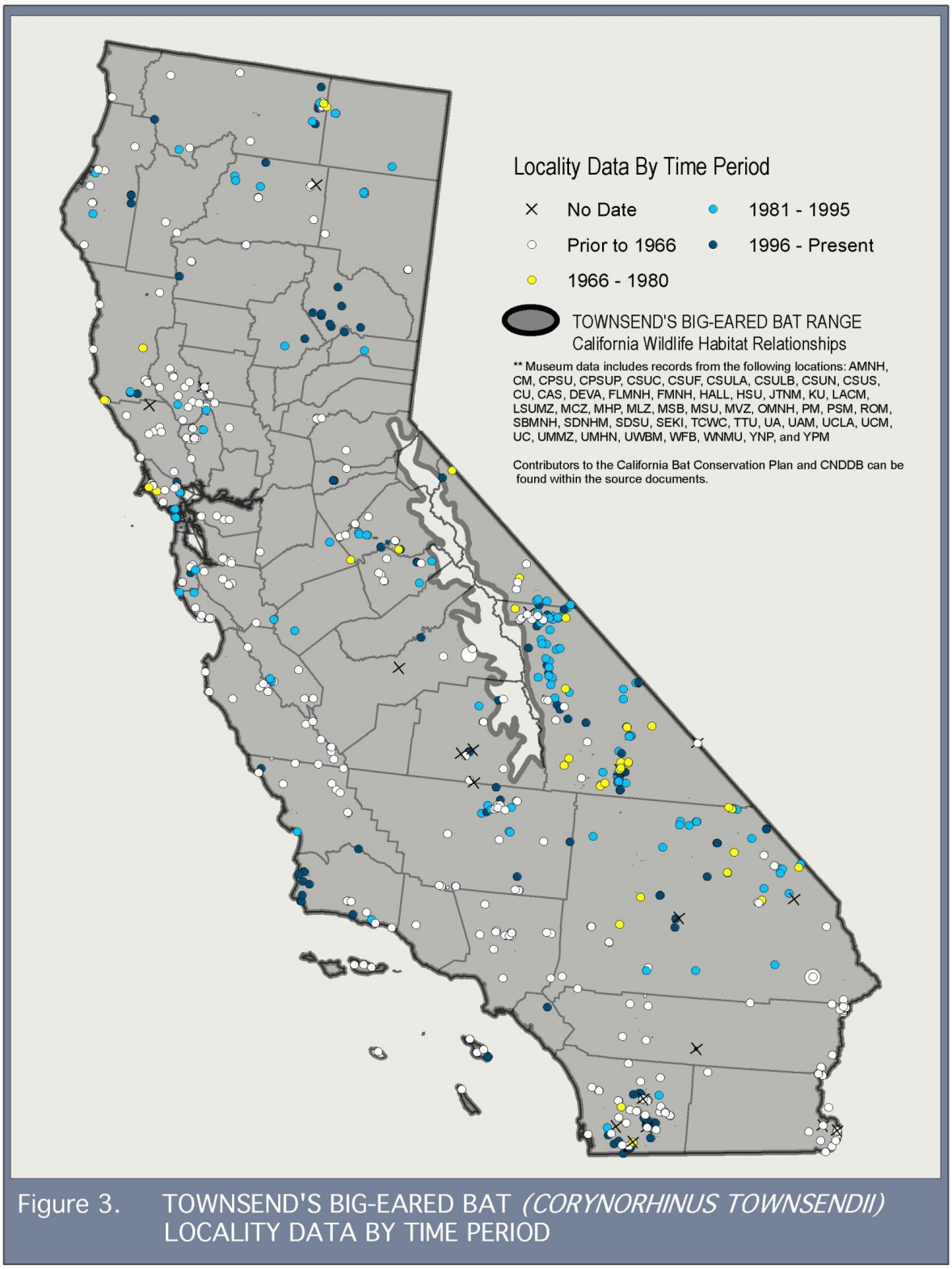


Figure 3. TOWNSEND'S BIG-EARED BAT *(CORYNORHINUS TOWNSENDII)* LOCALITY DATA BY TIME PERIOD

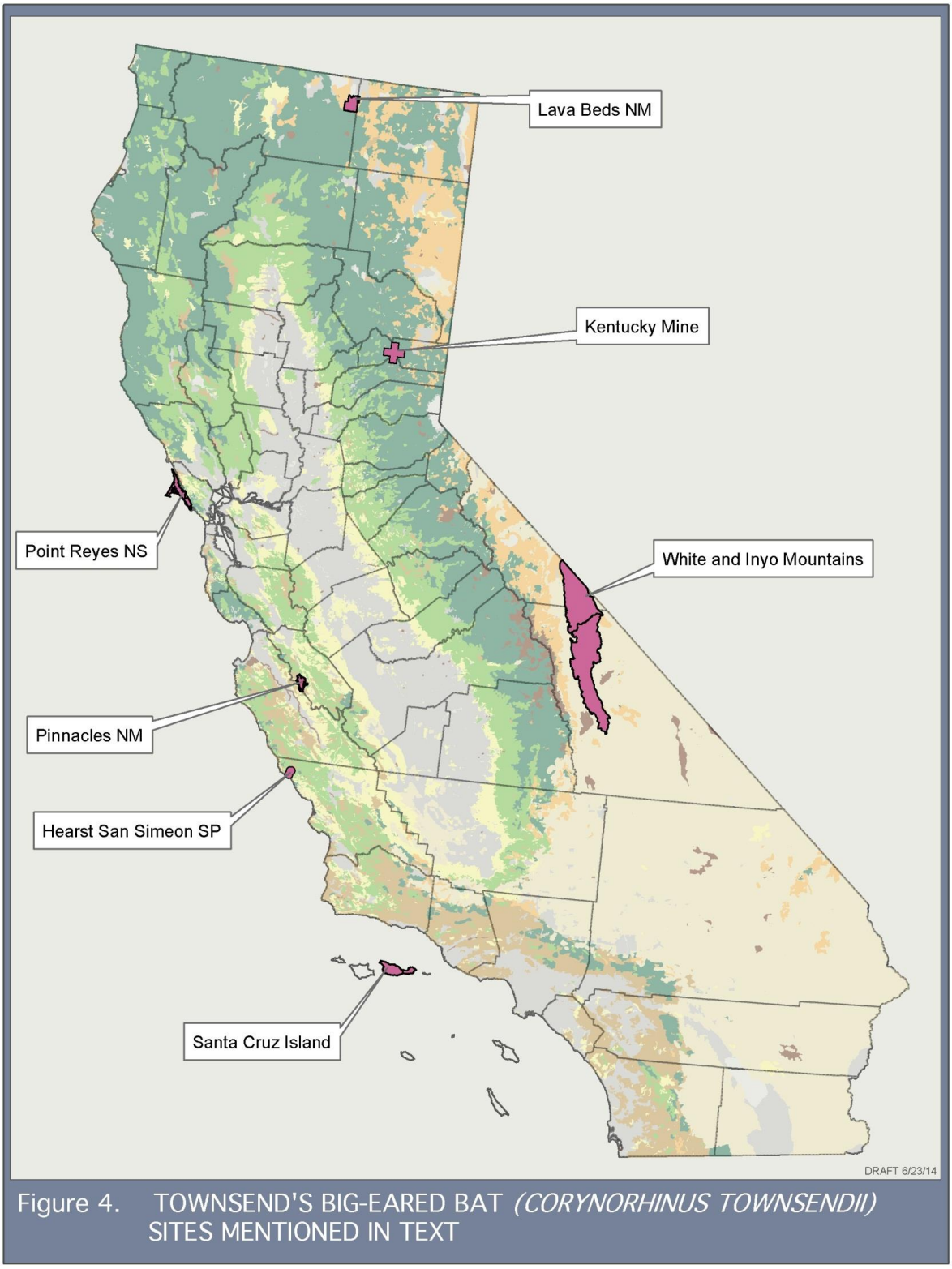
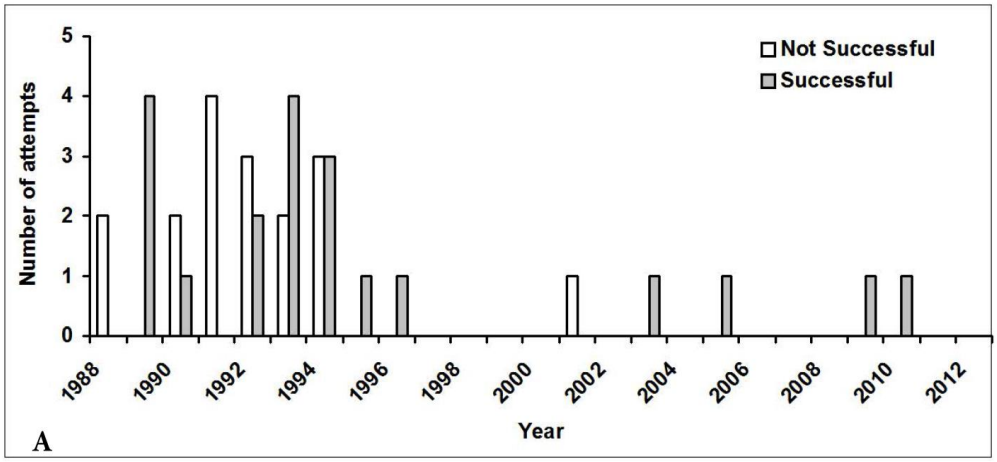


Figure 4. TOWNSEND'S BIG-EARED BAT *(CORYNORHINUS TOWNSENDII)* SITES MENTIONED IN TEXT

Figure 5.


Not Successful
Successful
Number of attempts
0
1
2
3
4
5
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Year
A

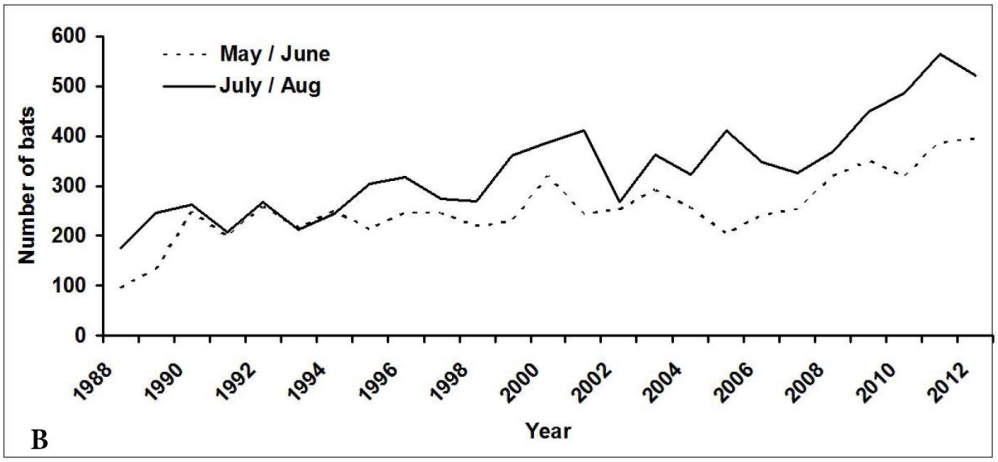

May / June
July / Aug
Number of bats
0
100
200
300
400
500
600
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Year
B

Figure 6. (A)

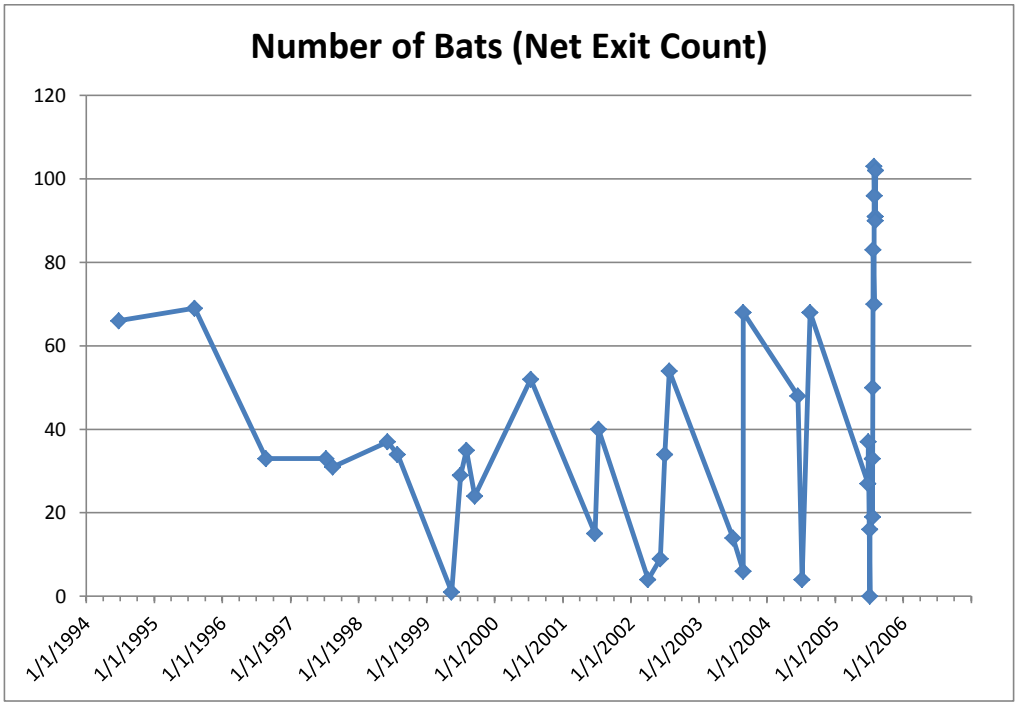

Number of Bats (Net Exit Count)
120
100
80
60
40
20
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004
1/1/2005
1/1/2006

Figure 6. (B, C)

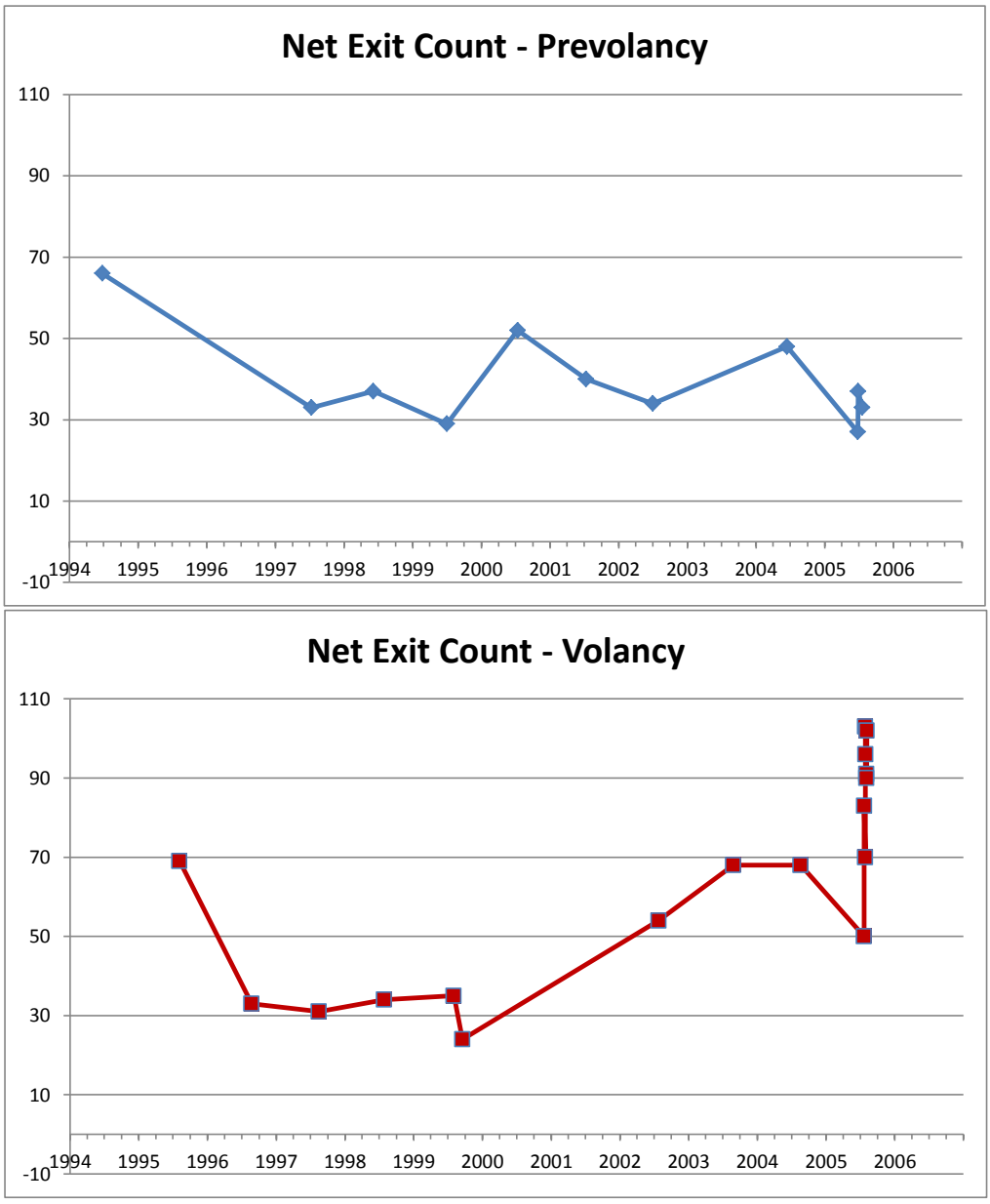

Net Exit Count - Prevolancy
110
90
70
50
30
10
-10
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
Net Exit Count - Volancy
110
90
70
50
30
10
-10
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006

Figure 7.

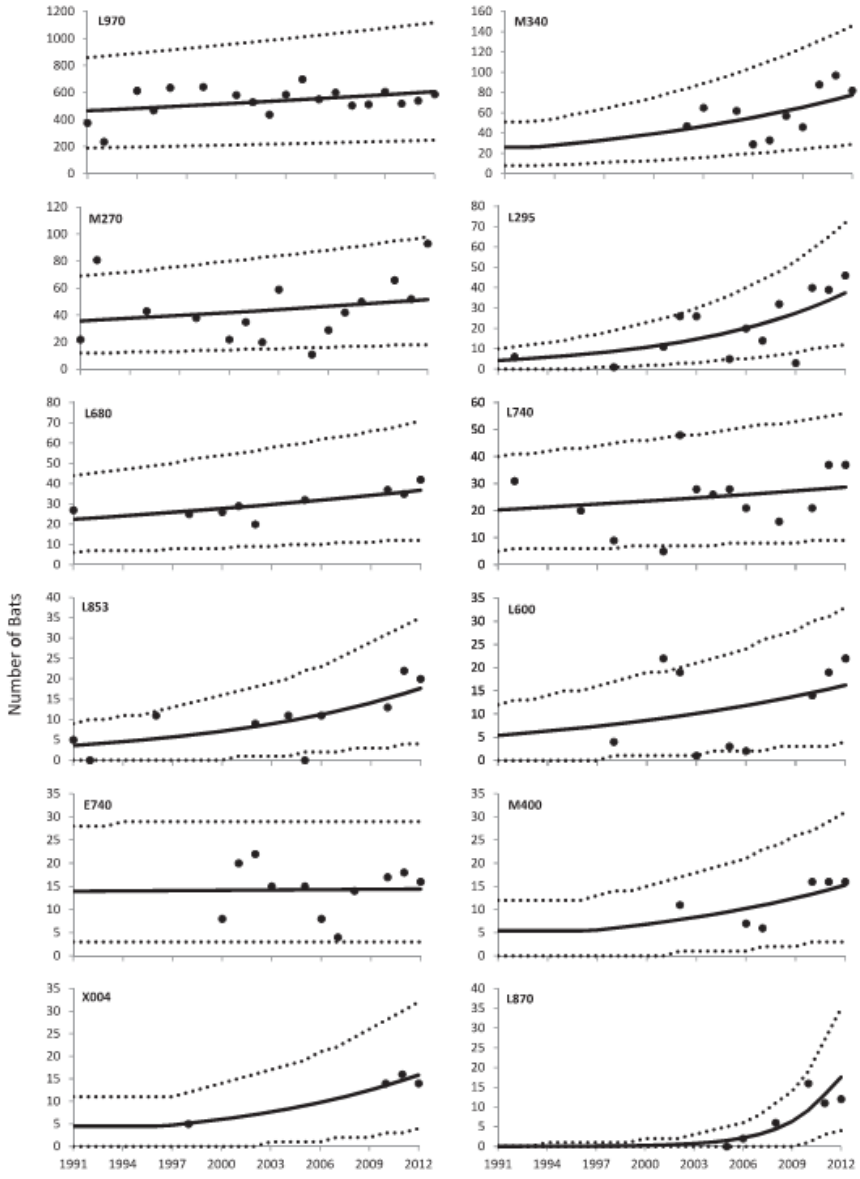

L970
M340
M270
L295
L680
L740
L853
L600
E740
M400
X004
L870
Number of Bats
1991
1994
1997
2000
2003
2006
2009
2012

Figure 7 (continued).

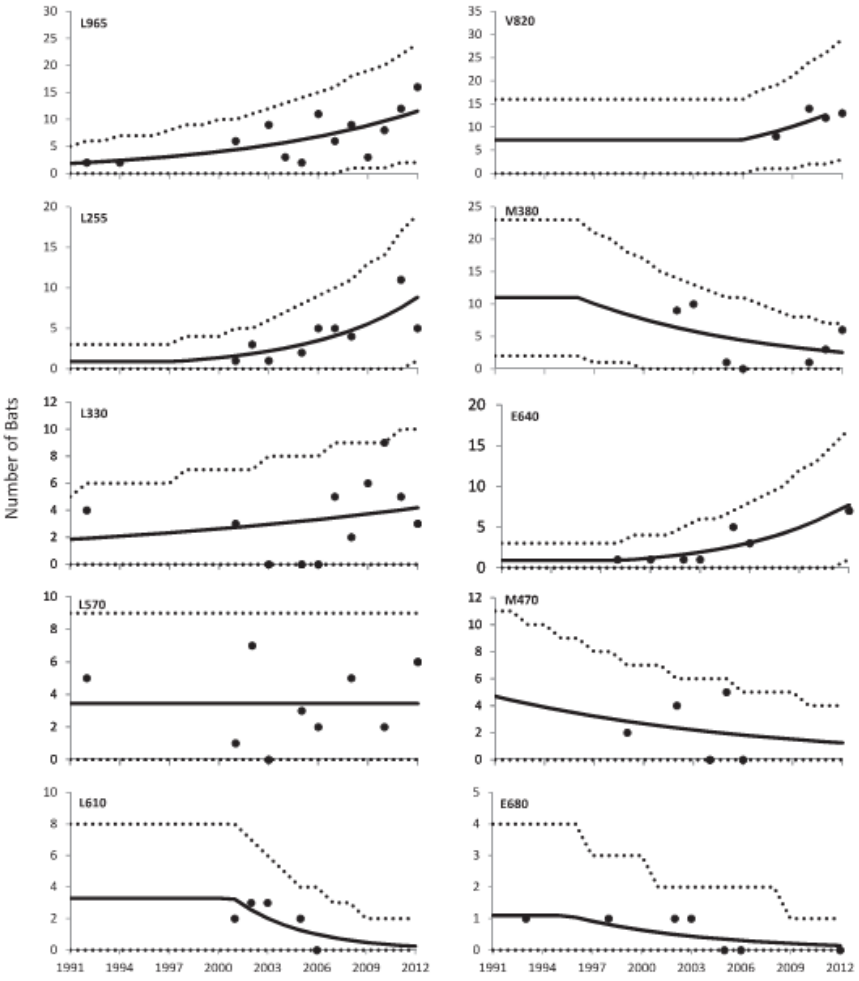


Figure 8.

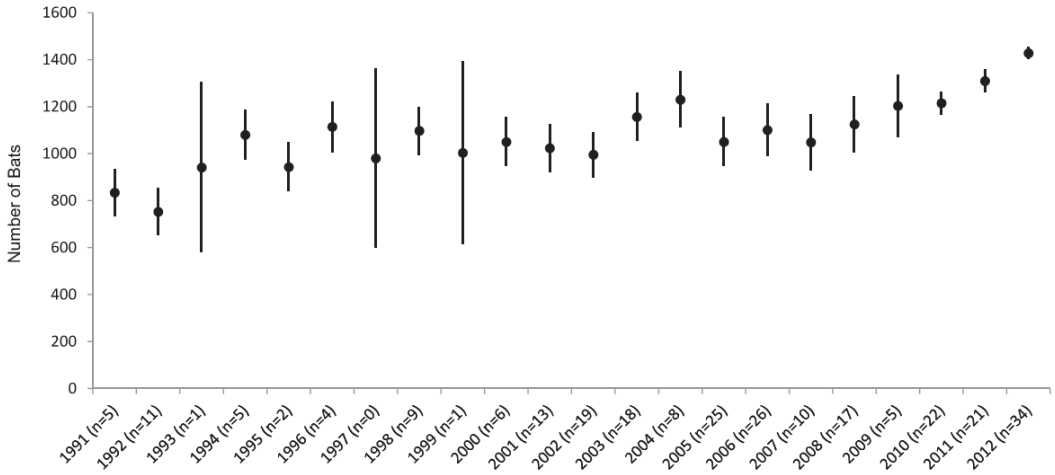
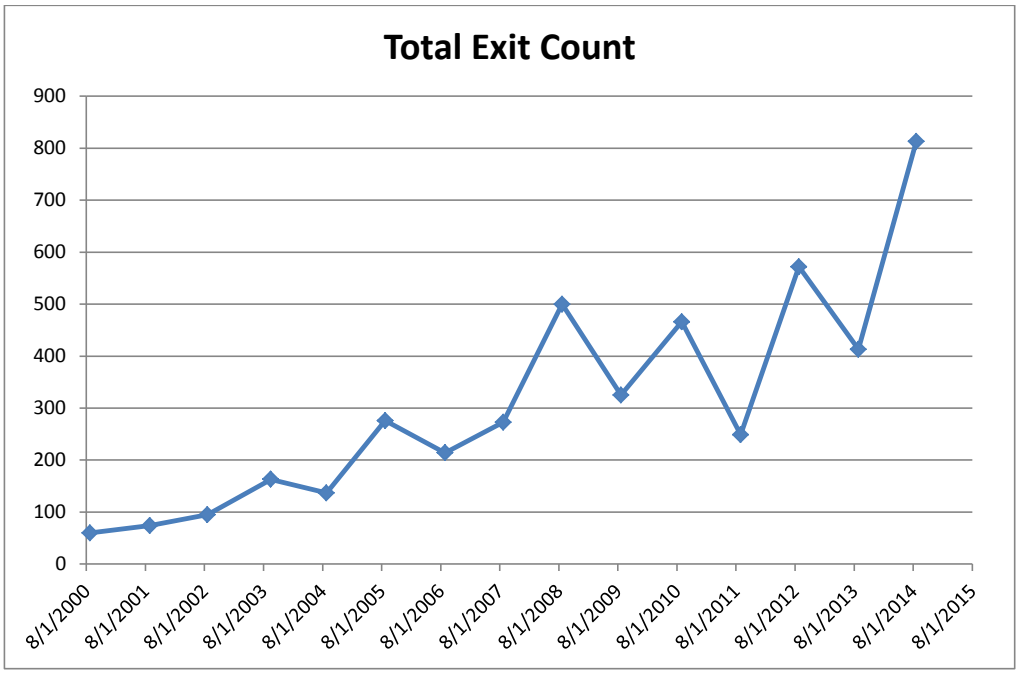

Number of Bats
1600
1400
1200
1000
800
600
400
200
0
1991 (n=5)
1992 (n=11)
1993 (n=1)
1994 (n=5)
1995 (n=2)
1996 (n=4)
1997 (n=0)
1998 (n=9)
1999 (n=1)
2000 (n=6)
2001 (n=13)
2002 (n=19)
2003 (n=18)
2004 (n=8)
2005 (n=25)
2006 (n=26)
2007 (n=10)
2008 (n=17)
2009 (n=5)
2010 (n=22)
2011 (n=21)
2012 (n=34)

Figure 9.


Total Exit Count
900
800
700
600
500
400
300
200
100
0
8/1/2000
8/1/2001
8/1/2002
8/1/2003
8/1/2004
8/1/2005
8/1/2006
8/1/2007
8/1/2008
8/1/2009
8/1/2010
8/1/2011
8/1/2012
8/1/2013
8/1/2014
8/1/2015

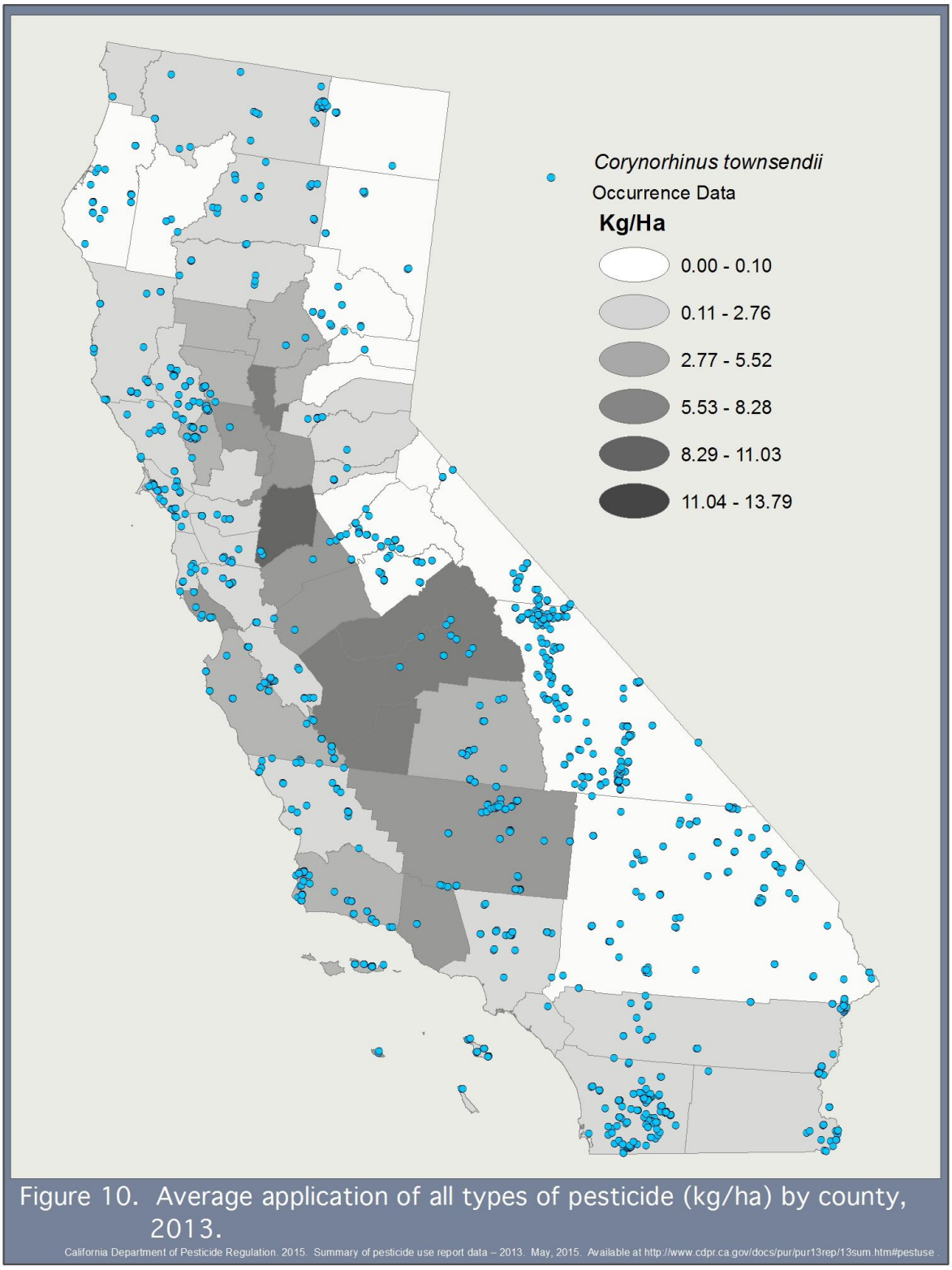


Figure 10. Average application of all types of pesticide (kg/ha) by county, 2013.

California Department of Pesticide Regulation. 2015. Summary of pesticide use report data – 2013. May, 2015. Available at http://www.cdpr.ca.gov/docs/pur/pur13rep/13sum.htm#pestuse .

Figure 11.

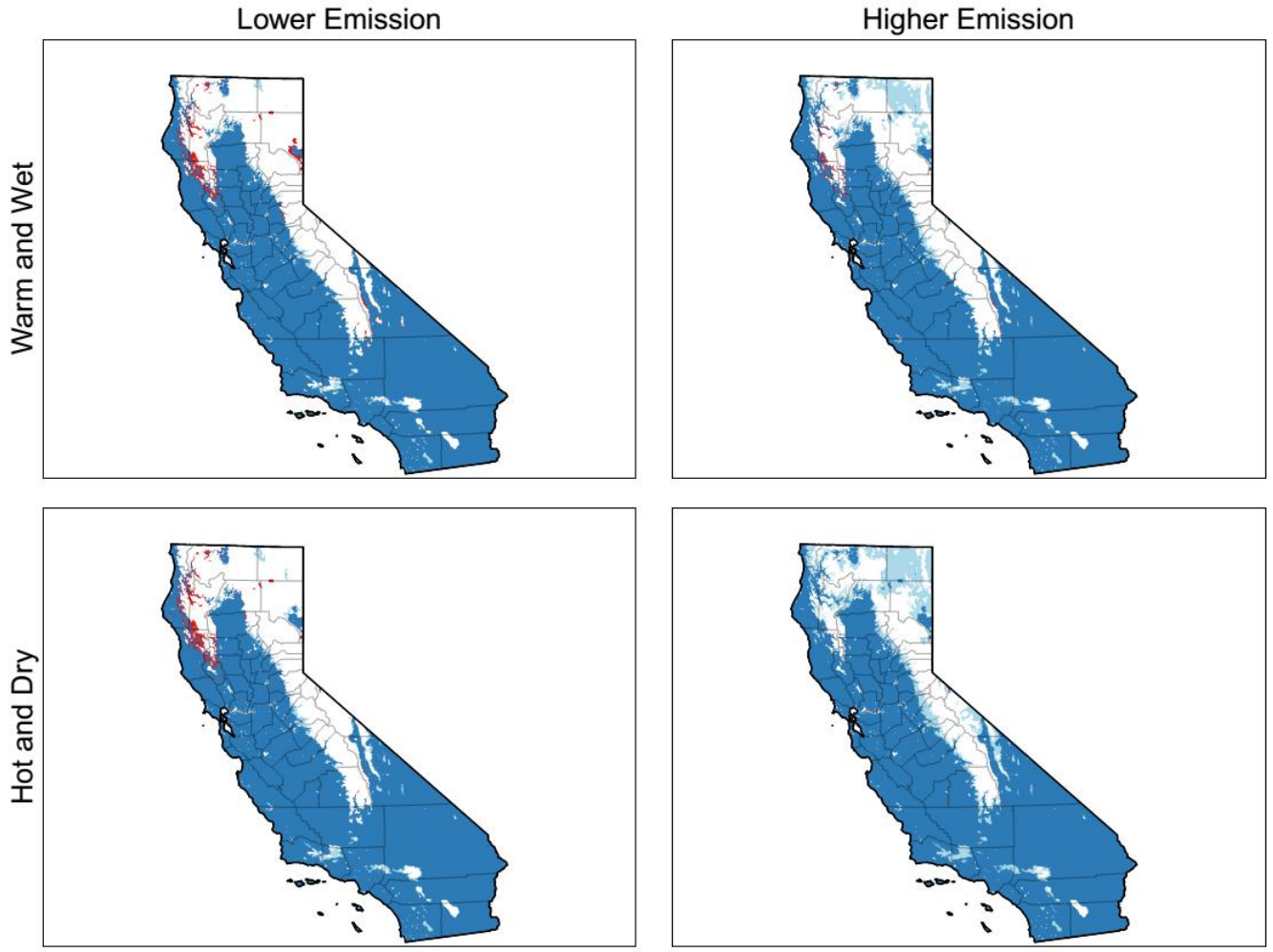


Figure 12.


EDMUND G. BROWN, JR., GOVERNOR, STATE OF CALIFORNIA
JOHN LAIRD, SECRETARY, NATURAL RESOURCES AGENCY
DAVID BUNN, DIRECTOR, DEPARTMENT OF CONSERVATION
OFFICE OF MINE RECLAMATION, ABANDONED MINE LANDS PROGRAM
CALIFORNIA ABANDONED MINES
POTENTIAL, INVENTORIED AND REMEDIATED
MINE FEATURE LOCATIONS
Physical Hazard Remediations*
* Remediations are AMLP data only.
Other agency closures exist, but are not shown on this map
USGS Mapped Mine Features*
* Based on USGS 7.5 minute topographical map mine symbols
AML Program Inventoried Features
Map produced by the Department of Conservation
Abandoned Mine Lands Program (AMLP), July 2015

Townsend's big-eared bat CESA Status Review – Tables

Captions

1. From Weller et al. (2014, Table 1). Number of caves searched and total number of Townsend's big-eared bats ( ) counted between November 15 and March 15 at Lava Beds National Monument, Siskiyou County, California, during the years 1991-2012. Cave L970 contained, by far, the largest number of hibernating bats in the monument.

2. Pinnacles National Park COTO maternity and hibernation roost count summary (NPS unpublished data). Visual counts made during one or more visits during the maternity and hibernation seasons. Where clusters of bats were observed, the number of bats were estimated from the area occupied, assuming between 100 and 150 COTO individuals per square-foot of ceiling area. In years when more than one survey was made in a season, the highest count is reported here. To avoid excessive disturbance to roosting bats in some years, presence only of the maternity colony was noted, or a minimum number of bats was estimated.

3. Summary of Townsend's big-eared bat monitoring studies referenced in the report.

Table 1.

Year	No. of Caves Surveyed	Cave L970 Count	Total Count
1991	5	376	438
1992	11	236	384
1993	1	—	1
1994	5	614	643
1995	2	469	512
1996	4	637	672
1997	0	—	—
1998	9	643	727
1999	1	—	2
2000	6	582	640
2001	13	530	665
2002	19	437	702
2003	18	586	811
2004	8	699	739
2005	25	551	733
2006	26	601	756
2007	10	505	620
2008	17	513	723
2009	5	607	665
2010	22	519	1,026
2011	21	541	1,117
2012	34	588	1,346

Table 2.

Year	Total Maternity*	Total Hibernacula
1997	150-200 (including pups)	60
1998	300-400 (including pups)	114
1999	320 (including pups)	254
2000	200-300	252
2001	300-600 (including pups)	282+
2002	Present	50++
2003	150+	364
2004	300-450	378
2005	100+	409
2006	600-1000 (4 clusters)	384
2007	Unknown/Not surveyed at peak of maternity season	261
2008	200-300	396
2009	125-160+	75
2010	240-290+	44
2011	Present	15
2012	225-235++	51
2013	Present	40
2014	~250+	43
2015	440-615	

Table 3.

Hibernation	
Lava Beds National Monument	Statistically significant population increase over 22 years
White-Inyo Mountains	No statistical inference possible; many repeat visits had lower counts than initial visits 10-plus years earlier
Pinnacles National Park	No inference possible based on uneven monitoring effort
Maternity	
Randall House	Statistically significant population increase over 25 years
Kentucky Mine	Statistical tests not conducted, but colony appears to be stable
Lava Beds National Monument	No inference possible
Pinnacles National Park	Statistical tests not conducted, but colony appears to be stable or increasing
Hearst Castle	Statistical tests not conducted, but colony appears to be stable or increasing
Santa Cruz Island	No statistical tests conducted, but colony has decreased from historical size

APPENDICES [to be completed for the final following external review]

1. **Public Comment Summary**
2. **List of Peer Reviewers and Invitation Letters**
3. **Peer Reviewer Comments**

STATE OF CALIFORNIA
NATURAL RESOURCES AGENCY
DEPARTMENT OF FISH AND WILDLIFE

EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE

REPORT TO THE FISH AND GAME COMMISSION

A STATUS REVIEW OF
TOWNSEND'S BIG-EARED BAT (*CORYNORHINUS TOWNSENDII*)
IN CALIFORNIA

CHARLTON H. BONHAM, DIRECTOR
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

Draft Date: January 7, 2016

Report to the Fish and Game Commission
A Status Review of Townsend's Big-Eared Bat in California

Table of Contents

FIGURES, TABLES, and APPENDICES follow text.

Executive Summary

[To be completed following external review]

INTRODUCTION

Petition Evaluation Process

On November 1, 2012, the California Fish and Game Commission (Commission) received the "Petition to List the Townsend's big-eared bat *(Corynorhinus townsendii*) as endangered under the California Endangered Species Act" (dated October 18, 2012; hereafter, the Petition), as submitted by the Center for Biological Diversity. Commission staff transmitted the Petition to the Department of Fish and Wildlife (CDFW) pursuant to Fish and Game Code (Fish & G. Code) section 2073 on November 9, 2012, and the Commission published formal notice of receipt of the Petition on November 30, 2012 (Cal. Reg. Notice Register 2012, No. 48-Z, p. 1747). After evaluating the Petition and other relevant information CDFW possessed or received, CDFW provided the Commission with the a report "Evaluation of the Petition from the Center for Biological Diversity to List Townsend's Big-Eared Bat (*Corynorhinus townsendii*) as Threatened or Endangered Under the California Endangered Species Act" (Evaluation). CDFW determined, pursuant to Fish & G. Code § 2073.5, subdivision (a), that sufficient scientific information exists to indicate that the petitioned action may be warranted and recommended the Commission accept the Petition (CDFG 2013). At its scheduled public meeting on June 26, 2013 in Sacramento, California, the Commission considered the Petition, CDFW's Evaluation and recommendation, and comments received. The Commission found that sufficient information existed to indicate the petitioned action may be warranted and accepted the Petition for Consideration. Upon publication of the Commission's notice of its findings, Townsend's big-eared bat was designated a candidate species on November 14, 2013 (Cal. Reg. Notice Register 2013, No. 52-Z, p. 2092).

Department Status Review

Following the Commission's action designating the Townsend's big-eared bat as a candidate species, and pursuant to Fish & G. Code section 2074.4, CDFW solicited information from agencies, educational institutions, tribes, and the public to inform the review of the species' status using the best scientific information available. This report contains the results of CDFW's status review, including independent peer review of the draft report by scientists with expertise relevant to the Townsend's big-eared bat. At its scheduled public meeting on December 3, 2014 in Van Nuys, California, the Commission granted CDFW a six-month extension to facilitate external peer review. The purpose of this status review is to fulfill the mandate as required by Fish & G. Code section 2074.6 and to provide the Commission with the most current, scientifically-based information available on the status of Townsend's big-eared bat in California and to serve as the basis for CDFW's recommendation to the Commission.

BIOLOGY AND ECOLOGY[1]

Species Description

Townsend's big-eared bat is a medium sized (10-12 g) bat with an adult forearm length of 39-48 mm and ear length of 30-39 mm. Townsend's big-eared bat generally has buffy brown dorsal fur with somewhat paler underparts (Barbour and Davis 1969, Kunz and Martin 1982). Among western North American bats, Townsend's big-eared bat is unique with its combination of a two-pronged, horseshoe-shaped lump on the muzzle and large, long ears. Although other California bats have long ears, no other has both large ears and the two-pronged nose lump. The other large-eared bat species have other characteristics that readily distinguish them from Townsend's big-eared bat.

Townsend's big-eared bat has relatively broad and short wings, which provides a low body mass-to-wing area ratio (wing load) (Norberg and Rayner 1987). Low wing loading confers high maneuverability and good economy of power, and take-off at low speeds. It may also allow the species to take advantage of pulses in prey availability by ingesting a large mass of insects when they are available (Norberg and Rayner 1987).

Systematics

Townsend's big-eared bat (Class Mammalia, Order Chiroptera) is in the Microchiropteran family Vespertilionidae, which contains the most species of the four bat families in the United States. There are two other species of *Corynorhinus*: *Corynorhinus rafinesquii,* Rafinesque's big-eared bat, and *Corynorhinus mexicanus,* the Mexican big-eared bat. The North American genus of big-eared bats now known as *Corynorhinus* was for several decades known as *Plecotus*, and much of the older scientific literature used that name.

There are five currently recognized subspecies of Townsend's big-eared bat in the United States (Handley 1959, Piaggio and Perkins 2005) (see Figure 1). Two of the subspecies (*C. t. townsendii* and *C. t. pallescens*) occur throughout much of western North America (including California), two (the Ozark big-

[1] Much of the information presented here on the biology of Townsend's big-eared bat has been adapted from the draft species account prepared by E.D Pierson, W.E. Rainey, and L. Angerer for the California Bat Conservation Plan (CDFW in prep.). Personal communications and personal observations cited without a year reference are from the draft species account. All other personal communications were between the referenced person and Scott Osborn, CDFW Senior Environmental Scientist with the Wildlife Branch, Nongame Wildlife Program.

eared bat, *C. t. ingens,* and the Virginia big-eared bat, *C. t. virginianus*) occur in the eastern United States, and one (*C. t. australis*) is distributed primarily in Mexico but also extends into Texas. Both of the eastern subspecies of Townsend's big-eared bat (the Ozark and Virginia big-eared bats) are listed by the U.S. Fish and Wildlife Service as Endangered.

This classification scheme follows the presumed evolutionary history of Townsend's big-eared bat and related bats species. Tumlison and Douglas (1992) used cladistics analysis of shared acquired characteristics to determine that the New World *Corynorhinus* species comprise a distinct lineage from both the Old World *Plecotus* species (which they had formerly been grouped with under the genus name *Plecotus*) and two other big-eared bat genera (*Idionycteris* and *Euderma*).

Piaggio and Perkins (2005) examined the evolutionary relationships within the *Corynorhinus* genus using both mitochondrial and nuclear DNA. Their results confirmed the status of the five Townsend's big-eared bat subspecies, suggested that Townsend's big-eared bat and *Corynorhinus mexicanus* are more closely related to each other than to *Corynorhinus rafinesquii*, and that levels of genetic divergence among the Townsend's big-eared bat subspecies are relatively high (Piaggio and Perkins 2005).

Within Townsend's big-eared bat itself, DNA analyses have shown the western-most subspecies, *C. townsendii townsendii*, may have diverged from the other Townsend's big-eared bat subspecies between 41,000 and 64,000 years ago, while *C. townsendii pallescens* diverged 12,000 to 23,000 years ago, and *C. townsendii australis* diverged between 6,000 and 20,000 years ago (Smith et al. 2008). The timings of divergence and geographic pattern of the subspecies' ranges today suggested to the authors that the subspecies developed during periods of extensive glaciation in western North America when Townsend's big-eared bat populations were isolated from each other. Other mitochondrial DNA evidence suggests an earlier divergence of the five Townsend's big-eared bat subspecies (possibly as early as 1 million years ago), with subsequent effects on distribution during the Pleistocene (Lack and Van Den Bussche 2009).

Geographic Range and Distribution

Townsend's big-eared bat ranges throughout much of the western United States and Canada (Figure 1). In California, its geographic range is generally considered to encompass the entire state, except for the highest elevations of the Sierra Nevadas (Figure 2). Within the general range, there are areas of greater and lesser probability of occupancy by Townsend's big-eared bat with greatest concentrations in areas offering caves (commonly limestone or basaltic lava) or mines as roosting habitat.

Deleted: . Populations are concentrated

Conversely, a general lack of Townsend's big-eared bat records in the Central Valley and Imperial Valley (Figure 2), along with a paucity of suitable roost structures, suggests these areas are unlikely to include day roosts of large numbers of resident Townsend's big-eared bat.

Deleted: harbor

Deleted: populations

Individuals have been found from sea level along the coast to 1,820 m (6,000 ft) in the Sierra Nevada (Dalquest 1947, Pearson et al. 1952, Pierson and Rainey 1998). In the White Mountains, summer records for males extend up to 2,410 m (7,900 ft), and hibernating groups have been found in mines as high as 3,188 m (10,460 ft) (Szewczak et al. 1998). Maternity colonies are more frequently found below 2,000 m (6,560 ft) (Pierson and Fellers 1998, Szewczak et al. 1998). Outside California, Townsend's big-eared bat has been found to 2,400 m (7,900 ft) (Jones 1965, Jones and Suttkus 1971) and 2,900 m (9,500 ft) (Findley and Negus 1953).

As for the two Townsend's big-eared bat subspecies that occur in California, *C. t. townsendii* occurs primarily in the western-most portion of the species' range in California, Oregon, Washington, Nevada, Idaho, and possibly southwestern Montana and northwestern Utah. *C. t. pallescens* occurs in all the same states as *C. t. townsendii*, plus in more interior portions of the continent in Arizona, Colorado, New Mexico, Texas, and Wyoming (Handley 1959, Piaggio and Perkins 2005). Throughout much of their range in California, Idaho, Nevada, Oregon and Washington there are extensive zones of intergradation where it is difficult to assign individuals to one subspecies or the other.

Population Genetics

Genetic studies can inform our understanding of animal populations, including the amount of mixing between subpopulations and level of genetic variability among and between individuals or subpopulations. Smith (2001) demonstrated the Townsend's big-eared bats in Oklahoma show high movement (high gene flow) of males across her study area (nuclear microsatellite DNA results) with finer scale movements of females (mitochondrial DNA results). This suggests higher local fidelity of females often remaining near natal roosts relative to males. While individual maternity colonies were highly differentiated from each other, they also included high levels of within colony variation, indicating some movement of females among maternity colonies.

Miller's (2007) study of Townsend's big-eared bat genetics in southeastern Idaho used nuclear DNA and revealed that most individuals within a small number of hibernacula were not closely related to each other, contrary to an earlier suggestion by Pearson (1959) that Townsend's big-eared bats within a hibernaculum should be closely related, since Townsend's big-eared bat mate at their hibernacula and have high fidelity to these sites. Miller (2007) suggested that "juveniles may disperse from natal colonies before settling and becoming philopatric to a single [hibernation] site, which could create these communities of unrelated individuals." Alternatively, it is possible that Townsend's big-eared bats in her study area are either not loyal to a single hibernaculum or do not mate at the hibernacula in which they over winter. She also found that adult females in maternity colonies are more closely related to each other than are juveniles, which is consistent with males dispersing longer distances than females.

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Deleted: for the two subspecies and

Deleted: often not possible

Deleted: populations

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Deleted: their

Deleted: The female subpopulations

Deleted: but also highly variable within the subpopulations.

Deleted: population

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Deleted: within a

The study by Piaggio and others (2009) of genetic structure, diversity, and dispersal among three subspecies of Townsend's big-eared bat in the Rocky Mountains region (*C. t. townsendii*, *C. t. pallescens*), and in the southeastern U.S. (the endangered *C. t. virginianus* subspecies) using both nuclear and mitochondrial DNA analyses. Their data revealed significantly lower genetic diversity in *C. t. virginianus*, compared to the other two subspecies, which is likely due to the lower number of individuals *and their extended physical isolation from other groups of C. townsendii which has historically precluded input of novel haplotypes through gene flow.* Their study also indicated relatively low levels of gene flow between *C. t. townsendii* and *C. t. pallescens* subspecies. On the other hand, some gene flow can occur at distances of 310 km between roosts, which (with other recent data) suggests that some individuals do move greater distances than has been historically hypothesized. These genetic results are consistent with the observation that a simple geographic demarcation between the *C.t. pallescens* and *C.t. townsendii* subspecies is not sufficient to differentiate between individuals of the two subspecies.

Reproduction and Development

Townsend's big-eared bat is a colonial species. Maternity colonies form between March and June, with the timing varying based on local climate, elevation, and latitude. Colony sizes typically range from a few dozen to several hundred individuals, although colonies of over 1,000 have been documented. Mating generally takes place in both migratory sites and hibernacula between September or October and February. "Swarming" – a behavior where both sexes mix in autumn prior to moving to hibernacula – has been observed during the latter half of September in the Mojave Desert. Females are generally reproductive in their first year, whereas males typically do not reach sexual maturity until their second year. Gestation length varies with climatic conditions, but generally lasts from 56 to 100 days (Pearson et al. 1952). Some evidence indicates maternity colonies may have up to three different roost sites for given stages of reproduction – one each for pregnancy, birthing, and rearing (Sherwin et al. 2000). This is particularly true of colonies roosting in smaller subterranean features, where colonies tend to be smaller and routinely move within and among many roosts during the course of the maternity period (Sherwin et al., 2003).

A single pup is born between May and July (Easterla 1973, Pearson et al. 1952, Twente 1955). Townsend's big-eared bat pups average 2.4 g at birth, nearly 25% of the mother's postpartum mass (Kunz and Martin 1982). While adult males are typically solitary during the maternity season, adult females and their pups cluster together in colonial roosts (Pearson et al. 1952). Aggregations in maternity roosts have typical densities of between 100 and 150 adults and young per square foot of roost surface area occupied. Such clustering minimizes heat loss and allows more energy to be used for milk production (adults) and growth (pups). Young bats are capable of flight at 2.5 to 3 weeks of age and are likely gradually weaned by 2 months (Pearson et al. 1952). Nursery colonies typically begin to

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disperse in August about the time the young are weaned and break up altogether in September and October (Pearson et al. 1952, Tipton 1983).

Vital Rates (Reproduction, Survival)

Maximum fecundity per adult female is one pup per year. Pearson et al. (1952) estimated an average fecundity for the colonies in their study to be about 0.45 female pups per adult female per year. Examining exit count data from an undisturbed colony where counts were made both before and after young Townsend's big-eared bat became volant, it appears that the number of bats may increase by a factor of 1.5 to 2 (unpublished CDFW analysis of Kentucky Mine counts in 2005 and 2006). Assuming a 50:50 sex ratio of young, this would be equivalent to annual recruitment rates of 0.25 to 0.5 female young per adult female.

Pearson et al. (1952) estimated annual survival at about 50% for the first year of life and about 80% for adults. The authors determined these survival rates, combined with their estimates of fecundity, were "just sufficient" to maintain a stable population during the years these colonies were studied (Pearson et al. 1952). Ellison (2010) estimated winter survival in a Washington Townsend's big-eared bat colonies to range between 54% and 76%, with higher survival for females than for males. Band recoveries have yielded individual longevity records of 16 years, 5 months (Paradiso and Greenhall 1967) and 21 years, 2 months (Perkins 1994).

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Behavior

Townsend's big-eared bat's perceived susceptibility to human disturbance at roost sites is usually cited as a key behavioral characteristic putting the species at conservation risk (Twente 1955, Barbour and Davis 1969, Humphrey 1969, Humphrey and Kunz 1976). As summarized by Pierson et al. (1991):

> Townsend's big-eared bats are so sensitive to human disturbance that simple entry into a nursery roost can be enough to induce the colony to abandon a site (Mohr 1972, Humphry and Kunz 1976). Activities as apparently harmless as recreational caving have been shown to have negative impacts and have driven Townsend's big-eared bat from a number of their traditional roost sites in California (Graham 1966, Pierson, unpubl. data).

Pearson (1952) documented temporary abandonment of maternity roosts in California as a direct result of his research team entering the roost site to band young. Fellers and Halstead (2015) showed a strong negative relationship between attempted unlawful entries into the Randall House Townsend's big-eared bat maternity roost (coastal Marin County) and overall colony reproductive success on an annual basis.

Contrary to the general pattern of susceptibility to disturbance, one Townsend's big-eared bat maternity colony in California has demonstrated some tolerance to disturbance (Freeman 2012). The Kentucky Mine colony in Sierra County has persisted despite daily tours in the historic stamp mill building where the bats typically roost, though some impacts to the colony and changes in behavior (including temporary roost abandonment) have occurred there over the years (M. Tierney pers. comm. 2015). It should be noted that the Kentucky Mine roost site is managed under guidance that emphasizes quiet, predictable disturbance events (tours) and minimizes other, novel types of disturbance. Clark et al. (1997) also noted one of the eastern Townsend's big-eared bat subspecies, the Ozark big-eared bat (*C. townsendii virginianus*) did not abandon roosts or caves despite some human entry and surmised that *C. t. virginianus* may tolerate more human activity than the western subspecies.

Once a roost site has been successfully colonized by Townsend's big-eared bat (whether for the warm or hibernation season), it is likely to be used in subsequent years, so long as it remains suitable (Humphrey and Kunz 1976). However, it is not unusual for individuals to move among multiple maternity colonies and even for entire maternity colonies to switch roosts during the course of the season (Fellers and Pierson 2002, Sherwin et al. 2000, 2003). It is likely that these patterns of roost switching have historically been interpreted as roost abandonment rather than normal behavioral patterns. While human disturbance can certainly negatively impact colonies of Townsend's big-eared bats, the intensity, duration, and type of disturbance must be evaluated before automatically assuming human disturbance is the driving force behind dynamics of roost use (Sherwin et al., 2003, 2009). For most colonies, movements routinely occur within and among roosts throughout the course of a given maternity season, with some roosts only used for short periods or during occasional years. Historically, these movements have been interpreted as the result of human disturbance, yet little data exists to support this assumption. In fact, maternity colonies of *C. townsendii* studied in Utah, Nevada, and California exhibit high levels of resiliency to disturbance with colonies maintaining occupancy of highly disturbed sites for many years prior to the protection of these roosts with bat gates (ex., Logan Cave, Utah). Additionally, in cases where maternity roosts are reclaimed (often as a result of renewed mining or for emergency closures) it has proven extremely difficult to exclude females from these roosts often requiring several weeks of intensive effort. This is in spite of the fact that these exclusions are conducted outside of the active maternity season (typically in the fall) (Sherwin et al., 2003, 2009). Clearly, colonies do not benefit from human disturbance and in many cases, colony sizes, and patterns of roost use (ex., location of roosting areas, exiting behaviors) do change following protection, there is little compelling evidence to support anecdotal accounts of wholesale system collapse resultant from the typical levels of human disturbance realized at most roosts (Brigida 2015; Sherwin and Brigida, in prep; Sherwin et al., 2003).

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Night roosts are used opportunistically during breaks from foraging. Such roosts allow the bats to rest and digest meals, socialize, and hydrate while minimizing predation risk. Use of night roosts has been historically understudied, and while there is some data to suggest that individual Townsend's big-eared bats roosting in basal tree hollows do not show particularly high fidelity to night roosts (Fellers and Pierson 2002), however, caves and abandoned mines are often used predictably by this species. Night roosts of Townsend's big-eared bats are often occupied by many individuals, and are often shared with other species. During early-evening foraging bouts of six light-tagged Townsend's big-eared bat in Oklahoma, Caire et al. (1984) documented their study animals rested between bouts of foraging about 17% of the time under observation. It is likely the overall resting time between foraging bouts in a given night is greater.

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Diet

Diet of Townsend's big-eared bat has not been examined in detail in California, however it is likely that as elsewhere, they are Lepidopteran specialists, feeding primarily on medium-sized moths, supplemented with occasional captures of other insects, including flies, beetles, and aquatic insects (Ross 1967, Whitaker et al. 1977, 1981, Dalton et al. 1986, Sample and Whitmore 1993, Furford and Lacki 1998, Dodd and Lacki 2007).

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Vocalizations

Townsend's big-eared bat produces ultrasonic calls that are used for navigating in the dark, and for locating and capturing prey. They also use both ultrasonic and mid frequency ranges for social communication. While cruising or searching for prey, a semi-regular pattern of calls is emitted at 10 to 20 calls per second (Kunz and Martin 1982). Search- and cruising calls are usually simple downward sweeps in frequency, typically starting at about 40 to 45 kHz and ending at about 19 to 23 kHz, with the maximum power (volume) produced at about 21 to 26 KHz (J.M. Szewczak, unpublished data 2011). Calls may include sounds produced at the harmonic frequencies at two- and three times the fundamental call frequencies – sometimes with more power applied to a harmonic than to the fundamental call. Townsend's big-eared bat is commonly known as a "whispering" bat, because of the relatively low power of its calls – typically about 40 to 50 dB quieter than those of *Myotis lucifugus* (Kunz and Martin 1982). The relatively low volume of its echolocation calls makes Townsend's big-eared bat difficult to detect with acoustic equipment.

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Predation

Pearson et al. (1952) discounted predation as a factor limiting Townsend's big-eared bat populations, but individuals may be preyed upon by a variety of native and non-native predators, as has been documented for other bats. Hensley et al. (1995) listed several potential predators of Townsend's big-eared bat in the recovery plan for the endangered Ozark big-eared bat (*C. townsendii virginianus*),

including raccoons (*Procyon lotor*), bobcats (*Lynx rufus*), house cats (*Felis catus*), skunks (*Mephitis*, *Spilogale*), and snakes. These and other generalist predators, such as ringtails (*Bassariscus astutus*) likely take Townsend's big-eared bat opportunistically in California.

Fellers and Halstead (2015) stated several owl species known to prey on bats may have influenced Townsend's big-eared bat emergence times at the Randall House maternity roost. These included great horned owls (*Bubo virginianus*), barn owls (*Tyto alba*), and spotted owls (*Strix occidentalis*). Townsend's big-eared bat's tendency to avoid foraging in open grassland and other areas of low vegetation cover has been hypothesized to be a mechanism for avoiding aerial predators such as owls (Pierson and Fellers 1999). However, this behavior may also be driven by the distribution of the bat's prey as reproductively active females Townsend's big-eared bats in Nevada routinely travel over 30km over a barren alkali flat traveling from their maternity roosts to foraging areas (Ives et al., *In Review*; Sherwin et al., In Review).

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Fellers (2000) also reported that non-native black rats (*Rattus rattus*) preyed upon young Townsend's big-eared bats at the Randall House roost before measures were taken to prevent rat entry into the structure.

Movements

Migration. Townsend's big-eared bat is considered a relatively sedentary species, for which no long-distance migrations have been reported (Barbour and Davis 1969, Humphrey and Kunz 1976, Pearson et al. 1952). The longest movement known for this species in California is 32.2 km (20 mi) (Pearson et al. 1952). There is some evidence of local migration, perhaps along an elevation gradient.

Townsend's big-eared bats in Oregon appear to move from their hibernacula to active season (maternity) roosts over a period of several nights, using interim roosts before settling into the maternity roost (Dobkin et al. 1995). This study recorded a maximum distance between hibernation site and foraging areas of 24 km (15 mi). Recent data from Nevada indicates movements of over 150 km between maternity roosts and hibernation sites, and even nightly foraging distances in excess of 50km, indicating that individuals are capable of far greater movements than has been previously appreciated. The assumption that individuals are relatively sedentary has led to a general perception that maternity colonies represent discrete populations and that any changes in numbers of bats, or patterns of roost use at the local scale are biologically meaningful and have conservation implications. However, the fact that individuals are capable of moving large distances within and among seasons means that meaningful trend data must be collected at larger spatial scales and that the accumulation of local anecdotes are often extremely misleading (Brigida 2015, Ives 2015, Ives et. al., *in prep*, Sherwin and Brigida, *in prep*; Sherwin *et al*., 2002; 2003, 2009, *in prep*)

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Feeding. Despite its reputation as a sedentary species, Townsend's big-eared bat may cover a lot of ground while foraging each night. As described in one species account for Townsend's big-eared bat (WBWG 2005), "these bats often travel large distances while foraging, including movements of over 150 kilometers during a single evening (R. Sherwin pers. comm.). Evidence of large foraging distances and large home ranges has also been documented in California (E.D. Pierson pers. comm.)."

Thermoregulation and Hibernation

Townsend's big-eared bat, like most mammals, maintains a high body temperature primarily through heat produced by its metabolism. High metabolic rate and elevated (and typically constant) body temperature allow mammals to maintain high aerobic activity levels, which in turn has allowed them to occupy ecological niches only available to highly energetic animals. Like many bat species inhabiting temperate regions, Townsend's big-eared bat uses torpor[2] as a physiological and behavioral strategy in winter to deal with diminished food resources and cool or cold ambient temperatures, which make it energetically costly to maintain normal high body temperature. By allowing core body temperature to cool to near ambient, bats in torpor reduce their energy expenditure to a small fraction of what would be used to keep body temperature elevated. Despite the energy savings conferred by torpor, hibernating bats may lose more than 50% of their body mass during the hibernation season (Humphrey and Kunz 1976). Townsend's big-eared bat and other bats that use torpor have a suite of physiological adaptations to allow them to remain healthy during torpor and to arouse at appropriate times throughout the winter to feed and move within and among roosts.

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An important behavioral trait of hibernators is the selection of suitable sites for the inactive period. Townsend's big-eared bat hibernation sites are generally caves or mines (Pearson et al. 1952, Barbour and Davis 1969), although animals are occasionally found in buildings (Dalquest 1947). Deep mine adits and shafts, known to provide significant hibernating sites in New Mexico (Altenbach and Milford 1991), may also be important in California. Winter roosting is typically composed of mixed-sexed groups from a single individual to several hundred or several thousand individuals; however, behavior varies with latitude. In areas with prolonged periods of non-freezing temperatures, Townsend's big-eared bat tends

[2] "Torpor" is a general term for reduced metabolic rate and body temperature. For animals adapted to use torpor as described, it can range from "shallow torpor" which occurs when winter temperatures are relatively mild and where the animal may only drop its body temperature a few degrees, to deep hibernation, which occurs in more extreme cold. In hibernation, ambient temperatures may be near or below freezing and the torpid animal may maintain its temperature just above freezing. Bats in hibernation may appear almost completely inanimate with no visible sign of breathing. Arousal from deep torpor may take many minutes to over an hour. Bats in shallow torpor may respond to handling or other stimuli by slowly moving and visibly breathing, and will often arouse in several minutes.

to form relatively small hibernating aggregations of single to several dozen individuals (Barbour and Davis 1969, Pierson et al. 1991, Pierson and Rainey 1998). Larger aggregations (75-460) are confined to areas that experience prolonged periods of freezing temperatures (Pierson and Rainey 1998).

Studies in the western U.S. have shown that Townsend's big-eared bat selects winter roosts with stable, cold temperatures, and moderate air flow (Humphrey and Kunz 1976, Kunz and Martin 1982). Individuals roost on walls or ceilings, often near entrances (Humphrey and Kunz 1976, Twente 1955). If undisturbed, individuals will frequently roost less than 3 m (10 ft) off the ground (Perkins et al. 1994), and have been found in air pockets under boulders on cave floors (E. Pierson pers. obs.). Temperature appears to be a limiting factor in roost selection. Recorded temperatures in Townsend's big-eared bat hibernacula range from -2.0°C to 13.0°C (28°F to 55°F) (Humphrey and Kunz 1976, Genter 1986, Pearson et al. 1952, Pierson et al. 1991, Twente 1955), with temperatures below 10°C (50°F) being most common (Perkins et al. 1994, Pierson and Rainey 1998). Within a hibernaculum, Townsend's big-eared bat most frequently hibernates singly, but pairs and clusters ranging from a few to several hundred torpid individuals have been observed. In the White and Inyo mountains, larger groups were observed in sites where air temperature was around 5°C (41°F) while smaller groups occurred at locations with air temperatures that were colder (Szewczak et al. 1998). In the Mojave Desert in the winter, hibernating Townsend's big-eared bat have been found at temperatures of 15.5°C (60°F) as these might be the coolest temperatures available (P. Brown pers. obs.). Hibernating Townsend's big-eared bats in Death Valley, California were found to seek very specific microclimates within roosts that were typically 1-3° C cooler than areas immediately surrounding each bat and 5° C cooler than the average conditions found throughout the mine. These data were collected using thermal imaging cameras and reveals that the selection of roosting areas within hibernacula is highly regulated. As such, average roost climates, or more coarse measurements may be quite misleading for understanding the thermal needs of hibernating Townsend's big-eared bats (Gordon and Sherwin, 2015; Sherwin and Gordon, in prep.)

The period of hibernation is shorter at lower elevations and latitudes. Coastal populations of Townsend's big-eared bat, which experience particularly mild winters, may use shallow torpor on a daily basis and are often active during the winter as they take advantage of warm weather and prey availability (Pearson et al. 1952).

Thermoregulation is also an important aspect of the active season for Townsend's big-eared bat, especially for the energetically-demanding processes of pregnancy and lactation. Adult females require warm microclimates to facilitate the rearing of their young as warm temperatures minimize the energy lost as heat during pregnancy and help newborn and young pups conserve energy for growth. Clustering behavior of females and their young further enhances energy conservation and cluster size has been observed to increase and decrease based on the ambient temperature of the roost site (Betts

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2010). Clustering also serves to modify the temperature of the colony as combined metabolic heat from the mothers and pups has been documented to raise the temperature of the roosting area by as much as 10° C. This allows females to use a wider variety of subterranean habitat for maternity use as they are not dependent upon abiotic factors of the roosts itself to produce suitable roosting conditions (Sherwin et al., 2009).

Habitat Utilization

Habitat associations for Townsend's big-eared bat in California include the inland deserts, cool, moist coastal redwood forests, oak woodlands of the inner Coast Ranges and Sierra Nevada foothills, and lower to mid-elevation mixed coniferous-deciduous forests. Townsend's big-eared bat has also been observed hibernating in the bristlecone-limber pine habitat (Szewczak et al. 1998) of the White Mountains (Inyo County). Distribution is patchy throughout their range and is strongly correlated with the availability of caves and cave-like roosting habitat, with highest concentrations often occurring in areas dominated by exposed, cavity forming rock and/or historic mining districts (Genter 1986, Graham 1966, Humphrey and Kunz 1976, Kunz and Martin 1982, Perkins et al. 1994, Pierson and Rainey 1998). The species' habit of roosting on open surfaces within roosts makes it readily detectable and it is often the species most frequently observed (but often in low numbers) in caves and abandoned mines throughout its range.

Roosting Habitat. Townsend's big-eared bat prefers open surfaces of caves or cave-like structures, such as mine adits and shafts (Barbour and Davis 1969, Graham 1966, Humphrey and Kunz 1976). It has also has been reported in such structures as buildings, bridges, and water diversion tunnels that offer a cavernous environment (Barbour and Davis 1969, Dalquest 1947, Howell 1920, Kunz and Martin 1982, Pearson et al. 1952, Perkins and Levesque 1987, Brown et al. 1994, Pierson and Rainey 1998). It has been found in rock crevices and, like a number of bat species (Gellman and Zielinksi 1996), in large hollow trees (Fellers and Pierson 2002, Mazurek 2004). While they can often be found roosting in structures that contain multiple openings they are equally common in more simple caves and mines with single openings. Nor is any type of seasonal use limited by roost structure. Maternity colonies, large hibernation colonies, and important swarming sites have all been documented in horizontal and vertical structures with less than 10 feet of underground workings. Specific roosts may be used at only one time of year or may serve different functions throughout the year, such as for maternity roosts, hibernation, or other uses (Sherwin et al. 2000, 2003). Roosting surfaces often occur in locations with partial light during the day; however, many roosting areas have been found very deep inside caves or mines including at deep levels of shafts (Sherwin et al. 2003, 2009). Of 54 maternity roost sites tabulated by Pierson and Fellers (1998), 43% were in caves, 39% were in mines, and 18% were in buildings.

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Townsend's big-eared bat has often assumed to have fairly restrictive roost requirements (Humphrey and Kunz 1976, Perkins et al. 1994, Pierson et al. 1991). However, while the internal roost temperatures are often critical (Lacki et al. 1994, Pearson et al. 1952, Pierson and Rainey 1998), it only takes a small area within a feature, supporting adequate thermal specifications, to make a seemingly unusable roost opportune (Sherwin 2003). Temperatures vary in maternity roosts throughout California from 19°C (66°F) in cooler regions to 30°C (86°F) in warmer southern regions (Pierson et al. 1991). Some colonies are known to change roosts during the maternity season, using cooler roosts earlier in the year (Pierson et al. 1991, P. Brown pers. comm., V. Dalton pers. comm., Sherwin 2003) and using warmer roosts while pup-rearing. Roost dimensions may also be important, however, this may be more of an artifact of data recording and scale of data collection than of sound biological merit. For example, the majority of the roosts examined in California by (Pierson et al., 1991) were described as fairly spacious, being at least 30 m (100 ft) in length, with the roosting surface located at least 2 m (6.5 ft) above the ground, and roost openings at least 15 cm by 62 cm (6 inches by 24 inches). However, local geology typically determines how large caves and mines in a particular location are, so historical mining districts that produced little ore, tend to be dominated by many small prospects. Townsend's big-eared bats are just as likely to utilize these smaller workings during all use periods, however, they may be more apt to move among multiple roosts to satisfy their roosting needs than colonies located in large roosts (Sherwin et al., 2000, 2003, 2009). Night roosts include caves, rock shelters, open buildings, mines and bridges. They can be of any shape and size, and are often located within day roosts. Many of these roosts will host multiple species and often include large numbers of Townsend's big-eared bats.

Foraging Habitat. Foraging associations include edge habitats along streams and areas adjacent to and within a variety of wooded habitats (Brown et al. 1994, Fellers and Pierson 2002, Pierson et al. 2002). Radiotracking and light-tagging studies have found Townsend's big-eared bat foraging in a variety of habitats, including within collapsed lava tubes and trenches (Pierson and Fellers 1998). Brown et al. (1994) showed that on Santa Cruz Island in California, Townsend's big-eared bat avoided the lush introduced vegetation near their day roost, and traveled up to 5 km (3 mi) to feed in native oak and ironwood forest. P. Brown (pers. comm.) also documented Townsend's big-eared bat foraging in desert canyons with water on the west slopes of the Panamint Mountains (Inyo County). Radiotracking in Nevada revealed adaptive foraging throughout the year with individuals (reproductive males and females) routinely adjusting foraging patterns and habitat associations in response to resource availability. For example, individuals foraged heavily over an ephemeral pond for a 2 week period. Once the pond dried, individuals shifting their nightly activity to a variety of local habitats including sage-brush, juniper woodlands, riparian areas, cliff faces and alkali flats. Individual use of these areas was predictable as each bat appeared to have a preferred foraging area (Ives 2015; Ives and Sherwin; in review).

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Radiotracking and light-tagging studies in northern California have found Townsend's big-eared bat foraging within forested habitat, within the canopy of oaks (Pierson and Rainey unpubl. data), and along heavily vegetated stream corridors, avoiding open, grazed pasture land (Fellers and Pierson 2002). In Oklahoma, *C. townsendii ingens* more frequently used edge habitats (along intermittent streams) and open areas (pastures, agricultural fields, native grass) compared to wooded habitat (Clark et al. 1993), but also tended to focus foraging along canyon walls (Caire et al. 1984).

Light-tagging studies in West Virginia (V. Dalton pers. comm.) showed a bimodal foraging pattern for *C. t. virginianus*, with animals foraging over hayfields during the first part of the night, and within the forest later in the night, traveling up to 13 km (8 mi) from the day roost. They foraged as long as weather permitted in the fall, and were periodically active in winter (Pierson et al. 1991). Townsend's big-eared bats have also been observed flying in snowstorms (G. Tatarian pers. comm.), seemingly taking advantage of winter insect hatches (Sherwin pers. comm.).

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CONSERVATION STATUS

Despite the long-standing designation of Townsend's big-eared bat as a Species of Special Concern in California (Williams 1986), there has not been a statewide effort to assess the conservation status of the species since Pierson and Rainey's work in the late 1980s and early 1990s (Pierson and Rainey 1998). CDFW is working with a contract team from Humboldt State University and Texas A & M University to survey maternity roosts and hibernacula over the next two years. This effort will serve as a comprehensive update to the Pierson and Rainey effort, but the results of this new project will not be available until 2017.

In the meantime, and in the interest of informing the Commission's decision on whether to list Townsend's big-eared bat according the statutory schedule required by CESA, CDFW offers the following summary of the conservation status of the species. This summary is based on a variety of recent and on-going efforts to study and monitor Townsend's big-eared bat in California and elsewhere.

Regulatory Status

State, federal and non-governmental organizations designate "at risk" species (e.g., threatened and endangered species, Species of Special Concern, Species of Greatest Conservation Need, etc.) and assess and rank their conservation needs. Status designations for Townsend's big-eared bat are summarized below by jurisdiction or organization:

State of California Status. The Fish and Game Commission designated Townsend's big-eared bat a "candidate" for listing as endangered or threatened under CESA, effective December 27, 2013. With the notice of its candidacy for listing, the CESA prohibition against unauthorized "take" of Townsend's big-eared bat is currently in effect. (Fish & G. Code, §§ 2080, 2085). "Take" is defined in the Fish & G. Code as to hunt, pursue, catch, capture, or kill, or to attempt to engage in any of these activities. (*Id.*, § 86.) Take of species protected by CESA, including Townsend's big-eared bat, may be authorized under certain circumstances.

"Species of Special Concern" (SSC) is a Department administrative designation intended to alert biologists, land managers, and others to a species' declining status and to encourage additional management considerations for these species to ensure population viability and to preclude the need for listing. SSCs are defined as species, subspecies, or distinct populations of an animal native to California that currently satisfies one or more of the following (not necessarily mutually exclusive) criteria: extirpated from the State or, in the case of birds, in its primary seasonal or breeding role; listed under the federal Endangered Species Act (but not CESA) as threatened or endangered; meets the State

definition of threatened or endangered but has not been formally listed; is experiencing, or formerly experienced, serious (noncyclical) population declines or range retractions (that have not been reversed) that, if continued or resumed, could qualify it for State threatened or endangered status; has naturally small populations exhibiting high susceptibility to risk from any factor(s), that if realized, could lead to declines that would qualify it for State threatened or endangered status (Comrack et al. 2008).

Townsend's big-eared bat has been designated as a Mammal Species of Special Concern (MSSC) since the list was established in 1986 (Williams 1986). The MSSC list is now undergoing a formal update and revision using an objective, criterion-based method developed by CDFW (see Shuford and Gardali 2008 for a recent published example of the current method). As part of the update process, Townsend's big-eared bat has been evaluated, scored, and ranked using eight criteria along with all other terrestrial mammal taxa naturally occurring in California. Based on current information, it is likely Townsend's big-eared bat will be on the updated MSSC list (assuming it is not CESA-listed as threatened or endangered first).

Projects carried out on state and private lands that are funded or authorized by public agencies (such as highway construction, residential and commercial development, and energy development projects) are subject to the provisions of California Environmental Quality Act (California Public Resources Code, Division 13, section 21000 *et seq*. and Guidelines published under the California Code of Regulations, Title 14, section 150000 *et seq*.). CEQA requires that actions that may substantially reduce the habitat, decrease the number, or restrict the range of any species that can be considered rare, threatened, or endangered (regardless of status under state or federal law) must be identified, disclosed, considered, and mitigated or justified. (Cal. Code Regs., tit. 14, §§ 15065(1), 15380.) Impacts to species identified as SSCs should be carefully evaluated in CEQA planning documents.

In summary, as a Candidate for CESA listing, Townsend's big-eared bat enjoys a high-level of assessment and disclosure of potential impacts of proposed CEQA projects. The standard "no-take" requirement for projects helps ensure that population-level impacts do not occur when a project is implemented. Should the species not be listed, then the SSC designation should still ensure that proposed projects include assessment and disclosure of potential impacts, but protection from impacts is less certain and take of individuals may occur.

Federal Status. Townsend's big-eared bat is not currently listed as endangered or threatened nor is it a candidate for listing under the federal Endangered Species Act. However, several federal land management agencies (e.g., U.S .Forest Service, Bureau of Land Management) have special management designations for the species. See the EXISTING MANAGEMENT, MONITORING, AND RESEARCH ACTIVITIES section below for additional information on federal agency management of Townsend's big-eared bat.

Status in Surrounding States.

Oregon – The Oregon Department of Fish and Wildlife (ODFW) designates Townsend's big-eared bat as a Sensitive/Critical species.[3] Sensitive species are "naturally-reproducing fish and wildlife species, subspecies, or populations which are facing one or more threats to their populations and/or habitats. Implementation of appropriate conservation measures to address the threats may prevent them from declining to the point of qualifying for threatened or endangered status." The Critical designation indicates ODFW has determined that Townsend's big-eared bat is a species "imperiled with extirpation from a specific geographic area of the state because of small population sizes, habitat loss or degradation, and/or immediate threats. Critical species may decline to point of qualifying for threatened or endangered status if conservation actions are not taken."

Nevada – The Nevada Department of Wildlife (NDOW) does not have a special status designation for Townsend's big-eared bat. However, the Nevada Bat Conservation Plan (Bradley et al. 2006), which was adopted by a variety of state agencies and federal agency offices in Nevada, including NDOW, designates the species as "Sensitive." The Nevada Bat Conservation Plan designates the conservation risk to Townsend's big-eared bat as "High" (Bradley et al. 2006). According to the plan, "A far more broad-scaled and complete monitoring effort is needed in Nevada to truly discern the status and trend of this species." Sustained surveys of potential roosts, and continued research throughout Nevada has revealed that maternity colonies are much more common than has been previously supposed and that the use of roosts by Townsend's big-eared bat is much more fluid and complex than is typically considered in assessments of their conservation status.

Arizona – The Arizona Game and Fish Department (AGFD) published the Arizona Bat Conservation Strategic Plan (AGFD 2003). The plan outlines the current status of all 28 bat species occurring in Arizona. For Townsend's big-eared bat, the plan states that population trends and conservation status of the species is unclear, though some losses of maternity roost sites are known to have occurred. AGDF published an update to its State Wildlife Action Plan (SWAP) in 2011 (AGFD 2011), in which it designates Townsend's big-eared bat as a Tier 1B Species of Greatest Conservation Need. That status is based primarily on AGDF's determination that the species is in a "demographically poor situation: Unusually low birth rates or high death rates combined with small or declining population size. Demographic rates are affected by known stressors likely causing a worsening situation in parts of Arizona." The Arizona SWAP also notes the species' vulnerability due to its concentration at certain points in its life cycle (colonial roosting habits) and an unknown population trend in the state.

[3] http://www.dfw.state.or.us/wildlife/diversity/species/sensitive_species.asp

Non-governmental Organization Designations. NatureServe, a non-profit conservation organization whose mission is to provide the scientific basis for effective conservation action through its network of natural heritage programs, ranks Townsend's big-eared bat as a whole and each of the two non-listed subspecies (*C. t. pallescens* and *C. t. townsendii*) as "G3G4/T3T4" throughout their respective geographic ranges This designation indicates uncertainty regarding conservation status, which may be characterized as either Apparently Secure (G4/T4) or Vulnerable (G3/T3).

NatureServe defines "Vulnerable" as "at moderate risk of extinction or elimination due to a restricted range, relatively few populations, recent and widespread declines, or other factors" and "Apparently Secure" as "Uncommon but not rare; some cause for long-term concern due to declines or other factors." (http://explorer.natureserve.org/granks.htm).

International Union for the Conservation of Nature (IUCN). The current version of the IUCN Red List (http://www.iucnredlist.org/details/17598/0) designates Townsend's big-eared bat as a 'Least Concern' species based on the latest assessment of the species range-wide. The IUCN had previously designated the species in 1996 as 'Vulnerable.' The Least Concern designation is based on "its wide distribution, presumed large population, occurrence in a number of protected areas and because it is unlikely to be declining at nearly the rate required to qualify for listing in a threatened category."

The Western Bat Working Group (WBWG) is a consortium of agency biologists, consultants, academic researchers, and other interested persons throughout the western states and Canada working to ensure a coordinated approach to bat conservation in western North America (http://wbwg.org/). Based on its initial assessment of the conservation status of western bat species in 1998, WBWG rated Townsend's big-eared bat as "high" priority (the highest conservation concern designation). According to the WBWG website, this designation "represents those species considered the highest priority for funding, planning, and conservation actions. Information about status and threats to most species could result in effective conservation actions being implemented should a commitment to management exist. These species are imperiled or are at high risk of imperilment." It is important to note however, that these designations and assessments have not been the result of peer review and are largely based upon anecdotal information rather than any collective and robust data set.

Bat Conservation International (BCI) is a not-for-profit organization dedicated to the conservation of "the world's bats and their ecosystems to ensure a healthy planet." BCI does not have an assessment of the conservation status of Townsend's big-eared bat on its website, but has published articles related to the importance of proper mine and cave management to ensure successful roosting of this and other cave/mine-dwelling bat species.

Current Distribution

Based on recent records, Townsend's big-eared bat appears to be fairly well distributed throughout much of its historic range in California. Figure 3 displays Townsend's big-eared bat observations in California symbolized by time period of observation. The observations are from a number of sources, including museum specimens, observations submitted to the California Natural Diversity Database (CNDDB), and capture and acoustic records from biologists permitted by CDFW to study Townsend's big-eared bat. No obvious pattern of a reduction in distribution is apparent in Figure 3, though it is likely that occurrences are now rarer in the South Coast and Bay Area than before urbanization.

Population Trends

Summary of Pierson and Rainey (1998) Statewide Assessment and Other Information Cited in the Petition

To describe Townsend's big-eared bat population trend in California, the Petition relied heavily on the work conducted by Pierson and Rainey (1998) for the Department of Fish and Game. Pierson and Rainey conducted surveys of Townsend's big-eared bat maternity colonies and hibernacula throughout much of the species' range in California during the period 1987 to 1991. Their surveys focused primarily on maternity colonies to assess population status and reproductive capacity. In addition to visiting and counting the numbers of bats at all known large (> 30 females) Townsend's big-eared bat maternity colony roost sites in California, the authors also searched for additional or alternate roost sites within 15 km (9.3 mi) of the known sites. The authors also visited five known Townsend's big-eared bat hibernation sites in California and described the observations of other researchers at several other hibernation sites. The authors developed several measures of population status and trend in their study, including total estimated number of adult females at maternity colonies in the state, total number of colonies, average size of maternity colonies, and average and total size of hibernation colonies.

The work by Pierson and Rainey (1998) suggests a decline in the numbers of Townsend's big-eared bats roosting in historical sites over the period between the original surveys of the maternity colony roost sites and the re-surveys conducted by the authors. Eighteen historically known maternity colonies with estimates of colony sizes were assessed in the study. The original dates of detection ranged from 1918 to 1974, with most of the original surveys conducted in the 1930s through 1960s. Six of the colonies appeared to have been extirpated, five had declined in number of females by more than 20%, four had remained relatively constant in numbers, and three colonies had increased by more than 20%. The authors lumped all 18 colonies' original population counts to get a historical-period population estimate of 3,004 adult females. Based on their counts during the 1987-1991 surveys, they estimated these colonies had declined by 55% to a total of 1,365 adult females.

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Comment [RHOP1]: maternity colonies are NOT populations. As a single population often includes individuals from multiple maternity colonies and can be spread across a wide geographic area. As a result, non-concurrent data from all maternity roosts across a broad geographic range can only yield information regarding use of a specific site during the specific time of survey. Without landscape level surveys, and a true understanding of the dynamics of roost use in the area, trends information cannot be inferred.

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Comment [RHOP2]: how were these counts done? Was there sufficient replication for statistical analyses and estimates of error? What techniques were used? How often were they conducted? I have seen too many vague "counts" that are biologically and statistically meaningless. This is a very critical element of this petition and the rigor of these data needs to be highlighted and/or evaluated

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Comment [RHOP3]: is there compelling evidence that these animals suffered direct mortality due to human activities? If not, this term is inappropriate. I suggest "... six of the colonies were found vacant during our surveys"... but again... how often were they visited? What tools were used? How rigorous were both the initial and follow-up surveys?

The authors also found a decline in the total number of colonies known from the historical period to the resurveys. Of 46 historically-known maternity colonies (many without population counts), the authors could not find 24 (either at the original site or within 15 km (9.3 mi) of the original site), which represented a 52% decrease in the number of historically-known colonies.

Comment [CNU4]: Colonies are not populations.

Additional maternity colonies were located in the period after 1980, either by the authors or reliably reported to the authors by other researchers. These colonies were sufficiently distant from historically-known colonies for the authors to conclude they were not part of the historical set. Although no conclusion about population trend could be made based on the inclusion of the additional colonies, Pierson and Rainey's (1998) point estimate for the total known adult female Townsend's big-eared bat population size in California was 4,252 individuals, which distributed among 39 maternity colonies. The authors cited reliable reports of four other colonies of unknown size. The Petition cites reports and personal communications of an additional four maternity colonies known as of 2003, as well as observations of lactating females in areas without known colonies, suggesting there are additional maternity colonies not yet discovered.

Pierson and Rainey (1998) also compared the average size of the 18 historically-known maternity colonies to the 38 colonies with estimates found at the time of their surveys. They found average number of adult females in the historical colonies to be 164, while the currently-known colonies averaged 112 females. Thus, the recent colony size was 32% smaller than the historical colony size.

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Comment [CNU5]: Are there any other statistics available? Range, standard deviation, error? How often were sites surveyed each year and for how many years to develop both historical estimates of colony sizes and those reported in 1998.

Pierson and Rainey (1998) also assessed the size of five historically-known hibernation colonies in California. One of the colonies (at Lava Beds National Monument) had remained stable at approximately 30 individuals. The other four, which had original counts of between 55 and 177 bats, showed dramatic declines of between 70% and 94%. These sites were in Shasta, Lake, and Napa counties.

The Petition also cited observations by Williams (1986), who was an active researcher of the conservation status of mammals in California in the latter half of the 20th century. As mentioned in the Petition, Williams (1986) stated his impression that Townsend's big-eared bat had been common in central California through the 1960s, but had dramatically declined by the early 1970s. Williams (1986) mentioned that he had only captured one individual Townsend's big-eared bat during his 14 years of work in central California in the 1970s and 1980s. Townsend's big-eared bat has been recently observed in the central coast area of California, on Department lands and Vandenberg Air Force Base (R. Stafford 2014, 2015 pers. comm.; R. Evans 2014 pers. comm.). These observations, which included a maternity roost site for both of the jurisdictions, as well as a large extant maternity colony at Hearst San Simeon State Historical Monument, indicate the species continues to occur in the region, although no information on population or range trend is available for this area.

Comment [CNU6]: This is pretty tenuous… and impression of dramatic declines is very worrisome as part of a foundation for listing. Certainly this might warrant research into whether these observations are accurate, but is not definitive evidence. Townsend's are very hard to mist net. I have netted for thousands of hours and never caught a Townsend's… but this netting occurred in landscapes surrounded by hundreds of their roosts and over 1,000 individuals

Other published observations of declines in Townsend's big-eared bat colonies in the Sierra Nevada and lower Colorado River area (Graham 1966, Stager 1939) were mentioned in the Petition.

In summary, the petition relies heavily on the qualitative information regarding possible changes in colony sizes of colonies at a subset of historical roosts compared with finddings cited in the Petition is Pierson and Rainey's (1998) statewide assessment. They propose that of the 18 historically-known maternity roosts with colony counts, six of the colonies were not occupied during surveys conducted by the authors. Another six colonies showed a decline in the number of adult female Townsend's big-eared bat present at time of survey. Although five colonies had increased in size (and one remained stable at 50 females), the overall decline in numbers from the historical period appeared to be substantial.

These comparisons between historical and recent colony numbers, colony size, and then extrapolated to suggest changes in total population sizes infer that, as of the early 1990s, there had been a decline in the total numbers of Townsend's big-eared bat in California since the early 20th century. However, these data are interpreted based on a suite of assumptions (static use of roosts, populations delineated at local scales, etc.) that leave these findings as largely speculative. It is possible that declines may have been substantial in some areas, particularly due to the unregulated closure of abandoned mines during the 1970's and 1980's, but recent data suggests that colonies throughout the western United States and parts of California are currently thriving as a result of revised approaches to abandoned mine reclamation that mitigate for this species. In combination with other aspects of the species' biology and observations of human disturbance at Townsend's big-eared bat roost sites, the trend information collated by Pierson and Rainey (1998) led to the inference that the California Townsend's big-eared bat population had declined over the several decades before their study.

CDFW is aware of ongoing efforts to monitor or revisit several important Townsend's big-eared bat maternity and hibernation roosts in California. These efforts include monitoring at both hibernation and maternity colonies at Lava Beds National Monument (S. Thomas 2013 pers. comm.), revisiting known Townsend's big-eared bat hibernacula in the White and Inyo mountains (Szewczak et al. 1999, M. Morrison 2013 pers. comm.), long-term annual counts of a maternity colony in a historical building in Sierra County (W. Copren 2013 pers. comm.), as well as at other sites. The following section summarizes recent results from these ongoing monitoring efforts.

Townsend's Big-Eared Bat Roost Site Monitoring Case Studies

To assess Townsend's big-eared bat population trends since Pierson and Rainey's (1998) work, CDFW has compiled information from a number of maternity and hibernation roosts from around California. The following is a summary of studies that assess colony sizes and infer trends at specific sites. While this summary does not comprise a statistically valid estimate of the Townsend's big-eared bat

Comment [CNU7]: There are many more recent accounts in both peer reviewed and technical reports indicating that roosts of all types are much more common than was supposed in the 1990's.

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Comment [CNU8]: Again I don't know what this means… how intensive were these surveys? Are there statistics for historical data? Where animals actively collected during these early surveys (as was often the case)… Did Pierson and Rainey take into account the dynamic nature of roost use that is typical of this species?

Comment [CNU9]: Vacant does not mean extirpated. Unless there is direct evidence of human removal and/or human induced mortality this is an inappropriate term.

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Comment [CNU10]: Without very intense historical and recent surveys including concurrent sampling of all potential roosts, and even radio telemetry this statement cannot be supported by these data. I have studied many roosts that are used intensively for very short periods of time, but are usually vacant, and there are no biological residues of past use. Without understanding patterns of roost use at the landscape scale these …

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Comment [CNU11]: Again, this is a hypothes …

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population size or trend statewide, it does illustrate how colony sizes and threats vary around the state, as well as how management of roosts directly affects the local assemblages of Townsend's big-eared bats in these areas. Locations referenced here are depicted in Figure 4.

Randall House Maternity Roost (Marin County). Fellers and Halstead (2015) reported results from 25 years of monitoring the Randall House maternity roost site in Marin County. The Randall House is a two-story late 19th Century ranch house situated in a valley at Point Reyes National Seashore. It was last occupied by humans in the 1970s and in 1987 was discovered to be the roost of a Townsend's big-eared bat maternity colony. At that time, the colony numbered 95 adult females. The site had been subject to repeated break-ins by local teenagers prior to 1987, but upon discovery of the Townsend's big-eared bat colony, the National Park Service fortified the house against unauthorized entry and has since maintained the house for use by the bats.

Using night-vision equipment, Fellers and his collaborators conducted 178 exit counts of Townsend's big-eared bat during the maternity season between 1988 and 2012. In addition to information on the number of adult females and young present at the site, this long-term monitoring study also yielded important information on the effects of human disturbance on colony status, effects of season and environmental factors on emergence time from the roost, and other natural history aspects of the species.

Over the course of the 25-year study, the Randall House Townsend's big-eared bat maternity colony increased in size (see Figure 5B). Adult female maximum number recorded increased from 95 in 1988 to 395 in 2012. The maximum recorded number of adult females plus volant young increased from 176 to 512. The annual rate of increase was estimated to be 8.7% for adult females and 5.3% for volant young.

Attempted and successful break-ins to the roost building occurred occasionally during the study period, despite increased security at the site. These disturbance events were documented and the authors found a significant negative correlation between disturbance events and subsequent numbers of adult females and volant young (compare Figures 5A and 5B). In other words, there were fewer Townsend's big-eared bat adults and young at the roost site in years with human disturbance events.

The authors note the Randall House is one of the most important remaining Townsend's big-eared bat maternity roost sites in coastal California. Because of the NPS commitment to maintaining the Randall House for Townsend's big-eared bat use, it is one of the few maternity roosts classified by Pierson and Rainey (1998) as "secure." Prior to its discovery in 1987, two other nearby historical roosts (the Olema Inn and an old barn near Inverness) had already been lost. Fellers and Halstead (2015) note that only one other Townsend's big-eared bat maternity roost is known in the area and, although also located on NPS land, it is structurally dilapidated and its long-term suitability for Townsend's big-eared bat use is

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Comment [CNU12]: This also suggests resiliency as these bats did not die… they relocated to alternate roosts until the threat had subsided and then returned. Certainly disturbance can be a factor, but these animals are fully capable of mitigating impacts through temporary relocation as needed.

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questionable. Like other old wooden buildings used by Townsend's big-eared bat around the state, these structures are vulnerable to degradation and loss over time. Replacement structures tend to be made of materials and use designs less suitable for bats.

Nevertheless, the Randall House is an example of how management of a roost structure may allow Townsend's big-eared bat to continue to occupy an area and even expand in numbers over time.

Kentucky Mine Maternity Roost (Sierra County). The Kentucky Mine Historic Park and Museum is located in Sierra City, Sierra County, at an elevation of 1340 m (4400 ft). The Kentucky Mine Townsend's big-eared bat maternity colony was not known at the time of Pierson and Rainey's 1980s and early 1990s statewide assessment. The colony primarily roosts in a historical mine building (a stamp mill used to crush ore excavated from the nearby mine), but the bats appear to also use the nearby mine itself as an alternate roost site (M. Tierney 2015 pers. comm.).

As described by Freeman (2012), unlike most Townsend's big-eared bat maternity colonies, "this colony has acclimated to a level of disturbance typically considered intolerable for *C. townsendii*. The Sierra County Historical Society leads tours twice a day through the stamp mill throughout the maternity period. During these tours, guides wind up a massive iron stamp and let it pound down to demonstrate how it crushes rocks to remove the gold. This noisy activity frequently occurs directly beneath the roosting bats and causes the entire building to quiver. The grounds surrounding the stamp mill permit daily public use. On weekends, human disturbance continues into the night. An outdoor amphitheater located less than 50 meters from the colony is used for concerts during the nursery season. This colony persists despite these disturbances."

The U.S. Forest Service prepared a management plan for the colony in 2007 (Tierney and Freeman 2007) and the Sierra County Historical Society, which operates the park and museum, cooperates with the U.S. Forest Service to manage the risk of disturbance to the colony by following the recommendations of the plan (W. Copren 2012 pers. comm.; M. Tierney 2015 pers. comm.). Among the plan's guidelines are measures to make the on-going human activities at the roost site consistent and predictable to allow the bats to acclimate to disturbance.

Exit counts from the stamp mill during the maternity season have been conducted by the U.S. Forest Service and others since 1994, along with occasional roost counts within the stamp mill and exit counts from the shafts of the mine itself. Data are available for the period 1994 through 2005 (Tierney, unpublished data). Depending on year, the counts at the stamp mill were conducted at various times during the maternity season (and therefore may include either adult females only or adult females and their young). The counts were sometimes conducted on nights when the colony was apparently roosting at an alternative site. The exit count data at first glance is irregular (Figure 6A).

Comment [CNU13]: Where were these animals roosting before the buildings were created? Are there caves or grottos on the island or large diameter trees? If not, they were either roosting in a novel resource, or migrated following human occupancy. Either way, this is another example of their capacity for roosting plasticity

Comment [R14]: Exactly… a perfect example of proactive, adaptive management and how well this species responds. This is one of hundreds of such examples from throughout the western US and in southeastern California that I am aware of

Removing exit counts at the stamp mill roost with anomalously low numbers suggesting the bats were roosting at an alternative site (counts with fewer than 20 bats in years with other counts of 40 or more bats) and by separating the counts into the pre-volancy and volancy periods of the young (before mid-July and after the third week of July), a clearer pattern develops (Figures 6A and 6B).

Early season counts (consisting of adult females only) at the Kentucky Mine have generally been in the range of 30 to 50 bats since the first count of 66 bats was made in late June 1994. After young achieve flight starting around the last week of July, counts have varied between lows of around 35 in the late 1990s to between 50 and about 100 in the early 2000s (Figure 6A). Exit count data at the mine shaft roost site in late August and early September 2003 totaled 140 and 168 bats, but it is possible these very late counts included adult males as well as females and young of the year (Figure 6B). It is also quite possible that both the mill and mine are concurrently used by individuals of this colony, which is very common throughout the western portion of this species range.

CDFW does not have access to more recent exit count data from Kentucky Mill, but the U.S. Forest Service's estimate from data collected subsequent to 2005 is that the colony size has been fairly stable at or near 100 adult females (M. Tierney 2015 pers. comm.; K. Freeman 2015 pers. comm.).

Lava Beds National Monument Maternity Roosts (Siskiyou and Modoc counties). Lava Beds National Monument (LBNM) is located in northeastern California. The monument contains the largest concentration of lava caves in the contiguous United States; LBNM staff had identified more than 750 caves by 2013. The extensive network of caves at Lava Beds National Monument in Siskiyou and Modoc counties is proposed to be an area of high ecological importance for Townsend's big-eared bats in the region as Pierson and Rainey (1998) estimated that a quarter of the state's known breeding females occurred at LBNM at that time (Pierson and Rainey 1998). These caves have been monitored for Townsend's big-eared bat presence during the maternity season over the past couple of decades, but because of Townsend's big-eared bat's known sensitivity to disturbance, most surveys during the active season have been limited to quick checks for presence or absence of bats (T. Weller 2014 pers. comm.). Counts of bats were infrequently made during these surveys and only rough estimates of bat numbers are available. In accordance with cave resource management guidelines, caves where Townsend's big-eared bats were observed during the active season were then subsequently closed to recreational access.

Efforts to monitor the Townsend's big-eared bat colonies at LBNM during the maternity season are of low intensity in an effort to minimize the risk of disturbance of roosting bats. Three Townsend's big-eared bat maternity colonies are monitored for presence/absence and to collect cave microclimate data (temperature and relative humidity). Depending on staff availability, the monitoring occurs on a variable schedule of between once per week to once per month (Katrina Smith 2015 pers. comm.). Exit

Comment [R15]: This is another data rich source indicating maintained colony sizes

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counts have also been conducted, but conditions are not conducive to accurate counts (Katrina Smith 2015 pers. comm.).

As part of his analysis of recent (1990s and later) Townsend's big-eared bat monitoring data from LBNM, Weller attempted to discern patterns of occupancy by date and location during the active season (T. Weller 2014 pers. comm.). Apart from very general conclusions about the timing of the maternity season, no pattern of occupancy in particular caves at particular dates, nor trend in bat colony sizes, can be discerned from these data (T. Weller 2014 pers. comm.). Weller concluded the known roost-switching behavior of Townsend's big-eared bat during the maternity season and the opportunistic and infrequent attempts to monitor Townsend's big-eared bat at LBNM during the active season preclude inferences about active season numerical trends using existing data. He advocated instead the use of Townsend's big-eared bat counts at hibernacula, where individual bats may reliably be counted during the inactive season (and without undue disturbance of the bats) as the preferred method to estimate colony sizes and trend. See below for a summary of results of LBNM hibernaculum monitoring (Weller et al. 2014).

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Comment [R16]: In this case, the area proposed to include as much as 25% of the entire States breeding potential has no data to support this claim, let alone infer risk to these animals

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Lava Beds National Monument Hibernacula (Modoc and Siskiyou counties). The Lava Beds area of northern California is proposed to be home to one of the heaviest concentrations of Townsend's big-eared bat in California (Pierson and Rainey 1996). The National Park Service at Lava Beds National Monument (LBNM) has monitored winter bat use of the lava tubes and caves for many years (Weller et al. 2014). Townsend's big-eared bat are the most commonly encountered bat species in winter because of their habit of roosting in the open, but Myotis bats (*Myotis* sp.) and big brown bats (*Eptesicus fuscus*) are also occasionally observed (Katrina Smith 2015 pers. comm.).

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NPS considers the period from November 15 to March 15 to encompass the Townsend's big-eared bat hibernation season at LBNM. Any bat survey completed in caves during this period is included in the LBNM bat database and is considered hibernacula monitoring data. In recent years, a focused effort to monitor the numbers of hibernating individuals at LBNM has been conducted, with one entire week in mid-winter devoted to completing as many bat hibernacula surveys as possible. NPS staff and collaborators use a stratified random sampling method to select caves for survey based on the number of bats seen there in previous years. This allows collection of annual data on large known hibernacula and also to survey sites that have never been visited in winter. Using this method, in the past few years NPS has discovered four new hibernation sites with more than 30 bats, plus several sites with smaller numbers of Townsend's big-eared bat.

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Winter bat surveys at LBNM use headlamps and other caving gear to enter caves to tally all visually observed hibernating bats. Townsend's big-eared bats typically hibernate singly or in small groups, generally consisting of fewer than 20 individuals, though larger clusters are occasionally observed.

Along with counts of bats by species and location within the caves, cave microclimate data (air temperature, ceiling temperature, and relative humidity) are also recorded (Katrina Smith 2015 pers. comm.).

Weller et al. (2014) analyzed the results of NPS Townsend's big-eared bat hibernacula monitoring data from a 22-year period (1991-2012) at LBNM to determine if a trend in the number of Townsend's big-eared bat hibernating could be discerned. Over this period, bats were counted in a total of 52 caves. Although a concerted effort was made by NPS to monitor hibernating bats each year, the number of caves visited and number of surveys conducted varied based on staff availability. These analyses were also used to design a flexible yet statistically robust monitoring program in future years.

Weller et al. (2014) used regression analysis to model the changes and trend in Townsend's big-eared bat numbers at each cave that had at least four surveys conducted from 1991 and 2012, and for which at least half of the surveys had at least one bat recorded. Using these models, the authors generated predicted numbers of Townsend's big-eared bat for each cave in non-survey years, as well as for 2012. The 2012 predictions were compared to the actual counts for that year. They also estimated the total number of Townsend's big-eared bat hibernating in all the caves each year by combining actual counts and estimated numbers.

Seventeen of the 22 caves monitored during at least four years had a positive trend in the number of hibernating Townsend's big-eared bat during the 22-year study period (Figure 6), although not all of these were statistically significant. Most of these caves had large numbers of hibernating Townsend's big-eared bat. The decreasing trends for the other five caves were not statistically significant, nor did any of these caves ever have more than 10 Townsend's big-eared bat observed in a count.

The authors estimated the number of hibernating bats in the 52 surveyed caves increased from 834 bats in 1991 to 1,427 bats in 2012 (Figure 7). The estimated cumulative annual growth rate for the 52 caves over the period 1991–2012 was about 1.8% (Figure 8). The estimated annual population growth rate for the caves surveyed most often was about 4%. Estimates based on data from 1991 to 2011 generally predicted the 2012 counts well; however, the actual bats counted in most caves exceeded the predicted numbers in 2012. Seven caves had their highest count in 2012 and another three equaled their previous high count.

Although 52 caves among the 97 surveyed during the 22-year study period were observed to have hibernating Townsend's big-eared bats during one or more years, Cave L970 stands out as an especially important site. In 1990, 376 bats were counted there and it has consistently held the majority of bats counted each year (see Table 1 from Weller et al. 2014).

Although the authors list a number of caveats regarding their results, they are "confident that the number of bats in the 52 surveyed caves has increased or, at the least, remained stable." They state "the increasing number of hibernating individuals reaffirms LBNM as a population stronghold for Townsend's big-eared bats in a state (Pierson and Rainey 1998) and region (Pierson et al. 1999) where it is considered imperiled. Potential ecological explanations for the increase in hibernating bats are unclear but could be related to changes in management policy at LBNM. Beginning in 1991, approximately 10 caves were closed during the maternity period to limit disturbance of maternity colonies by visitors. Lava Beds National Monument also closed winter hibernation sites to visitors, starting with a few sites in the 1990s and increasing to nearly 20 caves by 2012."

Comment [R17]: This is another data rich example of stability. Numbers are increasing because of stable recruitment at maternity roosts

Pinnacles National Park Maternity and Hibernation Roosts (San Benito County). Pinnacles National Park, located about 65 km (40 mi) east of Monterey, encompasses approximately 9,700 ha (24,000 acres). Pinnacles National Monument (later Park) was established to protect and allow public use of the unique talus cave systems found there, which are formed from the remnants of a 23-million-year-old volcano. The Townsend's big-eared bat maternity colony that occurs in the cave system at Pinnacles National Park was not known at the time of Pierson and Rainey's statewide survey in the 1980s and early 1990s. Following its discovery in 1997, NPS closed the cave to the public for 4 years to allow the bats undisturbed use of the cave and to determine how best to manage the site (NPS 2002). The Pinnacles roost site is used by Townsend's big-eared bat for hibernation and for the maternity season. Portions of the cave are warm enough during the maternity season for gestation and pup-rearing, while other sections are cool enough in the winter to provide a suitable environment for hibernation. After the period of study, NPS adopted a management policy for the site that allows park visitors to seasonally access the portions of the caves not in use by the bats (NPS 2002, Paul Johnson 2015 pers. comm.).

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NPS conducts annual monitoring of the Townsend's big-eared bat colony, usually during both the maternity and hibernation seasons, to determine the effectiveness of this management strategy as well as to verify the dates for shifting visitor access. Because of the porous nature of the talus caves at Pinnacles, it is not possible to conduct exit counts at one or a few entrances to the roosts. Instead, NPS staff attempt to conduct visual counts of the maternity colony and hibernating bats within the roosts. Precise counts are not always possible due to limited access by humans to areas used by the bats, as well as the importance of minimizing disturbance to the roosting bats.

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Over the period from 1997 to 2014, the total maternity colony size (sometimes including pups) has ranged from about 150 to possibly as high as 1000 individuals; though in most years the total maternity colony size ranges between 200 and 400 individuals (Table 2). The hibernaculum counts are generally lower than the maternity roost counts (possibly due to dispersed winter roosting habits), ranging from about 15 to 400 individuals, with many years having counts of around 200 individuals (Table 2). The

annual count data shows an early increase in the total numbers of Townsend's big-eared bat individuals counted in both the maternity and hibernation seasons. This apparent increase in colony size may be attributed to the public cave closure from 1997 to 2002, followed by the adoption of the current management strategy of seasonal public access to the caves. Additional factors affecting the data are the intensity and frequency of survey effort in a given year. According to the NPS staff familiar with the surveys, the later years reported fewer survey visits to the roost site, which made it less likely that peak numbers would be detected in a given year (Paul Johnson 2015 pers. comm.). Despite the apparent decline in colony size since 2005-2006, NPS considers the Pinnacles Townsend's big-eared bat population to be relatively stable (Paul Johnson 2015 pers. comm.).

Hearst Castle Maternity Roost (San Luis Obispo County). The Townsend's big-eared bat maternity colony at Hearst San Simeon State Historical Monument was not known at the time of Pierson and Rainey's (1998) statewide survey. The Townsend's big-eared bat roost site was discovered during an assessment by Department of Parks and Recreation (DPR) of the bats occurring at Hearst Castle in 2000 (K. Miner 2015 pers. comm.). The maternity roost is located in a cavernous space within the reinforced concrete stair and landing structure at the main entrance to the complex of mansions that comprise Hearst Castle. Prior to the survey, the space was regularly inspected for structural integrity and used for closed-space rescue training by park staff during the maternity season, who reported that bats were disturbed by their presence. Once discovered that it was being used by Townsend's big-eared bats, DPR limited entry during the maternity season to only necessary safety inspections. Prior to 2003, Townsend's big-eared bats entered and exited the roost space through a narrow space below a screened door, forcing the bats to crawl on the ground. In 2003, the site was modified by adding two openings to the roost at more typical locations above the ground and sized to accommodate flying Townsend's big-eared bats accessing the site (R. Orr 2015 pers. comm.). DPR also developed management guidance to ensure maintenance and repair activities at the site have minimal impact on roosting bats, including Townsend's big-eared bat (DPR 2003).

Exit counts conducted by DPR staff since 2000 suggest the management of the site has enabled the colony to thrive. Most of the exit counts at the Townsend's big-eared bat roost have been conducted during late August, at which time the counts would likely include both adult females and their volant young and possibly adult males, as well. Late summer exit counts ranged from 60 to 95 total individuals prior to the roost entrance modification work. Since the modification and adoption of the bat protection policy in 2003, total counts of Townsend's big-eared bat during the late summer have increased fairly steadily through the years (Figure 9). Over the period 2012-2014, late summer counts ranged from 413 to 813 total Townsend's big-eared bat individuals at the site.

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Comment [R18]: A perfect example of their behavioral plasticity and capability to access and use roosts of any shape or size as long as suitable microclimatic conditions exist within the roost

Comment [R19]: Another success story

Santa Cruz Island Maternity Colony (Channel Islands National Park). Santa Cruz Island is the largest and most habitat-diverse of California's Channel Islands and it is the only Channel Island known to harbor a reproductive colony of Townsend's big-eared bat (Brown et al. 1994). Because of its distance to the mainland, it is thought that the Santa Cruz Island Townsend's big-eared bat colony may be isolated from Townsend's big-eared bat colonies on the mainland. If so, it is possible the island population may have unique genetic characteristics. The Santa Cruz Island colony was first described in 1939 as roosting in a 2-story ranch house at Prisoners Harbor on the north-central side of the island. At that time, it was estimated to number more than 300 individuals, which were likely both adult females and their volant young (Brown et al. 1994). A total of 246 individuals were collected for scientific collections during this and two subsequent collection trips in 1949 and 1964 (Brown et al. 1994). Pierson and Rainey (1998) cited Museum of Vertebrate Zoology records as stating the colony in 1948 numbered 150 adult females.

At some point between the mid-1960s and 1974, the Prisoners Harbor ranch house was demolished. Despite extensive searches, large colonies of Townsend's big-eared bat s were not observed again on the island until 1991, when they were reported to Pat Brown as occurring in the Bakery in an old adobe building at Scorpion Ranch on the northeast end of the island (Brown et al. 1994). It is not clear whether the Scorpion Ranch site was colonized by Townsend's big-eared bat displaced from Prisoners Harbor or if it was already in use prior to the loss of the Prisoners Harbor site. The National Park Service has since then assumed management of the entire island, including the Scorpion Ranch buildings, as part of the Channel Islands National Park.

NPS and others have conducted regular exit counts at the maternity roost site during the spring (adult females only) and late summer (adult females and their young). Exit count data available to CDFW suggest the number of Townsend's big-eared bats at Scorpion Ranch have never been as high as at the Prisoners Harbor roost site. Spring counts in the early 2000s ranged from about 50 to 105 adult females, while fall counts ranged from about 75 to 165 adult females and their young.

Work was conducted in 2009 to renovate and reoccupy other portions of the old adobe building. Exit counts by NPS personnel at the bakery roost site continued during maternity season during this time (T. Coonan 2014 pers. comm.). During the 4-year period from 2010 to 2013, the bakery roost site was abandoned, either temporarily (2010 and 2011) or for the remainder of the maternity season (2012 and 2013). The latter abandonment events resulted in the known death of pups at the caves to which the adult females had moved. Early season counts suggest between 60 and 90 adult females arrived at the roost site each year. The cause(s) and exact dates of abandonment are not known, but could include public visitor entrance over the half-door into the roost site or other activity in and around the building, including use of other rooms within the building by NPS personnel.

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Comment [R20]: Relevance?

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Comment [R21]: Doesn't this make sense seeing as roughly 250 of the 300 bats were collected from the Prisoners Harbor roost? These numbers seem about right, considering that documented "take", and I would guess some subsequent recruitment from the mainland as reproductive output from the remaining females certainly could not account for the high end of these estimates

Proposals have been made to increase monitoring activity at the mate roost site to more closely track human activity and bat numbers (T. Coonan 2014 pers. comm.), as well as to exclude human entrance into the roost site with a bat-friendly gate. These proposals have not been implemented due to lack of funding (T. Coonan 2014 pers. comm.).

In summary, the Santa Cruz Island Townsend's big-eared bat colony has fared relatively poorly since it was first described in 1939. Repeated collections for scientific purposes, demolition or reconfiguration of roost sites, and disturbance have all impacted the bats, which had its highest recorded number (more than 300) reported when it was first counted. Although the failed or reduced recruitment that occurred during 2010 through 2013 may not yet have significantly reduced the colony size of this long-lived species, repeated reproductive failures will impact the age structure of the population. If reproductive failure of this colony continues, it is possible the Santa Cruz Island Townsend's big-eared bat population may become unviable.

White-Inyo Mountains Hibernacula (Tulare and Mono counties). Szewczak et al. (1998) conducted an extensive survey program for bats in the White and Inyo Mountains from 1990 through 1996. As part of that survey effort, many observations of Townsend's big-eared bat were made, along with counts of Townsend's big-eared bat in individual hibernacula, which typically were in caves and abandoned mines. The authors have revisited many of the hibernation roosts since the original study was completed (M. Morrison 2014 pers. comm.). Some hibernation sites were repeatedly surveyed over multiple years while others were surveyed only once.

Morrison and Szewczak conducted 92 surveys of 47 sites within 28 different mines and caves in the study area from 1991 to 2014 (M. Morrison 2014 pers. comm.). Counts of hibernating Townsend's big-eared bat ranged from 0 to 80 individuals per site. The median count per site for all Townsend's big-eared bat surveys was 4 individuals. Of the 47 sites, 33 were surveyed more than once. Of these, 62% of the sites had a decrease in the number of hibernating Townsend's big-eared bat, 19% showed an increase in numbers, 16% showed an initial increase but then decreased in recent years, and 3% showed an initial decrease and then increase in recent years. A mean decrease of 3 individuals per site was recorded among the revisited sites.

These data from Townsend's big-eared bat hibernacula in the White and Inyo mountains are preliminary and do not lend themselves to strong conclusions. However, the preliminary data suggest that, unlike the situation at Lava Beds National Monument, the number of Townsend's big-eared bats in the southeastern part of the state may be decreasing.

Summary of Population Monitoring Studies. Table 3 summarizes the results of monitoring of Townsend's big-eared bat hibernation and maternity colonies at the aforementioned sites. Two of the

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Comment [R22]: Wrong word. This is not unique to island dwelling species. Stochastic disturbance events will always have a more profound influence than on mainland populations as there are fewer opportunities for refugia and less immigration

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Comment [R23]: I completely disagree. Individuals routinely move within and among roosts throughout the winter so any inference regarding biologically meaningful changes in number require incredibly intensive surveys for multiple years. This is especially true of small colonies (less than 20 or so) where numbers are continually in flux throughout the winter.

sites (one hibernation and one maternity) had statistically significant increases in total population size over two-plus decades of monitoring. At the other sites, no statistical conclusions could be made about population trend.

Because the total current Townsend's big-eared bat population size and the status of many roost sites in California are unknown, CDFW applied for and received a State Wildlife Grant from the U.S. Fish and Wildlife Service to conduct a two-year study to address this information need. This study, which is being conducted in collaboration with researchers from Humboldt State University and Texas A&M University, will provide a current snapshot of the distribution and numbers of individuals in surveyed areas throughout the state which can be compared with inferences made by Pierson and Rainey (1998) for the historical period (pre-1980) as well as the estimates made by Pierson and Rainey based on their own survey work in the 1980s and 1990s. It is hoped that these surveys will provide CDFW and the Fish and Game Commission a much clearer picture of the species' status in California than do the isolated case studies summarized here. The results of the two-year study are expected to be available by June 2017

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Threats

CDFW has identified the following factors as potential threats to the continued existence of Townsend's big-eared bat in California: loss, degradation, and sustained disturbance at roost sites; loss and degradation of foraging habitat; disease; mining; environmental contaminants; climate change and drought; and overexploitation. Each of these topics is addressed below. Competition for resources (such as prey, water, and cover habitat) with other native or introduced species was considered as a potential threat but eliminated from further consideration due to lack of evidence that it may pose a threat to the continued existence of the species.

Comment [R24]: Unregulated closures of abandoned mines during mining operations?

Roosting Site Loss, Structural Degradation, and Disturbance.

The availability of suitable roosting habitat is often posited as a limiting factor for western bat populations. For example, Pierson (1998) stated "considerable evidence suggests that roosts are limiting for many bat species." Hayes (2003) cites several authors that "hypothesized [roosts] to be the primary factor" limiting bat populations. That roosts may limit bat populations, including Townsend's big-eared bat, is a reasonable conclusion, given bats may use multiple roost sites with different characteristics during the year; that roost site suitability may be based on a narrow range of suitable temperatures, relative humidity, physical dimensions, and so on; and that such sites may occur in low numbers on the landscape.

Comment [R25]: This is largely debatable and there is more evidence that a broad range of features can be acceptable than support for the assumption of roost specific constraints.

Impacts to roost sites are an important threat to Townsend's big-eared bat. Such impacts include both maintained human disturbance of bats at roosts, but most critically is the loss of roosts through lack of, or poorly executed biological evaluations prior to abandoned mine reclamation.

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Within the North Coast region of California, the loss of old-growth conifers with large, cavernous basal hollows during late 19th and early to mid-20th century industrial-scale logging is presented as a likely explanation for the apparent decline of Townsend's big-eared bat colonies in the coastal forest of northern and central California (Pierson and Rainey 1998). The association of Townsend's big-eared bat with large basal hollows has been demonstrated by the work of Pierson and Fellers (1998) and Mazurek (2004) and hypothesized as the historical roosting habitat of this species prior to the Wisconsin glaciation period (Humphrey and Kunz 1976).

More recent and ongoing forestry practices that could impact Townsend's big-eared bat include harvest of remnant old-growth trees with suitable roosting cavities, as well as disturbance associated with timber operations, increased access to roost sites by human visitors, loss of oak woodlands (which may provide roost sites and certainly provide foraging habitat), conversion of forest to agriculture such as vineyards, and application of chemicals.

New and renewed mining operations have the potential to impact Townsend's big-eared bat roosting in abandoned mines, either through disturbance of roosting bats or by destroying the old mine by conversion to open pit-style mining, or through natural collapse of abandoned mines (which also occurs naturally as no mines are inherently stable). Four examples of the destruction or loss of Townsend's big-eared bat roost sites are described in the Petition.

Dam construction or modification can result in the inundation of Townsend's big-eared bat roost sites. The Petition mentions one large colony that was displaced by construction of the New Melones Dam on the Stanislaus River. As stated in the Petition, much of the dam-building, reconstruction, and license renewal in California occurs at the same elevations in the foothills of the Sierra Nevada and Klamath and Trinity mountains that are optimal for Townsend's big-eared bat roosts.

Although generally considered a cave/mine roosting bat, Townsend's big-eared bat also roosts in large spaces in old buildings and in cavernous spaces in bridges and dams. Bats in such sites are subject to disturbance when humans enter for inspections or other activities. The roosts themselves are subject to eventual deterioration or demolition. Pierson and Rainey (1998) documented the loss of several Townsend's big-eared bat roosts found in buildings.

There is an ongoing interest among recreational explorers in caves and abandoned mines. There is also a collectible market for mining artifacts. People entering mines can disturb bats during the critical maternity and hibernation seasons. Townsend's big-eared bat appears to be particularly susceptible to such disturbance. Recreationists and homeless persons may also enter old buildings used as roosts and disturb bats. A house at the CDFW Chorro Creek Wildlife Area has provided a roost for a Townsend's big-eared bat maternity colony off and on for several years. The site has been repeatedly abandoned by

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Comment [R26]: But no evidence of the loss of these colonies. There is abundant evidence that they are adept at relocating as long as they are not physically entombed when their roosting structure fails

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Comment [R27]: This is hypothesized, but much of this appears based on normal movement patterns within and among roosts. Ex., they were here, now they are not…. Something must have forced them to leave.

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the bats after break-ins followed by subsequent re-occupancy after the house is resealed (R. Stafford 2014 pers. comm.). The same pattern of partial or complete abandonment has been observed at the Randall House maternity roost site (Fellers and Halstead 2015) and other sites.

While it is certainly true that natural roosting habitat for Townsend's big-eared bat has been impacted by humans over the past 150 years, it is important to consider that historical mining and building construction also added to the total available roost habitat in the state in the late 1800s and early 1900s. Assuming the location of roost habitat is a limiting factor for Townsend's big-eared bat, it is possible that the carrying capacity for the species actually increased throughout the west, or (more likely based on their low reproductive rates), their patterns of distribution became dramatically altered as they were free to move away from historical cave roosts into areas from which they were historically precluded due to the lack of subterranean habitat (Sherwin et al., 2009). It is unknown, however, to what degree the hypothesized decreases in colony sizes at natural roost sites of caves and large old trees with basal hollows have been offset by redistribution of individuals throughout the western United States. Many of these old buildings and mines themselves have been subsequently impacted, and in many cases lost, since the historical period. Moreover, with the documented loss of approximately 95% of old-growth coastal redwood forest on California's North Coast (Fox 1989), it is likely that this region has suffered a substantial decrease in roost site availability during the historical period.

In summary, CDFW considers loss, degradation, and disturbance at roost sites to be an important threat to Townsend's big-eared bat in California. Given the species' hypothesized susceptibility to disturbance, its reliance on roost sites with a relatively narrow range of suitability, and the colonial nature of the species, especially during the maternity season, it is possible that population-level or even statewide impacts could occur to the species from the loss or disturbance at relatively few roost sites.

Loss of Foraging Habitat (including water)

Loss of suitable foraging habitat has previously been identified as a threat to Townsend's big-eared bat (Pierson and Rainey 1998, Pierson and Fellers 1998). Ideal habitat for foraging likely includes a mix of edge and continuous vegetation cover. Land management practices that create large openings of low shrub or grass cover in forest and woodland areas, such as agricultural development and extensive clear-cutting probably reduce foraging habitat suitability for the species. Likewise, residential and urban development reduce available foraging habitat. This is especially true in the extensive, highly-developed regions along California's South Coast and Bay Area. Although individual Townsend's big-eared bats may still make forays into these areas, it is unlikely that populations could be supported in urbanized areas.

It has been estimated that 95 percent of California's riparian habitat, which is important for foraging Townsend's big-eared bats, has been lost to vegetation clearing or conversion and inundation behind

Comment [R28]: They are adaptable and will move as they need to. These animals did not die, they relocated and returned when conditions were again optimal. This is a good thing. They would be far worse off if they were so roost constrained that they could NOT leave….

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Comment [R29]: This is not supported in the literature

Comment [R30]: The fact that females remain active throughout the maternity period allows them to move from danger immediately upon noting human or animal disturbance. This actually helps them deal with disturbance, but may give the impression of susceptibility to it.

Comment [R31]: This may be true in some areas, but there is a direct correlation with roost type, availability and colony sizes. The threats vary based on location

Comment [R32]: This is based on a very small sample size of radio tracked bats. The literature reveals that they are quite capable in foraging in virtually any vegetative community and dense vegetation is rarely necessary.

Comment [R33]: Why? As a moth specialist these habitat types may be ideal. They routinely forage around street lights in rural areas and from a bats perspective a large city is likely very similar to cliffs and canyons

Comment [R34]: In most of their range there is no riparian habitat. They will use it when it is there, just like all available habitat, but in many areas there is no water and they appear to survive using metabolic water, and rarely drink

dams (Katibah 1984). Climate change, including the effects of protracted or severe drought, may also negatively affect foraging habitat suitability and insect prey availability, both through vegetation changes and reductions in free surface water availability.

In summary, CDFW considers loss of foraging habitat to be a potential threat to Townsend's big-eared bat in California.

White Nose Syndrome and other Disease

White Nose Syndrome (WNS) is a disease that has killed more than 6 million bats in eastern North America (USFWS 2012). It is caused by *Pseudogymnoascus destructans* (Pd), a cold-loving fungus that is thought to have been introduced into northeastern North America from Europe sometime in the early 2000s. The fungus grows in the skin and other tissues of hibernating bats and may affect multiple physiological systems of the bats during the winter period. The most obvious effect on hibernating bats is that infected individuals arouse from deep torpor much more frequently and for longer periods than non-infected bats, which drastically reduces the fat reserves needed to sustain the bats until insect prey is available in the spring. Most affected bats die of starvation, with mortality rates for some species (e.g., *Myotis lucifugus*, the little brown bat) approaching 100% in some eastern hibernacula[4].

WNS has not yet been detected in western North America west of Nebraska. Surveillance studies to sample for the Pd fungus have yet to detect it California (W. Frick 2012 pers. comm.). Pd has been detected from swabs taken from the fur of Townsend's big-eared bats in WNS-affected areas in the eastern United States, but so far WNS (the disease) has not been observed to manifest in this species (A. Ballmann 2015 pers. comm.).

Little is known about the occurrence of other diseases, such as rabies, in Townsend's big-eared bat. Based on recent submissions of bats to state and county public health test labs, there is nothing to suggest Townsend's big-eared bat populations in California have been subject to recent disease outbreaks (CDPH unpublished data 2015).

CDFW considers WNS an important potential threat to California populations of Townsend's big-eared bat. Based on observations in the eastern U.S., the species' susceptibility to the disease is unclear. Continued monitoring of hibernating bats (as at Lava Beds National Monument), surveillance for the fungal agent of WNS, and incorporation of measures to reduce the risk of introducing or transmitting the fungus to hibernation sites in California are all important measures to reduce the risk of WNS to California populations. CDFW does not consider other diseases such as rabies to be a threat to the Townsend's big-eared bat in California.

[4] https://www.whitenosesyndrome.org/

Environmental Contaminants

Environmental contaminants include both naturally occurring and human-generated toxins that may affect the health of plants or animals. Naturally occurring toxins, such as heavy metal minerals, sulfur oxides, ammonia, and carbon dioxide, generally do not naturally occur in sufficient concentrations to impact Townsend's big-eared bat populations and will not be addressed here. Human-produced toxins may be released or applied to the environment in many forms. Of greatest potential impact to Townsend's big-eared bat are toxins used for control of agricultural and other pests (pesticides), byproducts of mining and ore processing, and air quality contaminants.

Pesticides. The California Department of Pesticide Regulation publishes an annual Pesticide Use Report for California (available at www.cdpr.gov). These reports provide information on the types, amounts, and general location of pesticides used each year in the state. According to the 2013 annual report (CDPR 2015), a total of about 88 million kg of all types of pesticides were applied in California. Figure 10 (based on data provided in CDPR 2015, Table 1), depicts the 2013 average application (kg/ha) of all pesticides for each county in California. Pesticide use appears to be greatest in the San Joaquin Valley, an area with relatively few recorded observations of Townsend's big-eared bat. However, as noted in the Petition, drift of agricultural pesticides is known to occur – for example, pesticide chemicals applied in the Central Valley have been detected in frogs living in the Sierra Nevada (Sparling et al. 2001).

The most recent Pesticide Use Report (PUR-2013, CDPR 2015), which reports annual pesticide use for many classes of pesticides, states "regression analyses on use from 1996 to 2013 do not indicate a significant trend of either increase or decrease in total pesticide use." However, inspection of the report's figures suggests that total use of certain classes of pesticides has decreased over the period 1995-2013, while others have remained roughly the same or increased. In particular, the most heavily used classes of pesticides (Fungicide/Insecticide, Insecticide) have shown a fairly marked decrease over the period (see Figure 1 of the PUR-2013). CDPR also tracks use of various pesticide chemical classes, including "reproductive toxicity" chemicals, carcinogens, cholinesterase-inhibiting chemicals (organophosphates and carbamates), groundwater-impacting chemicals, toxic air contaminants, fumigants, and biopesticides (microorganisms and naturally-occurring chemicals used in lieu of synthetic chemicals). Some classes, such as the "reproductive toxic" chemicals, cholinesterase-inhibiting chemicals, and groundwater-impacting chemicals, have clearly decreased in usage (see Figures 6, 7, and 8 of PUR-2013). Others, such as carcinogens (PUR Figure 6), air contaminants (PUR Figure 9), and Fumigants (PUR Figure 10) have varied somewhat over the years but do not show a trend in use. Biopesticides (PUR Figure 12) have shown a steady increase in use over the report period.

The extent pesticide use in California impacts Townsend's big-eared bat populations is unknown; however, it is likely that some Townsend's big-eared bat individuals, at least, are impacted where these

toxins are concentrated, either by ingestion of prey (including the potential for bioaccumulation within prey or bat) or water contaminated by pesticides, or by absorption through the skin after contact with pesticides in the air or on surfaces. These impacts may result from both lethal and sub-lethal exposure effects on survival and reproduction. While it is encouraging that use of some of the most environmentally damaging pesticides has decreased over the past two decades, it is unknown what level of threat the current and future levels of application pose to Townsend's big-eared bat populations.

Mine Toxins. Mineral extraction can result in pools of water contaminated with toxic chemicals. Such toxic pools have long been recognized as a threat to wildlife, including bats that may drink from them (Clark and Hothem 1991). The rising price of gold in the 1980s led to the renewal of mining using cyanide leaching as an extraction method in gold fields previously considered depleted. See the section on Mining for more information on renewed mining). The research and publicizing of the threat to wildlife of open cyanide ponds resulted in greater attention to this problem by federal and state regulators (S. Reeves 2015 pers. comm.), as well as industry-led measures to reduce the environmental hazards associated with cyanide leach fields (SME 2014).

The "International Cyanide Management Code for the Manufacture, Transport, and Use of Cyanide In the Production of Gold" is an industry voluntary program for gold mining companies. It is intended to provide for the safe management of cyanide and cyanidation mill tailings and leach solutions. Companies that adopt the code must have their mining operations that use cyanide to recover gold audited by an independent third party to determine the status of code implementation. Those operations that meet the code requirements can be certified. The code was developed by a multi-stakeholder steering committee under the guidance of the United Nations Environmental Program and the International Council on Metals and the Environment (http://www.cyanidecode.org/about-cyanide-code#sthash.4jbDJ744.dpuf).

According to available information, the largest gold mines in California are certified under the code (S. Reeves 2015 pers. comm.). Although toxic leach fields and ponds remain a potential threat to Townsend's big-eared bat, CDFW believes that oversight of the mining industry by BLM, regional Water Quality Control Boards, and the California Geological Survey minimize the risks associated with mine toxins to an acceptably low level.

Air Quality. As described in the Petition, poor air quality on a local or regional basis may result from human transportation, energy production and manufacturing activities, ground disturbance, and erosion and loss of native vegetation cover. Although it is reasonable to conclude that Townsend's big-eared bat (and bats in general) may be affected by poor air quality due to their high metabolic rate when active, CDFW is not aware of any research indicating an impact of air pollutants in bat populations in California.

Climate Change

As described in CDFW's document outlining the agency's plans to address climate change (CDFG 2011), "a growing body of scientific research indicates California's remarkable diversity of habitats and wildlife is threatened by climate change. Ecological changes, including changes in species' distributions, timing of life cycles, and abundance, have already occurred in California over the past century in concert with increases in average temperature and changes in precipitation patterns (California Natural Resources Agency 2009). Existing stressors such as human population growth and associated land use changes, water management conflicts, invasive species, and other widespread stressors will be exacerbated by climate change, and could increase negative impacts to ecosystems beyond the effects of individual stressors."

To assess the potential for future climate change to affect the distribution of Townsend's big-eared bat, Stewart (J. Stewart, unpublished data) conducted MaxEnt modeling using climatic variables to model the current and possible future distribution of the species under several projections of future climate during the period 2070 to the end of the 21st Century. This method uses the concept of a "climate envelope", the geographic area with a climate suitable for a species' survival. Such "envelopes" are generally expected to move up in elevation and north in latitude in the future with a warming climate.

The best predictors of Townsend's big-eared bat distribution in California were temperature and snowpack, with average amount of snowpack providing the most parsimonious model – that is, the species is less likely to occur in areas with greater snowpack (J. Stewart 2015 pers. comm.). Under four different future climate change projections (generally described as Warm-Wet and Hot-Dry) and two greenhouse gas emission scenarios (High and Low), Townsend's big-eared bat is projected to fare reasonably well, in terms of availability of climatically suitable habitat in California (see Figure 11). Although under some scenarios the species' suitable range is projected to retract in some areas (red areas in the figure), most of the currently-suitable modeled habitat is projected to remain suitable. Some areas, notably in the northern and higher elevations areas of the state, are projected to increase in suitability in the future. Under the worst-case scenario for Townsend's big-eared bat, 88% of current known locations for the species are projected to remain suitable. Other scenarios indicated 90% to 95% of current locations would remain suitable.

Stewart (2015 pers. comm.) suggests these results are not surprising, given the generally wide distribution of Townsend's big-eared bat in California, as well as its broad distribution in North America, including south through much of Mexico to the edge of the tropics. While such modeling may not accurately or precisely predict future habitat suitability for a species, and additional work is needed to ensure that future climate does not substantially impact Townsend's big-eared bat (for example, though loss of surface water and suitable foraging habitat, or de-coupling of suitable roost site structures from

suitable climate areas), at this time CDFW has determined that climate change does not pose a significant threat to the species.

Mining

California has a long history of mining due to its variety of mineral and geologic resources. California ranks second nationwide in production of minerals other than fossil fuels (Department of Conservation 2000). Starting even before the Gold Rush era of the mid-1800s, tens of thousands of mines have been excavated in the state. The Abandoned Mine Lands Unit (AMLU) of the California Department of Conservation (Department of Conservation 2009) estimates that there are approximately 47,000 abandoned mine sites in California. Although mines exist throughout the state, the majority of these mines are concentrated in the desert regions and western Sierra Nevada foothills (see Figure 12). Approximately two-thirds of abandoned mine sites are on federal land, 31% are on private land, and 2% are on state and local government land.

Mines provide important shelter for Townsend's big-eared bat and other bat species that evolved to roost in natural caves and crevices. Historic mining has created habitat for bats and other wildlife. Eighty percent of the mines in the western U.S. show some evidence of bat activity (Tuttle and Taylor 1998). Mines may be used by Townsend's big-eared bat year round for their roosting needs. These include critically important maternity and hibernation seasons. Large, structurally diverse mines may provide both warm roosts for maternity colonies and the cool or cold temperatures during hibernation (Pierson and Fellers 1998, Pierson and Rainey 1991, 1998; Pierson et al. 1999).

Comment [R35]: There is abundant data since this report that indicates that mines of any shape and size can be used by this species in virtually every way.

Mines may also offer prey such as moths and other insects and open water for drinking in chambers that intercept ground water. Such water resources are especially important in desert regions where surface water may be uncommon.

Because of the importance of historical and abandoned mines to Townsend's big-eared bats, several management issues related to mines and mining may pose a threat to the species. These include: closure of mines, renewed mining, environmental contamination, and human disturbance at mine roosts. The latter two topics are discussed elsewhere in the Threats section of this report.

Abandoned Mine Lands (AML) programs are tasked with the closure of open mines hazardous to human safety. To determine the appropriate closure method at a mine, it is necessary to determine through surveys what species may be using the mine. Permanent abandoned mine closure methods have resulted in the destruction of roosting habitat and have also caused direct mortality of bats by trapping them within the closed mine without exclusion at the appropriate season (Brown 1995b; Altenbach and Pierson 1995). Bat conservationists have advocated for assessment and planning for the appropriate mine closure method (fences, bat gates, cupolas, large grates) that allow bats to pass through openings

too small for humans, while maintaining air flow patterns crucial for internal habitat conditions (Sherwin *et al.* 2009).

California's Department of Conservation has an AML unit that is actively engaged in reducing the hazards associated with open mines. It works with state and private mine owners to ensure that wildlife-compatible closure methods are implemented. It also coordinates with federal land management agencies for closures on BLM and other federal lands. See http://www.conservation.ca.gov/omr/abandoned_mine_lands for more information on AML issues in California.

Modern methods of mineral extraction have allowed mining companies to renew mining in historical areas previously abandoned. For example, the use of chemical extraction methods for gold from open pit mines often occurs directly in areas with abandoned shaft mines. Renewed mining in historical mine districts has the potential to impact Townsend's big-eared bat and other bat species where the modern mine removes the previous underground mine (Pierson et al. 1991). In addition, renewed mining may impact native vegetation and water sources used for foraging around the mine, and may introduce chemical contaminants used for mineral extraction to the environment. See the section on Environmental Contaminants for more information on this aspect of mining impacts to bats.

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In summary, CDFW considers the impacts associated with mine closures and renewed mining to be important potential threats to Townsend's big-eared bats. Active AML programs at the state and federal level should minimize the threat of mine closures to sensitive species. Environmental review of proposed mining projects through CEQA and NEPA should ensure adequate assessment and disclosure of potential impacts to Townsend's big-eared bat of such projects. Provided such programs are adequately funded by state and federal agencies, it is likely that population-level impacts associated with legacy mines and renewed mining would not occur. However, there is less certainty that important roost sites and Townsend's big-eared bat colonies would be adequately protected in the absence of a listing of the species as threatened or endangered.

Deleted: populations

Comment [R36]: There are abundant examples from throughout the west, including California of Townsend's colonies maintaining use of, and even thriving when mitigation is done correctly. It is not difficult to do and has not, to this point, required formal protection.

Overexploitation (for Scientific Use)

As a nongame mammal (defined in Fish and Game Code section 4150), Townsend's big-eared bat is not harvested or collected for commercial or personal use. Collection of Townsend's big-eared bat does occur in California on a limited basis for bona fide scientific and educational purposes. Such collection is regulated according to Fish and Game Code (sections 1002 *et seq*.), which is administered by CDFW.

In the past, scientific collections were made on a much greater scale than occurs today. The mammal collections at the Museum of Vertebrate Zoology, Los Angeles County Museum of Natural History, and at many other museums and universities in the western U.S. were established through the lethal taking

of representative specimens of California's mammalian fauna. Such collections remain an important resource for scientific investigations of the phylogeny, evolution, taxonomy, diet, morphology, physiology of California's fauna (Pyke and Ehrlich 2010).

For long-lived/low fecundity species such as Townsend's big-eared bat, it is possible that repeated scientific collection may have a population impact. As documented by Brown et al. (1994), the Townsend's big-eared bat maternity colony at Prisoners Harbor (Santa Cruz Island) was subjected to three collecting episodes over a period of 25 years in which a total of 246 individuals were taken. The Santa Cruz Island colony, which apparently numbered "more than" 300 individuals (which probably included both adult females and their young) in 1939, has never recovered to its historical size, though other impacts, including roost loss and disturbance have been contributing factors.

Non-collecting scientific study may also impact Townsend's big-eared bat populations through disturbance of roosts. Before Townsend's big-eared bat's susceptibility to roost site disturbance was well documented, Pearson et al. (1952) conducted investigations of the basic ecology and reproductive biology of Townsend's big-eared bat in California. These studies included occasional entry into maternity and hibernation roosts at multiple sites around California to collect information and to place wing-bands on bats. In one case, the authors banded 75 young Townsend's big-eared bats during the early night while the adult females were foraging. By the next morning, the young had been carried by their mothers to another roost site, presumably in response to the disturbance at the original roost site (Pearson et al. 1952). The authors did not document whether there was an impact in terms of growth or survival of the young from this disturbance event.

Comment [R37]: Over 250 bats were wing banded in a similar manner by well known, California based consultants in southern California in the 1990s with fewer than 6 ever seen again.

Placement of wing bands on bats is a long-standing method used to mark individual bats (Barclay and Bell 1988, Gannon et. al. 2007). Recapture of banded bats can provide information on movements, survival, and population size. Based on available information, it appears Townsend's big-eared bat does not handle wing-banding as well as other bat species. Ellison (2010) summarized results from her own and others' studies suggesting a relatively high proportion of banded Townsend's big-eared bat suffer from perforated wing membranes, scarring, tissue-swelling, infection, and irritation. Moreover, the banding activity may have disturbed some individuals sufficiently to cause them to move to different roost sites (Ellison 2010).

Because of the concerns related to over-collection, disturbance at roosts, and wing-banding, CDFW carefully controls the activities of scientific researchers working on Townsend's big-eared bat in California. All persons who may take[5] Townsend's big-eared bat for scientific or educational purposes

[5] "Take" is defined in Fish and G. Code §86 as "to hunt, pursue, catch, capture, or kill" or to attempt to do so.

are required to possess a current Scientific Collecting Permit and, while a candidate for listing, a CESA Memorandum of Understanding issued under the authority of Fish & G. Code § 2081(a). Among the standard conditions of research permits are: a prohibition on entry into known roost sites (unless specifically authorized for a particular study), immediate departure from sites discovered to be maternity roosts, and measures to minimize the risk of introducing the fungus that causes White Nose Syndrome to hibernacula. Wing-banding is not currently authorized for any researcher working on Townsend's big-eared bat. No collection of Townsend's big-eared bat specimens is currently authorized for any individual. Prior to Townsend's big-eared bat's designation as a Candidate for listing, Scientific Collecting Permits that authorized work with Townsend's big-eared bat had similar provisions for the protection of Townsend's big-eared bat individuals and populations.

Given the level of control exerted by CDFW on scientific researchers working with bats, overexploitation for scientific purposes is not considered to be a threat to the continued existence of Townsend's big-eared bat in California.

Habitat Essential for Continued Existence of the Species (FISH & G. CODE § 2074.6)

In 1952, after intensive study of Townsend's big-eared bat at several maternity and hibernation roosts at both coastal low elevation sites and interior high-elevation sites, Pearson and his co-authors considered factors that may be limiting Townsend's big-eared bat populations in California. They dismissed predation as a limiting factor, as they had never observed a predation event or evidence of such, nor were they aware of any important natural predators of Townsend's big-eared bat.[6] Disease was likewise discounted in importance due to lack of observation. Pearson et al. (1952) considered the availability of food and water as a possible limiting factor, but could not address this factor given a lack of data on prey availability. Regarding roost site availability, the authors noted that each maternity and hibernation roost site in their study seemed large enough to house many more Townsend's big-eared bat individuals than were observed. They reasoned that at the local scale food or water may be limiting, but on a regional scale appropriate roost sites may be limiting the total population size. Appropriate roost sites not only must have suitable size and other structural and microclimate characteristics, but also must be near suitable foraging habitat, including safe and accessible sources of open water for drinking.

With these considerations in mind, and with the apparent loss of historical roost sites documented by Pierson and Rainey (1998) and others, and the expected continued degradation and loss of old buildings suitable for use as roost sites (Fellers and Halstead 2015, G. Tatarian 2014 pers. comm.), CDFW

[6] But see Fellers's 2000 report of black rats, *Rattus rattus*, preying upon non-volant young Townsend's big-eared bat at the Randall House maternity roost, as well as his description of the possible effect of owl presence on roost departure times of Townsend's big-eared bat at the same site (Fellers 2014).

considers any structure, or set of structures, used by Townsend's big-eared bat as a maternity or hibernation roost to be habitat essential for the continued existence of the species. The essential characteristics of these suitable roost sites extend to the nearby foraging, commuting, and night-roosting habitat and therefore these adjacent habitats are also considered essential.[7]

It may be possible on a case-specific basis to identify alternative or replacement roost structures, or set of structures (to allow for roost-switching), and adjacent habitat that would serve a local Townsend's big-eared bat colony. The suitability of such alternative or replacement roost sites would need to be demonstrated (through comparable use by the local Townsend's big-eared bats) prior to considering any occupied roost unnecessary for the colony. CDFW is not aware of any replacement roost structure having been purpose-built for use by Townsend's big-eared bat, but this is a management action that should be explored on an experimental basis.

Deleted: population

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Comment [R38]: Several were installed at the CR Briggs mine by Pat Brown and all failed

EXISTING MANAGEMENT, MONITORING, AND RESEARCH ACTIVITIES

CDFW

The California Department of Fish and Wildlife is the state trustee agency for fish, wildlife, and botanical resources. In addition to its current status as a Candidate for CESA listing, CDFW designates Townsend's big-eared bat as a Species of Special Concern (Williams 1986). The SSC designation does not confer any legal protection on the species, but rather is intended to ensure management, conservation, and research activities are implemented to prevent future declines and the need for listing under the California Endangered Species Act (Comrack et al. 2008). As an SSC, Townsend's big-eared bat is also designated as a Species of Greatest Conservation Need (SGCN) in California's State Wildlife Action Plan (SWAP, CDFG 2007). This designation provides additional focus on the species by CDFW, as well as funding opportunities for research and conservation actions from the State Wildlife Grant program of the U.S. Fish and Wildlife Service.

As part of CDFW's general mission to monitor wildlife resources, known Townsend's big-eared bat roosts on CDFW lands (Wildlife Areas and Ecological Reserves) are monitored. This includes the maternity colony that occurs on the Chorro Creek Ecological Reserve in CDFW's Central Region. Through

[7] In particular, as noted by Tatarian (2015 pers. comm.), structures used for roosting by single Townsend's big-eared bats in the vicinity of maternity roosts and hibernacula may be essential to allow population-level behaviors essential to reproduction. These behaviors include socialization between adult females and males in the fall leading to mating at mixed-sex overwintering roost sites, as well as fledging and dispersal of young at the end of the maternity season.

on-going monitoring, CDFW has documented the impact of human disturbance at this site and has implemented measures to reduce the threat of disturbance to the colony (R. Stafford 2014, 2015 pers. comms.).

Townsend's big-eared bat is currently a Candidate for listing as threatened or endangered under the California Endangered Species Act. As such, the prohibition on "take" of listed and candidate species of CESA applies to Townsend's big-eared bat. Regulatory programs of CDFW now review proposed CEQA, timber harvesting plans, and scientific research applications to ensure that no take of the species would occur, unless authorized by one of the statutory exemptions allowing such take, such as the Incidental Take Permit and Safe Harbor mechanisms of CESA, or through a Memorandum of Understanding for take for scientific or educational purposes. All such take may only be authorized if it is fully mitigated and would not jeopardize the continued existence of the species in California. As mentioned above, should the species not be listed then it would revert to the Species of Special Concern designation. SSCs typically receive some attention during CEQA review, but protection from take and population-level impacts is less certain. This applies not only to projects for which CDFW is the lead or responsible agency, but for CEQA projects for which other state agencies (such as CDPR and CalFire, see below) or counties or cities are the lead agency.

CDFW is currently implementing three projects relevant to Townsend's big-eared bat that are funded by the State Wildlife Grant (SWG) program. The California Bat Conservation Plan (CBCP) was initially funded by SWG in the mid-2000s and, after several years of development is now nearing completion, thanks in part to a new SWG to complete final edits. The CBCP addresses the management and conservation of all bat species occurring in California, including Townsend's big-eared bat, and will provide specific recommendations for the management, policy development, and research for all species, all ecoregions, and all the major conservation issues affecting bats in the state. Included in the CBCP is a relative ranking of the species for conservation concern – Townsend's big-eared bat consistently was rated by the authors as among the greatest concern bat species.

The second SWG-funded project directly addresses the current conservation status of Townsend's big-eared bat in California. Previously, the California Department of Fish and Game funded a statewide survey for Townsend's big-eared bat in the 1980s by Elizabeth Pierson and William Rainey (Pierson and Rainey 1998). The new statewide survey effort is being conducted over a two-year period and is targeting known and highly-suitable locations for maternity and hibernation roosts. This project is being contracted to researchers from Humboldt State University and Texas A&M University (Joe Szewczak and Michael Morrison) and should provide an updated snapshot of the species' status as of 2015-2017.

SWG funding was also provided to CDFW to implement a project to expand bat monitoring in California according to the North American Bat Monitoring Program (Loeb et al. 2015). This project is initially

focused on acoustic monitoring of bat activity around the state, which probably will not provide a lot of data on Townsend's big-eared bat due to its quiet echolocation calls. However, CDFW plans to increase efforts to monitor important roosts for this and other species in the future as the NABat program continues to develop.

CDPR

The California Department of Parks and Recreation manages state parks throughout California. As with other land management agencies, CDPR manages sensitive biological resources, such as Townsend's big-eared bat, both through review of proposed project impacts under the environmental review process, as well as through focused monitoring efforts at known roosts (such as at Hearst San Simeon State Historical Monument).

CalFire

The California Department of Forestry and Fire Protection (CalFire) is the lead agency in California for timber harvest projects on private and state forest lands. Timber harvest review is a CEQA-equivalent environmental review process and, as such, requires proposed timber management projects to assess and disclose potential impacts on the environment, including to biological resources. Since the designation of Townsend's big-eared bat as a candidate for listing under CESA, CalFire has been proactive in working with timber companies and registered professional foresters to ensure significant impacts to the species, as well as "take," are avoided.

NPS

The National Park Service lands in California include several known Townsend's big-eared bat roost sites, including the large number of caves at Lava Beds National Monument, the Randall House maternity colony at Point Reyes National Seashore, the hibernacula and maternity roosts at Pinnacles National Park, and the Scorpion Ranch maternity roost on Santa Cruz Island. In general, the NPS approach to sensitive biological resources, such as Townsend's big-eared bat and its habitat, is to survey, monitor, manage, and to conduct research on the species.

In addition to the monitoring and management of the aforementioned sites, work by E.D. Pierson and others in Yosemite National Park (Pierson and Heady 1996, Pierson and Rainey 1997, and Pierson et al. 2006) provided baseline information on bat use of the Yosemite area, including on Townsend's big-eared bat (S. Stock 2014 pers. comm.).

BLM

The Bureau of Land Management designates Townsend's big-eared bat as a sensitive species. This designation requires land use plans to address the species and its habitat and to incorporate the species'

needs in a manner to reduce potential conflicts with other multiple use activities. On BLM-administered lands, BLM manages a sensitive species and its habitat to minimize or eliminate threats affecting the status of the species or to improve the condition of the species' habitat. BLM assists, as funding allows, in determining distribution, abundance, and condition of the species, and to manage the habitat in such a manner to improve the conservation status of the species and ensure that BLM actions do not move the species towards needing to be listed (A. Fesnock 2015 pers. comm.).

Based on information gathered for this status review report (A. Fesnock 2015 pers. comm.), Townsend's big-eared bats are known to occur on BLM lands throughout much of California. As with other lands, most records for the species are from roost structures, including mostly abandoned mines. The BLM has an active survey and assessment program that evaluates abandoned mines for public safety hazards, wildlife and historical resources, and recommended closure methods. Evaluations of abandoned mines conducted over the past 15 years indicate many such mines are used by Townsend's big-eared bats. Few repeat visits or monitoring programs have been implemented, however, and therefore inferences about population status or trend cannot be made. Many of the BLM roost sites surveyed since 1999 are being re-visited as part of the current CDFW-funded statewide survey project.

All of the BLM field offices in California consider Townsend's big-eared bat roost sites (both hibernacula and maternity roosts) to be important resources to protect and manage. Many such sites have been gated in the past two decades to allow bats to use the sites without human disturbance (BLM unpublished data). The BLM expects to continue with gating abandoned mines to protect bat habitat and for public safety (A Fesnock 2015 pers. comm.).

USFS

The U.S. Forest Service in California lists Townsend's big-eared bat on its Regional Foresters Sensitive Species list. As such, the species is given almost as much protection as a species listed as threatened or endangered under the federal Endangered Species Act (L. Angerer 2015 pers. comm.). USFS projects and management actions are evaluated to ensure project effects do not put the species on a trend towards endangered or threatened status.

In particular, the USFS completes Biological Evaluations for all Sensitive Species prior to implementing projects and management actions. Each Biological Evaluation includes management recommendations for the Sensitive Species. In general, Townsend's big-eared bat colonies are protected. When a project is proposed that may impact a roost site (such as a mine closure or historical building removal) measures are implemented to replace the lost structure or to improve the use of the structure by bats after project completion.

Most known Townsend's big-eared bat roost sites on Forest Service lands are not consistently monitored (though with some exceptions, such as the Kentucky Mine colony in the Sierra National Forest). The overall strategy implemented by the USFS has been to protect and avoid impacts (L. Angerer 2015 pers. comm.).

SUMMARY OF LISTING FACTORS (14 California Code of Regulations 670.1)

CESA directs CDFW to prepare this report regarding the status of Townsend's big-eared bat based upon the best scientific information available to CDFW. CESA's implementing regulations identify key factors that are relevant to the CDFW's analyses. Specifically, a "species shall be listed as endangered or threatened ... if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors: (1) present or threatened modification or destruction of its habitat; (2) overexploitation; (3) predation; (4) competition; (5) disease; or (6) other natural occurrences or human-related activities." (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A)).

The definitions of endangered and threatened species in the Fish and G. Code provide key guidance to CDFW's scientific determination. An endangered species under CESA is one "which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease" (Fish & G. Code, § 2062). A threatened species under CESA is one "that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by [CESA]" (*Id.*, § 2067).

The following summarizes CDFW's determination regarding the factors to be considered by the Commission in making its decision on whether to list Townsend's big-eared bat. This summary is based on the best available scientific information, as presented in the foregoing sections of the report.

Present or threatened modification or destruction of its habitat

Disturbance, degradation, and loss of suitable roost sites is a recognized threat to Townsend's big-eared bat populations, both in natural roost sites such as large, old trees and caves, as well as in artificial roosts such as old buildings and mines. Although recent examples of disturbance at roost sites are relatively rare compared to such events in the historical period, lacking the protections of CESA it is possible the species could be impacted at multiple roost sites in the future, which could lead to population-level impacts. However, there is no current indication disturbance of roost sites is a significant threat at this time. Additionally, although impacts to foraging habitat could also affect the species, there is no current indication that impacts to foraging habitat poses a significant threat at this

time. Therefore, CDFW does not consider modification and destruction of habitat to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Overexploitation

CDFW does not consider overexploitation to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Predation

CDFW does not consider predation to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Competition

CDFW does not consider competition to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Disease

White Nose Syndrome is an important potential threat to Townsend's big-eared bat in California. Monitoring and research to determine the species' susceptibility to the disease as well as its occurrence in western North American are needed to assess the actual level of this threat. As discussed above, however, this disease is not currently impacting Townsend's big-eared bat in California. Therefore, CDFW does not consider disease to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Other Natural Events or Human-Related Activities

Mining (including renewed mining), agricultural development and pesticide use, restoration or demolition of old buildings and other anthropogenic structures used as roosts, forest management, and recreational caving and mine exploration all have the potential to impact Townsend's big-eared bat populations. State and federal environmental review programs typically include assessment and disclosure of potential impacts to the species in the CEQA/NEPA process. Adequate environmental review should prevent such activities from affecting Townsend's big-eared bat at the population or statewide level.

Climate change, especially more frequent and severe drought, has the potential impact Townsend's big-eared bat in California. Continued and increased monitoring of the species' abundance and distribution should help determine the actual impact of these threats to the species.

MANAGEMENT RECOMMENDATIONS

These recommendations were developed by CDFW in accordance with the requirements of Fish & G. Code, § 2074.6. This list includes some recommendations developed by other authors, including Johnston (2004), Ellison et al. (2003), Tigner and Stukel (2003), Hinman and Snow (2003), and Bradley et al. (2006). CDFW recommends these actions be implemented regardless of the Commission's decision on listing Townsend's big-eared bat as threatened or endangered. This list includes recommendations for actions that could be undertaken by CDFW as well as by other public agencies, non-governmental organizations, and private land owners.

Research and Monitoring Needs

- Complete comprehensive statewide population assessment of Townsend's big-eared bat by 2017.
- Implement consistent long-term monitoring at representative Townsend's big-eared bat roost sites in California.
- Design and test artificial structures suitable for use by Townsend's big-eared bat during the maternity and hibernation seasons.
- Create standardized procedures for monitoring Townsend's big-eared bat populations. Ensure all such studies will not adversely impact the subject populations.
- Conduct additional analyses of the possible effects of climate change and drought on Townsend's big-eared bat and determine best approaches to address possible adverse effects.
- Conduct research on the role environmental contaminants play in the health of Townsend's big-eared bat populations.
- Develop methods to create basal hollows in suitable large old trees.
- Conduct genetic studies to determine the population genetic structure of Townsend's big-eared bat in California, with special attention to the degree of divergence and isolation of populations on Santa Cruz Island relative to the mainland and between coastal and interior populations.

CDFW Administrative Actions

- If results of current statewide Townsend's big-eared bat survey indicate a decline in the population status is occurring that may lead to endangerment, prepare a staff recommendation to list the species as Threatened or Endangered for consideration by the Fish and Game Commission.
- Working with partners at state and federal agencies, as well as private landowners, ensure that management of Townsend's big-eared bat roost sites is consistent with continued site occupancy at or above existing population levels.

- Attempt to secure new funding and position resources as a priority to establish a full-time permanent bat specialist position within the Nongame Wildlife Program of CDFW to address data assimilation and conservation of bats in California, including Townsend's big-eared bat.
- Support research on the design and effectiveness of artificial structures suitable for use by Townsend's big-eared bat during the maternity and hibernation seasons.
- Create interagency and other stakeholder cooperation in, and public support for, conservation efforts for Townsend's big-eared bat. Partner with non-governmental organizations such as Bat Conservation International, The Nature Conservancy, and local NGOs in such efforts.
- Develop greater awareness of Townsend's big-eared bat and other bat conservation and management issues within CDFW.
- Direct fiscal and position resources to complete the draft California Bat Conservation Plan.

Management of Known Roost Sites

- Prior to changing management of caves, mines, or buildings that could be used by Townsend's big-eared bat or other bat species, such sites should be evaluated and/or surveyed during appropriate seasons for their use by Townsend's big-eared bat.
- Existing roosts should be left undisturbed and occupied roosts should only be entered for management or research purposes.
- Bat-friendly gates should be installed at Townsend's big-eared bat roosts where other methods of controlling human entrance are not effective. Special consideration should be given to gate design to minimize risk of injury or unsuitability for Townsend's big-eared bat.
- Abandoned mines suitable for use by Townsend's big-eared bat should not be closed in a manner to prevent bat use, or if they cannot be maintained adequate mitigation and exclusion should be conducted prior to their closure.
- Effectiveness monitoring (use of data loggers to passively record bat use and human disturbance) should be implemented at gated roost sites and other roost sites actively managed for bat resources (as through signage, information for visitors, etc.).
- Ensure foraging habitat, including access to open water, within the vicinity of maternity roosts remains suitable for use by Townsend's big-eared bat. Analysis of habitat suitability should be made on a site-specific basis, but start with using the area within a 24-km radius of the roost site.
- Where a Townsend's big-eared bat or other bat roost site has a history of recreational use by humans, implement a management plan to ensure new impacts from human use do not occur. The Kentucky Mine Stamp Mill management plan (Tierney and Freeman 2007) is a good example of such a plan that appears to be successful.

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Comment [R39]: What is considered suitable habitat and why 24 km radius? Both seem very arbitrary and I am unaware of any compelling data to support either recommendation

Landscape Management Practices

- Developed springs and other water sources should be kept available for in-flight drinking as outlined in various "wildlife-friendly" water facility publications.
- If protracted drought poses a threat to Townsend's big-eared bat, develop additional water sources for drinking in areas where open water limits population size.
- Restore or enhance riparian habitat.
- Implement basal hollow creation projects to increase opportunities for Townsend's big-eared bat to use tree roosts in coastal redwood forests (and possibly in interior forests where large tree species, such as giant sequoia, have the potential to serve as roost sites)

CEQA Review of Proposed Projects

- Ensure direct and cumulative impacts from projects proposed under CEQA and CEQA-equivalent regulatory programs are not likely to result in a substantial reduction in population or range of Townsend's big-eared bat and other bat species.

Public Education and Outreach

- Conduct and cooperate with other agencies on public outreach events about Townsend's big-eared bat and other bat species.
- Disseminate the California Bat Conservation Plan to the public, when complete.
- Encourage citizen participation, as appropriate, in bat monitoring projects.
- Promote bat-friendly exclusions where it is necessary to remove bats from buildings and other structures.

Health and Disease

- Continue and expand surveillance for WNS by state and federal agencies and researchers.
- Support research on the etiology and epidemiology of WNS on *Corynorhinus* species, including Townsend's big-eared bat.
- Continue and expand, if necessary, decontamination requirements for persons entering hibernacula for Townsend's big-eared bat and other hibernating bat species to minimize the risk of introducing the fungus that causes WNS.
- Work with other state and federal regulatory agencies to prevent the introduction of environmental contaminants that may affect the health of Townsend's big-eared bat and other bats. These may include aerial pesticide application and chemicals used in processing mined minerals.

LISTING RECOMMENDATION

CESA directs CDFW to prepare this report regarding the status of Townsend's big-eared bat in California based upon the best scientific information. CESA also directs CDFW based on its analysis to indicate in the status report whether the petitioned action is warranted. (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).) CDFW includes and makes its recommendation in its status report as submitted to the Commission in an advisory capacity based on the best available science. In consideration of the scientific information contained herein, CDFW has determined that the petitioned action is or is not warranted at this time.

PROTECTION AFFORDED BY LISTING

It is the policy of the State to conserve, protect, restore and enhance any endangered or any threatened species and its habitat (Fish & G. Code, § 2052.). If listed as an endangered or threatened species, unauthorized "take" of Townsend's big-eared bat will be prohibited, making the conservation, protection, and enhancement of the species and its habitat an issue of statewide concern. As noted earlier, CESA defines "take" as to hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill. (*Id.*, § 86.) Any person violating the take prohibition would be punishable under State law. As to authorized take, the Fish & G. Code provides CDFW with related authority under certain circumstances. (*Id.*, §§ 2081, 2081.1, 2086, 2087 and 2835.) In general and even as authorized, however, impacts of the taking on Townsend's big-eared bat caused by the activity must be minimized and fully mitigated according to State standards.

Additional protection of Townsend's big-eared bat following listing is also likely with required public agency environmental review under CEQA and its federal counterpart, the National Environmental Policy Act (NEPA). CEQA and NEPA both require affected public agencies to analyze and disclose project-related environmental effects, including potentially significant impacts on endangered, rare, and threatened special status species. Under CEQA's "substantive mandate," for example, state and local agencies in California must avoid or substantially lessen significant environmental effects to the extent feasible. With that mandate and CDFW's regulatory jurisdiction generally, CDFW expects related CEQA and NEPA review will likely result in increased information regarding the status of Townsend's big-eared bat in California as a result of, among other things, updated occurrence and abundance information for individual projects. Where significant impacts are identified under CEQA, CDFW expects required project-specific avoidance, minimization, and mitigation measures will also benefit the species. State listing, in this respect, and required consultation with CDFW during state and local agency environmental review under CEQA, would also be expected to benefit the species in terms of related impacts for individual project that might otherwise occur absent listing.

Listing Townsend's big-eared bat increases the likelihood that State and federal land and resource management agencies will allocate funds towards protection and recovery actions. Funding for species recovery and management is limited, however, and there is a growing list of threatened and endangered species.

ECONOMIC CONSIDERATIONS

CDFW is charged in an advisory capacity in the present context to provide a written report and a related recommendation to the Commission based on the best scientific information available regarding the status of Townsend's big-eared bat in California. The topic areas and related factors CDFW is required to address as part of that effort are biological and not economic. (See Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).)

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Townsend's big-eared bat CESA Status Review – Figures

Captions

1. Map showing geographic ranges of species and subspecies of North American long-eared bats as described by Handley (1959). Adapted from Piaggio and Perkins (2005, Figure 1).

2. COTO CWHR geographic range map, with occurrence locations.

3. COTO CWHR range map, with occurrence locations symbolized by time period.

4. Locations mentioned in the Population Trend section.

5. From Fellers and Halstead (2014, Figure 1). (A) Attempts to break into the Randall House, site of a *Corynorhinus townsendii* roost at Point Reyes National Seashore, California. (B) Annual number of adults (maximum count during May or June) and total *C. townsendii* (adults plus volant young; maximum count during July or August) emerging from roost at Point Reyes National Seashore.

6. COTO exit count data at Kentucky Mine maternity colony (Sierra County), 1996 - 2005. A. All counts. B. Early maternity season counts (before late July), without counts when the colony likely roosted elsewhere. C. Late maternity season counts (late July and later), without counts when the colony was likely roosting elsewhere. (source: Marilyn Tierney, unpublished data, and Freeman 2012).

7. From Weller et al. (2014, Figure 2). Estimated trend (solid line), upper and lower 95% prediction intervals (dotted lines), and number of Townsend's bigeared bats (*Corynorhinus townsendii*) counted (solid circles) during hibernacula surveys at 22 caves in Lava Beds National Monument, Siskiyou County, California, during 1991–2012. Caves are ordered top left to bottom right as largest to smallest observed counts.

8. From Weller et al. (2014, Figure 4). Estimates, with 95% prediction intervals, for the total number of Townsend's big-eared bats (*Corynorhinus townsendii*) hibernating in 52 caves at Lava Beds National Monument, Siskiyou County, California, during 1991–2012. The total number of caves surveyed each year is denoted as n on the x-axis.

9. Late summer (August – mid-September) exit counts for the COTO maternity colony site at Hearst San Simeon State Park, 2000 – 2014 (R. Orr, pers. comm.). For years with more than one count was conducted during the late summer season, the date with the highest count is depicted.

10. Average application of pesticides (kg/ha) for California counties, 2013, plotted with Townsend's big-eared bat occurrence locations.

11. Current and future projected climatically-suitable areas for Townsend's big-eared bat in California (J.Stewart, unpublished data) under four projections of future climate. Climatically-suitable areas were modelled using MaxEnt and existing occurrence records. For the period 2070-2099, areas shown in dark blue remain suitable, areas shown in red are suitable under current climate conditions but are projected to become unsuitable, and areas in light blue are modelled as currently unsuitable but would become suitable in the future.

12. California abandoned mines.

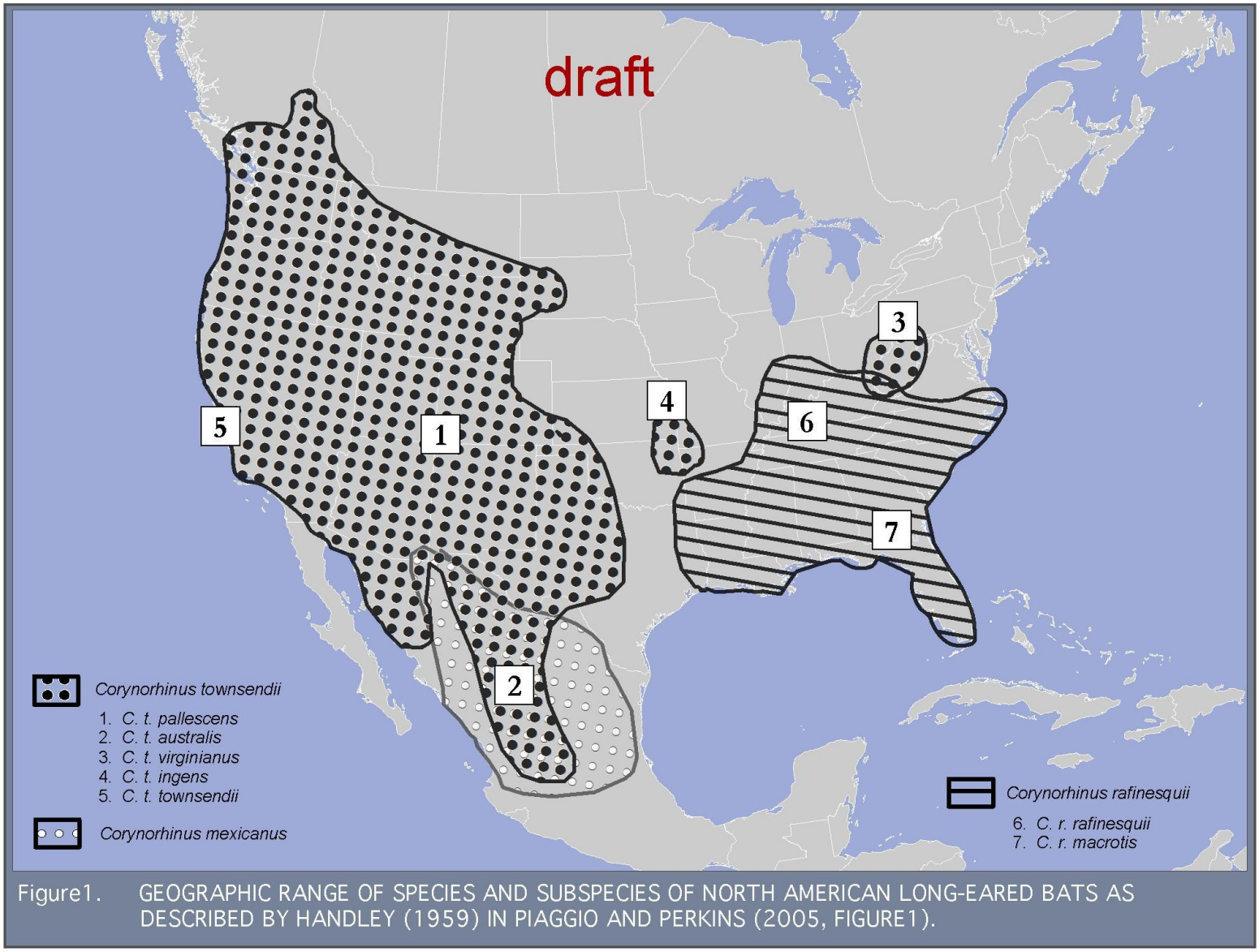


Figure1. GEOGRAPHIC RANGE OF SPECIES AND SUBSPECIES OF NORTH AMERICAN LONG-EARED BATS AS DESCRIBED BY HANDLEY (1959) IN PIAGGIO AND PERKINS (2005, FIGURE1).

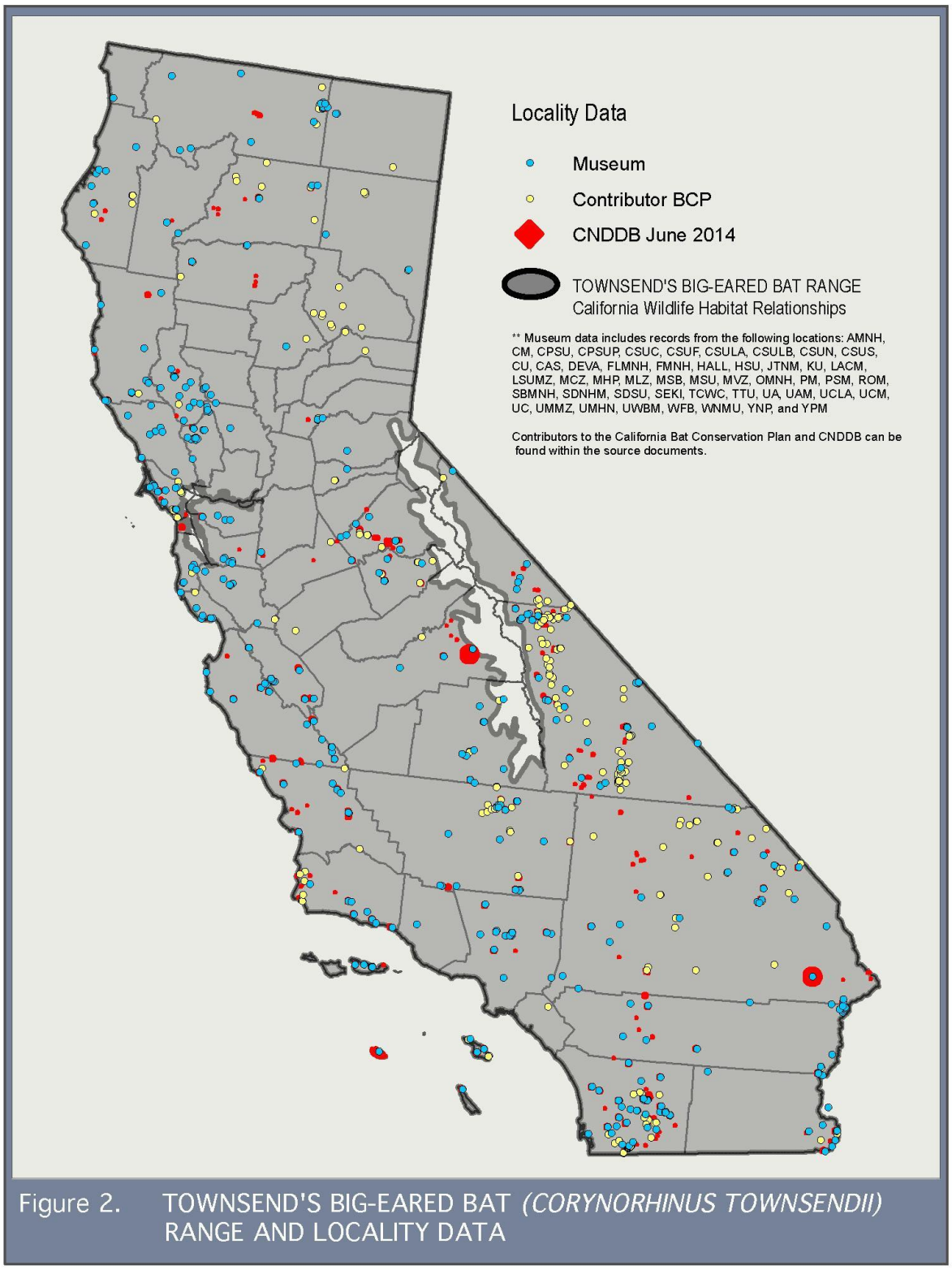


Figure 2. TOWNSEND'S BIG-EARED BAT *(CORYNORHINUS TOWNSENDII)* RANGE AND LOCALITY DATA

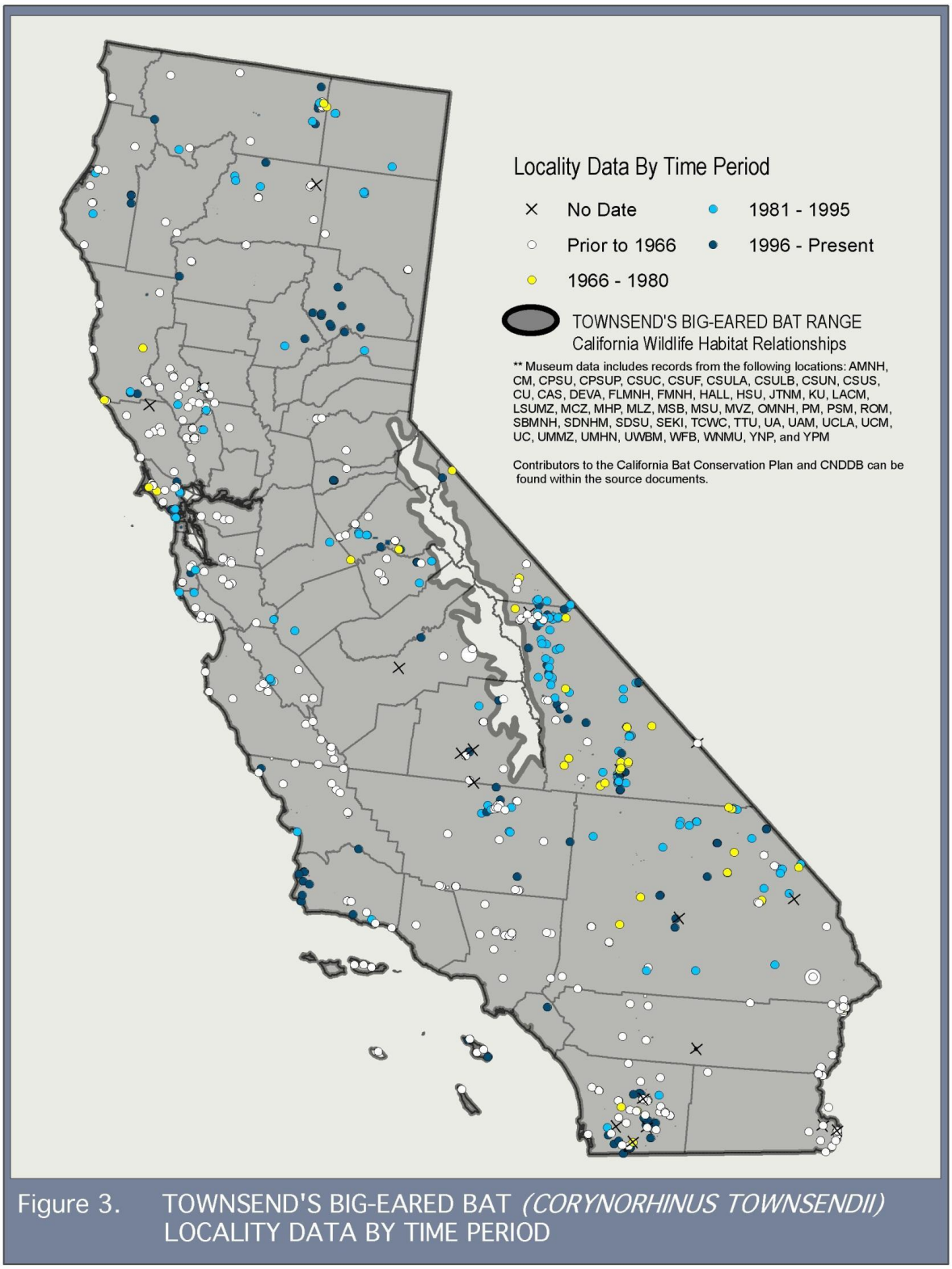


Figure 3. TOWNSEND'S BIG-EARED BAT *(CORYNORHINUS TOWNSENDII)* LOCALITY DATA BY TIME PERIOD

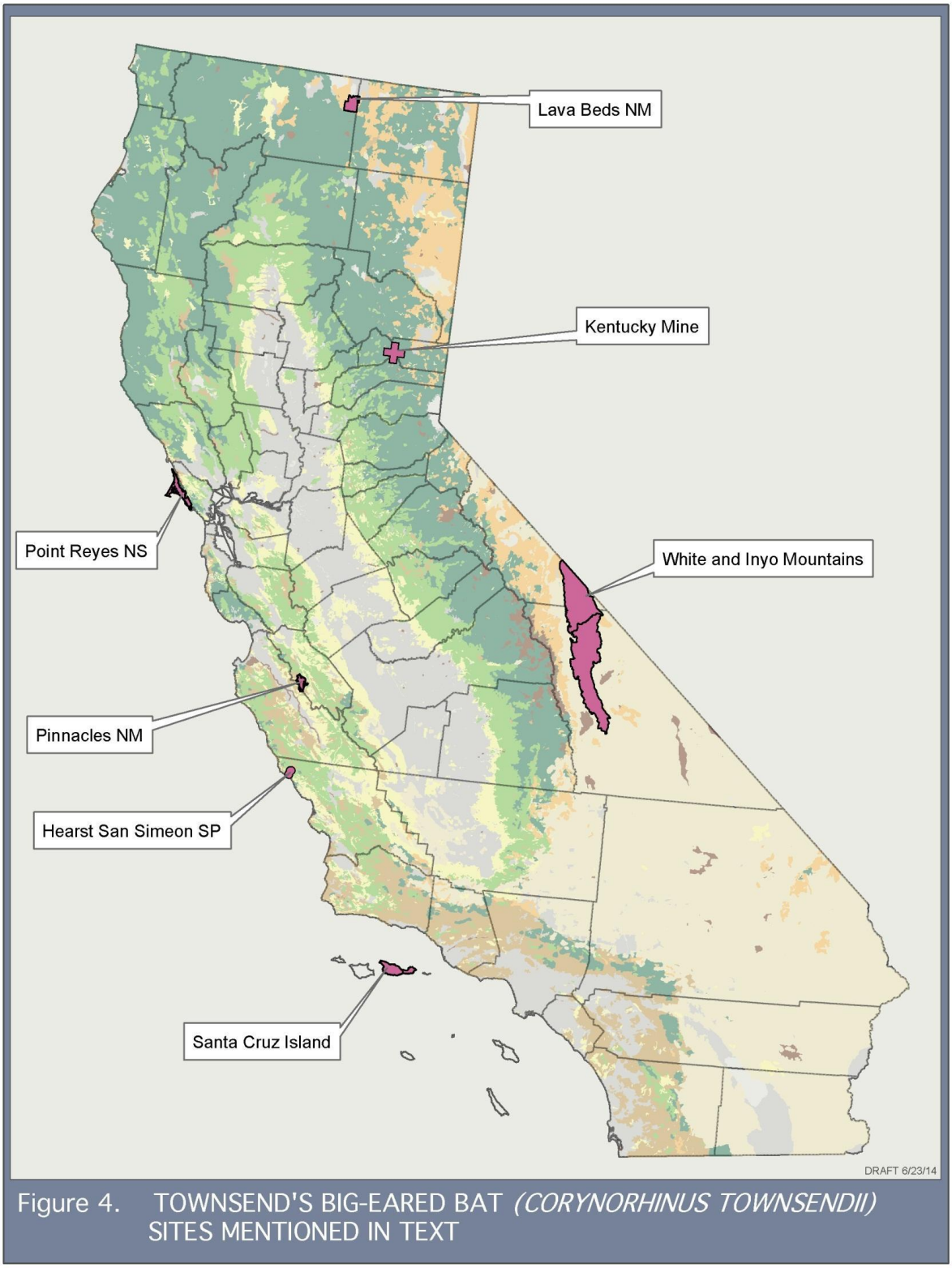


Figure 4. TOWNSEND'S BIG-EARED BAT *(CORYNORHINUS TOWNSENDII)* SITES MENTIONED IN TEXT

Figure 5.

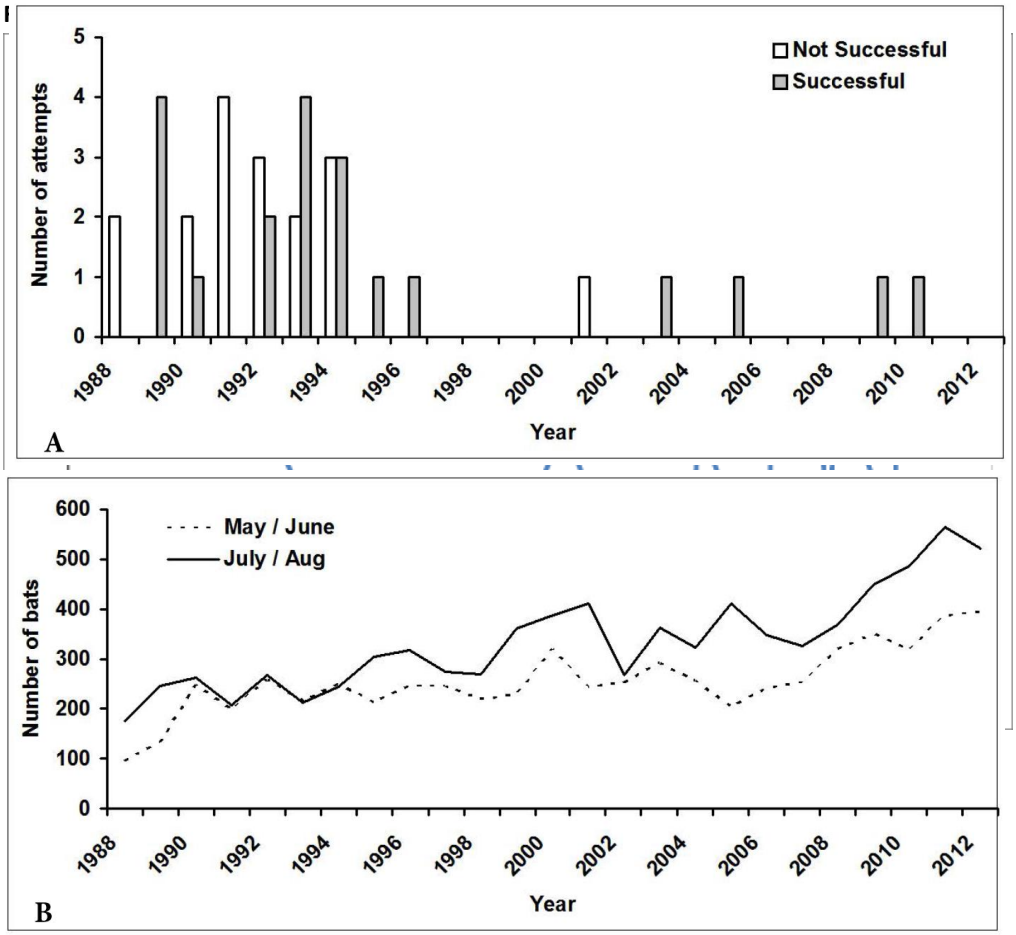
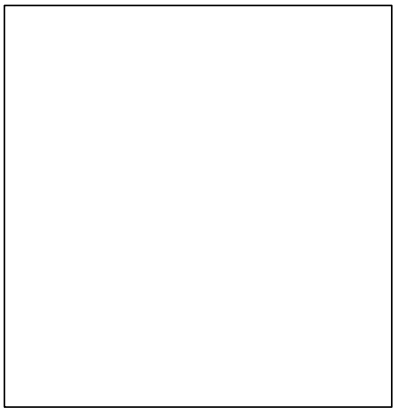
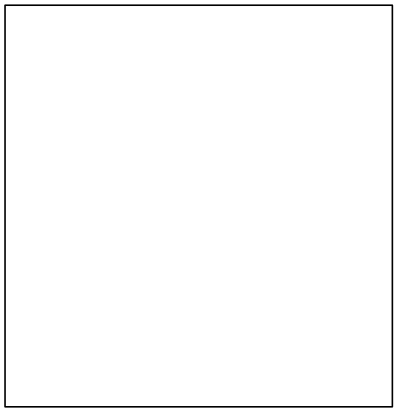

Not Successful
Successful
Number of attempts
Year
A
May / June
July / Aug
Number of bats
Year
B

Figure 6. (B, C)

Figure 7.





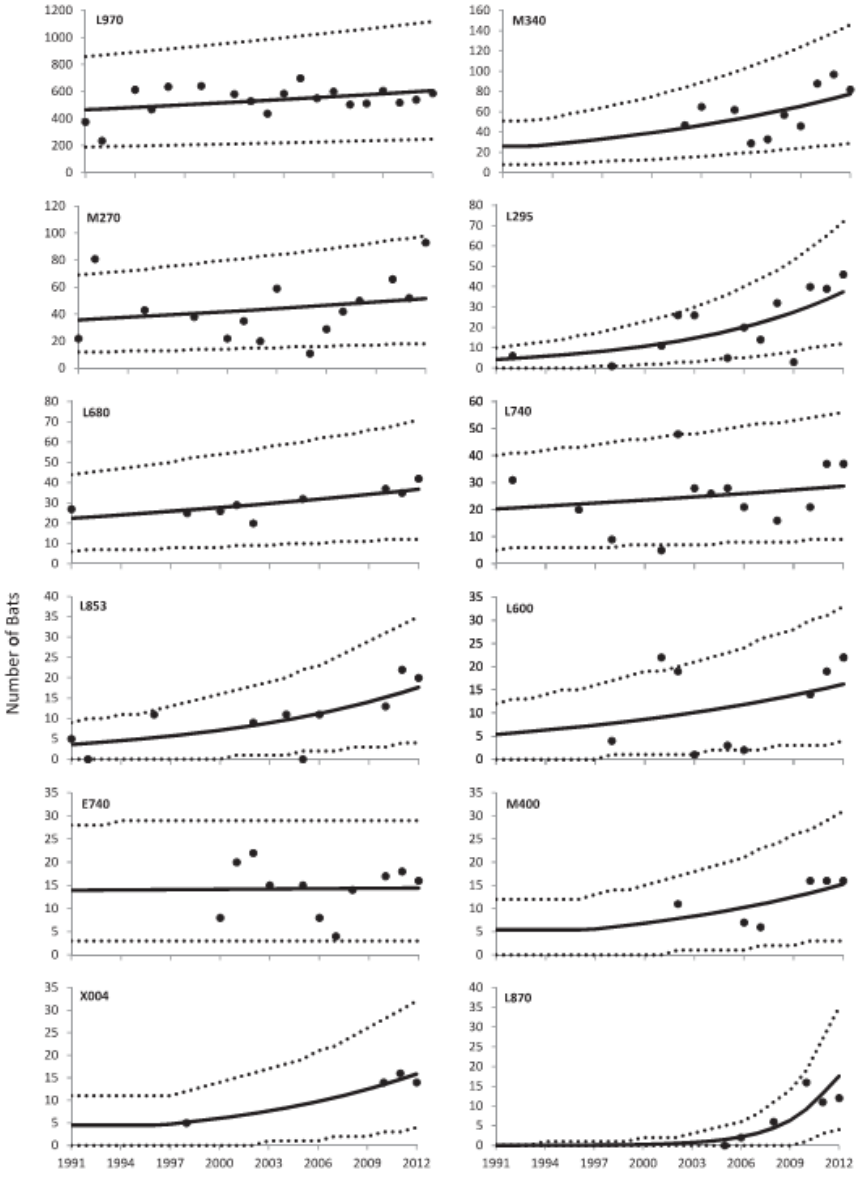

L970
M340
M270
L295
L680
L740
L853
L600
E740
M400
X004
L870
Number of Bats
1991
1994
1997
2000
2003
2006
2009
2012

Figure 7 (continued).

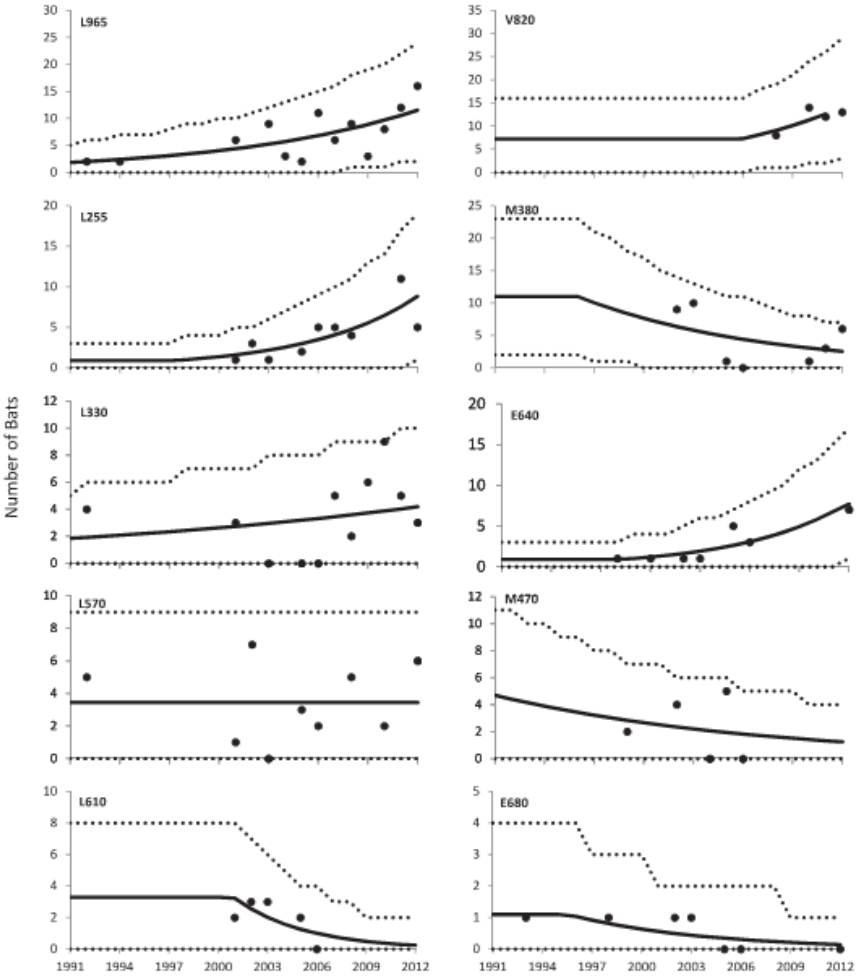
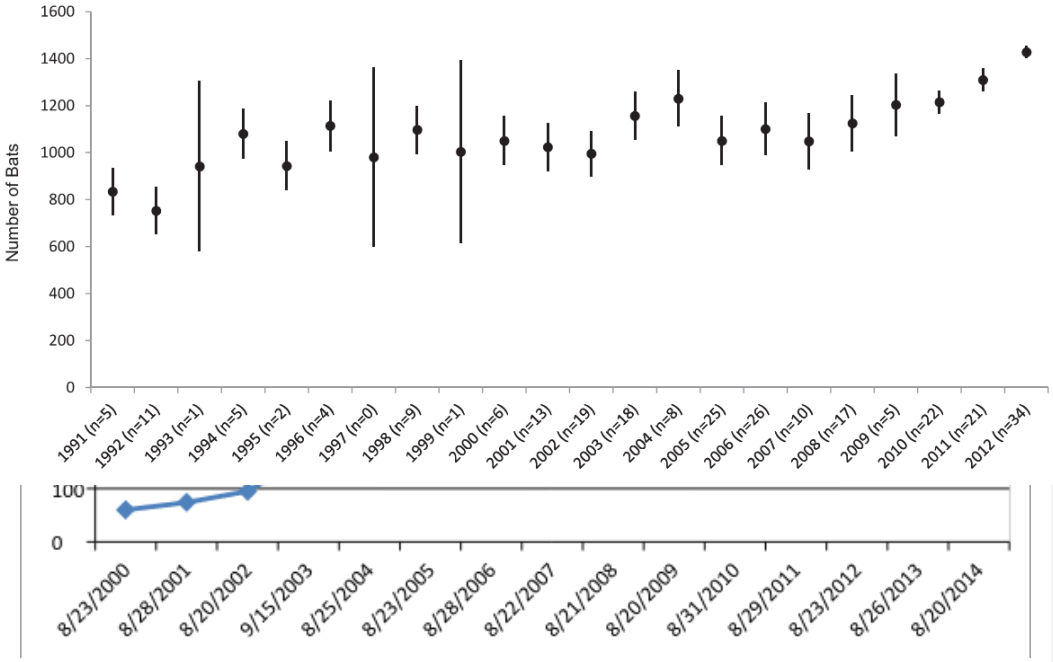


Figure 8.

Figure 9.


Number of Bats
1600
1400
1200
1000
800
600
400
200
0
1991 (n=5)
1992 (n=11)
1993 (n=1)
1994 (n=5)
1995 (n=2)
1996 (n=4)
1997 (n=0)
1998 (n=9)
1999 (n=1)
2000 (n=6)
2001 (n=13)
2002 (n=19)
2003 (n=18)
2004 (n=8)
2005 (n=25)
2006 (n=26)
2007 (n=10)
2008 (n=17)
2009 (n=5)
2010 (n=22)
2011 (n=21)
2012 (n=34)
100
0
8/23/2000
8/28/2001
8/20/2002
9/15/2003
8/25/2004
8/23/2005
8/28/2006
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8/29/2011
8/23/2012
8/26/2013
8/20/2014

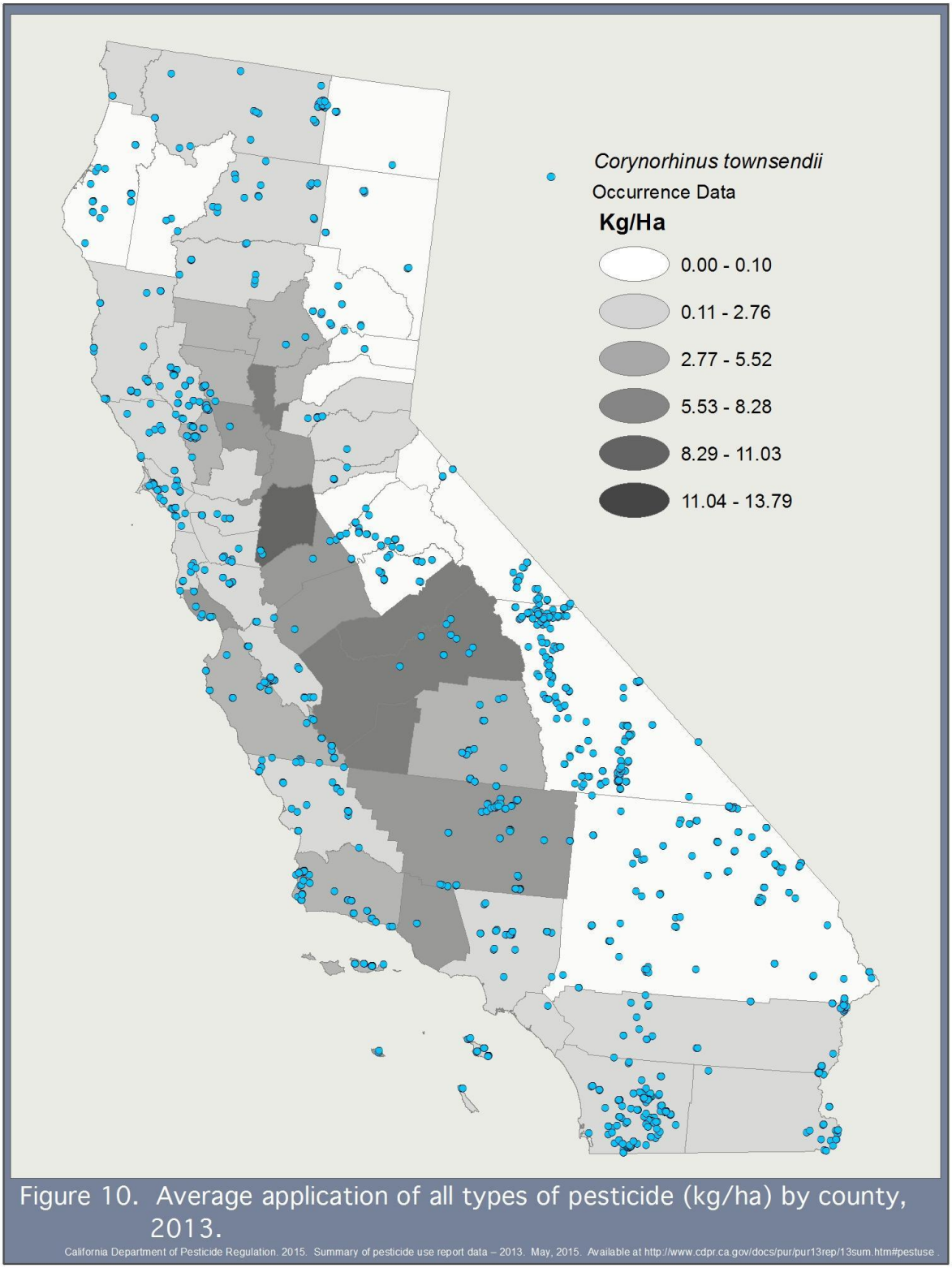
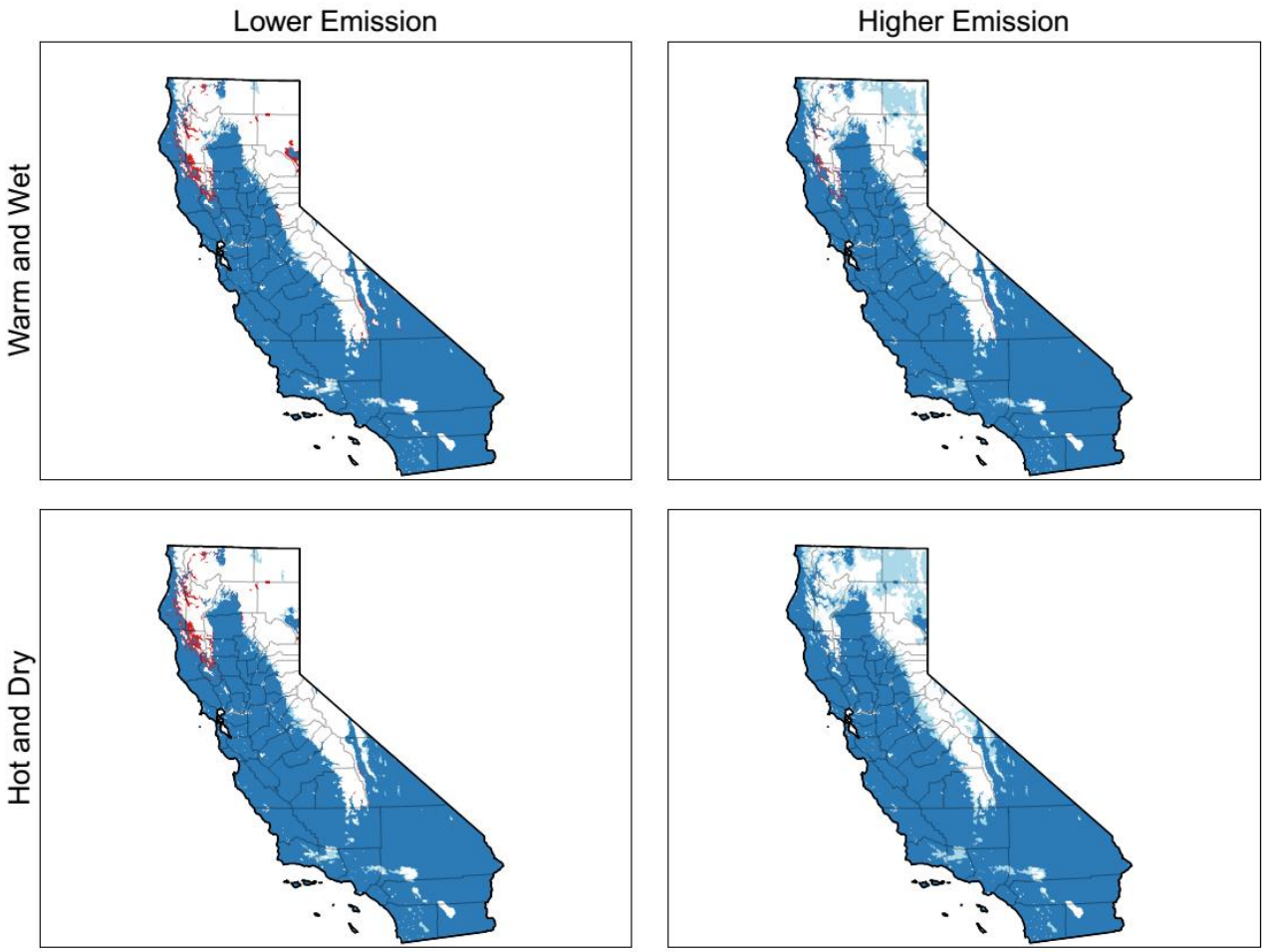


Figure 10. Average application of all types of pesticide (kg/ha) by county, 2013.

California Department of Pesticide Regulation. 2015. Summary of pesticide use report data – 2013. May, 2015. Available at http://www.cdpr.ca.gov/docs/pur/pur13rep/13sum.htm#pestuse .

Figure 11.




EDMUND G. BROWN, JR., GOVERNOR, STATE OF CALIFORNIA
JOHN LAIRD, SECRETARY, NATURAL RESOURCES AGENCY
DAVID BUNN, DIRECTOR, DEPARTMENT OF CONSERVATION
OFFICE OF MINE RECLAMATION, ABANDONED MINE LANDS PROGRAM
CALIFORNIA ABANDONED MINES
POTENTIAL, INVENTORIED AND REMEDIATED MINE FEATURE LOCATIONS
Physical Hazard Remediations*
*Remediations are AMLP data only. Other agency closures exist, but are not shown on this map
USGS Mapped Mine Features*
*Based on USGS 7.5 minute topographical map mine symbols
AML Program Inventoried Features
Map produced by the Department of Conservation Abandoned Mine Lands Program (AMLP), July 2015

Townsend's big-eared bat CESA Status Review – Tables

Captions

1. From Weller et al. (2014, Table 1). Number of caves searched and total number of Townsend's big-eared bats ( ) counted between November 15 and March 15 at Lava Beds National Monument, Siskiyou County, California, during the years 1991-2012. Cave L970 contained, by far, the largest number of hibernating bats in the monument.

2. Pinnacles National Park COTO maternity and hibernation roost count summary (NPS unpublished data). Visual counts made during one or more visits during the maternity and hibernation seasons. Where clusters of bats were observed, the number of bats were estimated from the area occupied, assuming between 100 and 150 COTO individuals per square-foot of ceiling area. In years when more than one survey was made in a season, the highest count is reported here. To avoid excessive disturbance to roosting bats in some years, presence only of the maternity colony was noted, or a minimum number of bats was estimated.

3. Summary of Townsend's big-eared bat monitoring studies referenced in the report.

Table 1.

Year	No. of Caves Surveyed	Cave L970 Count	Total Count
1991	5	376	438
1992	11	236	384
1993	1	—	1
1994	5	614	643
1995	2	469	512
1996	4	637	672
1997	0	—	—
1998	9	643	727
1999	1	—	2
2000	6	582	640
2001	13	530	665
2002	19	437	702
2003	18	586	811
2004	8	699	739
2005	25	551	733
2006	26	601	756
2007	10	505	620
2008	17	513	723
2009	5	607	665
2010	22	519	1,026
2011	21	541	1,117
2012	34	588	1,346

Table 2.

Year	Total Maternity*	Total Hibernacula
1997	150-200 (including pups)	60
1998	300-400 (including pups)	114
1999	320 (including pups)	254
2000	200-300	252
2001	300-600 (including pups)	282+
2002	Present	50++
2003	150+	364
2004	300-450	378
2005	100+	409
2006	600-1000 (4 clusters)	384
2007	Unknown/Not surveyed at peak of maternity season	261
2008	200-300	396
2009	125-160+	75
2010	240-290+	44
2011	Present	15
2012	225-235++	51
2013	Present	40
2014	~250+	43
2015	440-615	

Table 3.

Hibernation	
Lava Beds National Monument	Statistically significant population increase over 22 years
White-Inyo Mountains	No statistical inference possible; many repeat visits had lower counts than initial visits 10-plus years earlier
Pinnacles National Park	No inference possible based on uneven monitoring effort
Maternity	
Randall House	Statistically significant population increase over 25 years
Kentucky Mine	Statistical tests not conducted, but colony appears to be stable
Lava Beds National Monument	No inference possible
Pinnacles National Park	Statistical tests not conducted, but colony appears to be stable or increasing
Hearst Castle	Statistical tests not conducted, but colony appears to be stable or increasing
Santa Cruz Island	No statistical tests conducted, but colony has decreased from historical size

APPENDICES [to be completed for the final following external review]

1. **Public Comment Summary**
2. **List of Peer Reviewers and Invitation Letters**
3. **Peer Reviewer Comments**

STATE OF CALIFORNIA
NATURAL RESOURCES AGENCY
DEPARTMENT OF FISH AND WILDLIFE

EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE

REPORT TO THE FISH AND GAME COMMISSION

A STATUS REVIEW OF
TOWNSEND'S BIG-EARED BAT (*CORYNORHINUS TOWNSENDII*)
IN CALIFORNIA

CHARLTON H. BONHAM, DIRECTOR
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

Draft Date: January 7, 2016

Report to the Fish and Game Commission

A Status Review of Townsend's Big-Eared Bat in California

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FIGURES, TABLES, and APPENDICES follow text.

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Executive Summary

[To be completed following external review]

INTRODUCTION

Petition Evaluation Process

On November 1, 2012, the California Fish and Game Commission (Commission) received the "Petition to List the Townsends big-eared bat *(Corynorhinus townsendii*) as endangered under the California Endangered Species Act" (dated October 18, 2012; hereafter, the Petition), as submitted by the Center for Biological Diversity. Commission staff transmitted the Petition to the Department of Fish and Wildlife (CDFW) pursuant to Fish and Game Code (Fish & G. Code) section 2073 on November 9, 2012, and the Commission published formal notice of receipt of the Petition on November 30, 2012 (Cal. Reg. Notice Register 2012, No. 48-Z, p. 1747). After evaluating the Petition and other relevant information CDFW possessed or received, CDFW provided the Commission with the a report "Evaluation of the Petition from the Center for Biological Diversity to List Townsend's Big-Eared Bat (*Corynorhinus townsendii*) as Threatened or Endangered Under the California Endangered Species Act" (Evaluation). CDFW determined, pursuant to Fish & G. Code § 2073.5, subdivision (a), that sufficient scientific information exists to indicate that the petitioned action may be warranted and recommended the Commission accept the Petition (CDFG 2013). At its scheduled public meeting on June 26, 2013 in Sacramento, California, the Commission considered the Petition, CDFW's Evaluation and recommendation, and comments received. The Commission found that sufficient information existed to indicate the petitioned action may be warranted and accepted the Petition for Consideration. Upon publication of the Commission's notice of its findings, Townsend's big-eared bat was designated a candidate species on November 14, 2013 (Cal. Reg. Notice Register 2013, No. 52-Z, p. 2092).

Department Status Review

Following the Commission's action designating the Townsend big-eared bat as a candidate species, and pursuant to Fish & G. Code section 2074.4, CDFW solicited information from agencies, educational institutions, tribes, and the public to inform the review of the species' status using the best scientific information available. This report contains the results of CDFW's status review, including independent peer review of the draft report by scientists with expertise relevant to the Townsend big-eared bat. At its scheduled public meeting on December 3, 2014 in Van Nuys, California, the Commission granted CDFW a six-month extension to facilitate external peer review. The purpose of this status review is to fulfill the mandate as required by Fish & G. Code section 2074.6 and to provide the Commission with the most current, scientifically-based information available on the status of Townsend big-eared bat in California and to serve as the basis for CDFW's recommendation to the Commission.

BIOLOGY AND ECOLOGY[1]

Species Description

Townsend's big-eared bat is a medium sized (10-12 g) bat with an adult forearm length of 39-48 mm and ear length of 30-39 mm. Townsend's big-eared bat generally has buffy brown dorsal fur with somewhat paler underparts (Barbour and Davis 1969, Kunz and Martin 1982). Among western North American bats, Townsend's big-eared bat is unique with its combination of a two-pronged, horseshoe-shaped lump on the muzzle and large, long ears. Although other California bats have long ears, no other has both large ears and the two-pronged nose lump. The other large-eared bat species have other characteristics that readily distinguish them from Townsend's big-eared bat.

Townsend's big-eared bat has relatively broad and short wings, which provides a low body mass-to-wing area ratio (wing load) (Norberg and Rayner 1987). Low wing loading confers high maneuverability and good economy of power, and take-off at low speeds. It may also allow the species to take advantage of pulses in prey availability by ingesting a large mass of insects when they are available (Norberg and Rayner 1987).

Systematics

Townsend's big-eared bat (Class Mammalia, Order Chiroptera) is in the Microchiropteran family Vespertilionidae, which contains the most species of the four bat families in the United States. There are two other species of *Corynorhinus*: *Corynorhinus rafinesquii,* Rafinesque's big-eared bat, and *Corynorhinus mexicanus,* the Mexican big-eared bat. The North American genus of big-eared bats now known as *Corynorhinus* was for several decades known as *Plecotus*, and much of the older scientific literature used that name.

There are five currently recognized subspecies of Townsend's big-eared bat in the United States (Handley 1959, Piaggio and Perkins 2005)(see Figure 1). Two of the subspecies (*C. t. townsendii* and *C. t. pallescens*) occur throughout much of western North America (including California), two (the Ozark big-eared bat, *C. t. ingens,* and the Virginia big-eared bat, *C. t. virginianus*) occur in the eastern United States, and one (*C. t. australis*) is distributed primarily in Mexico but also extends into Texas. Both of the eastern subspecies of Townsend's big-eared bat (the Ozark and Virginia big-eared bats) are listed by the U.S. Fish and Wildlife Service as Endangered.

This classification scheme follows the presumed evolutionary history of Townsend's big-eared bat and related bats species. Tumlison and Douglas (1992) used cladistics analysis of shared acquired

[1] Much of the information presented here on the biology of Townsend's big-eared bat has been adapted from the draft species account prepared by E.D Pierson, W.E. Rainey, and L. Angerer for the California Bat Conservation Plan (CDFW in prep.). Personal communications and personal observations cited without a year reference are from the draft species account. All other personal communications were between the referenced person and Scott Osborn, CDFW Senior Environmental Scientist with the Wildlife Branch, Nongame Wildlife Program.

characteristics to determine that the New World *Corynorhinus* species comprise a distinct lineage from both the Old World *Plecotus* species (which they had formerly been grouped with under the genus name *Plecotus*) and two other big-eared bat genera (*Idionycteris* and *Euderma*).

Piaggio and Perkins (2005) examined the evolutionary relationships within the *Corynorhinus* genus using both mitochondrial and nuclear DNA. Their results confirmed the status of the five Townsend's big-eared bat subspecies, suggested that Townsend's big-eared bat and *Corynorhinus mexicanus* are more closely related to each other than to *Corynorhinus rafinesquii*, and that levels of genetic divergence among the Townsend's big-eared subspecies are relatively high (Piaggio and Perkins 2005).

Within Townsend's big-eared bat itself, DNA analysis has shown the western-most subspecies, *C. townsendii townsendii*, may have diverged from the other Townsend's big-eared bat subspecies between 41,000 and 64,000 years ago, while *C. townsendii pallescens* diverged 12,000 to 23,000 years ago, and *C. townsendii australis* diverged between 6,000 and 20,000 years ago (Smith et al. 2008). The timings of divergence and geographic pattern of the subspecies' ranges today suggested to the authors that the subspecies developed during periods of extensive glaciation in western North America when Townsend's big-eared bat populations were isolated from each other. Other mitochondrial DNA evidence suggests an earlier divergence of the five Townsend's big-eared bat subspecies (possibly as earlier as 1 million years ago), with subsequent effects on distribution during the Pleistocene (Lack and Van Den Bussche 2009).

Geographic Range and Distribution

Townsend's big-eared bat ranges throughout much of the western United States and Canada (Figure 1). In California, its geographic range is generally considered to encompass the entire state, except for the highest elevations of the Sierra Nevada (Figure 2). Within the general range, there are areas of greater and lesser probability of occupancy by Townsend's big-eared bat. Populations are concentrated in areas offering caves (commonly limestone or basaltic lava) or mines as roosting habitat.

Conversely, a general lack of Townsend's big-eared bat records in the Central Valley and Imperial Valley (Figure 2), along with a paucity of suitable roost structures, suggests these areas are unlikely to harbor populations of resident Townsend's big-eared bat.

The species is found from sea level along the coast to 1,820 m (6,000 ft) in the Sierra Nevada (Dalquest 1947, Pearson et al. 1952, Pierson and Rainey 1998). In the White Mountains, summer records for males extend up to 2,410 m (7,900 ft), and hibernating groups have been found in mines as high as 3,188 m (10,460 ft) (Szewczak et al. 1998). Maternity colonies are more frequently found below 2,000 m (6,560 ft) (Pierson and Fellers 1998, Szewczak et al. 1998). Outside California, Townsend's big-eared bat has been found to 2,400 m (7,900 ft) (Jones 1965, Jones and Suttkus 1971) and 2,900 m (9,500 ft) (Findley and Negus 1953).

As for the two Townsend's big-eared bat subspecies that occur in California, *C. t. townsendii* occurs primarily in the western-most portion of the species' range in California, Oregon, Washington, Nevada, Idaho, and possibly southwestern Montana and northwestern Utah. *C. t. pallescens* occurs in all the

same states as *C. t. townsendii*, plus in more interior portions of the continent in Arizona, Colorado, New Mexico, Texas, and Wyoming (Handley 1959, Piaggio and Perkins 2005). Throughout much of their range in California, Idaho, Nevada, Oregon and Washington there are extensive zones of intergradation for the two subspecies and it is often not possible to assign individuals to one subspecies or the other.

Population Genetics

Genetic studies can inform our understanding of animal populations, including the amount of mixing between subpopulations and level of genetic variability among and between individuals or subpopulations. Smith (2001) demonstrated the Townsend's big-eared bat populations in Oklahoma show high movement (high gene flow) of males across her study area (nuclear microsatellite DNA results) but low movement of females (mitochondrial DNA results). This suggests high site fidelity of females to their natal roosts relative to males. The female subpopulations were highly differentiated from each other, but also highly variable within the subpopulations.

Miller's (2007) study of Townsend's big-eared bat population genetics in southeastern Idaho used nuclear DNA to show most individuals within hibernacula were not closely related to each other, contrary to an earlier suggestion by Pearson (1959) that Townsend's big-eared bats within a hibernaculum should be closely related, since Townsend's big-eared bat mate at their hibernacula and have high fidelity to these sites. Miller (2007) suggested that "juveniles may disperse from natal colonies before settling and becoming philopatric to a single [hibernation] site, which could create these communities of unrelated individuals." Alternatively, it is possible that Townsend's big-eared bats in her study area are either not loyal to a single hibernaculum or do not mate at the hibernacula in which they over winter. She also found that adult females in maternity colonies are more closely related to each other than are juveniles, which is consistent with males dispersing longer distances than females.

The study by Piaggio and others (2009) of populations structure, genetic diversity, and dispersal among three subspecies of Townsend's big-eared bat in the Rocky Mountains region (*townsendii*, *pallescens*), and in the southeastern U.S. (the endangered *virginianus* subspecies) used both nuclear and mitochondrial DNA analyses. Their study indicated significantly lower genetic diversity in *virginianus*, compared to the other two subspecies, which is expected due to the lower overall population size of *virginianus*. Their study also indicated relatively low levels of gene flow among populations of the *townsendii* and *pallescens* subspecies, which tend to be isolated. On the other hand, some gene flow can occur at distances of 310 km between roosts, which (with other recent data) suggests that Townsend's big-eared bat may move greater distances than typically thought. These genetic results are consistent with the observation that a simple geographic demarcation between the *pallescens* and *townsendii* subspecies is not sufficient to differentiate between individuals of the two subspecies.

Reproduction and Development

Townsend's big-eared bat is a colonial species. Maternity colonies form between March and June, with the timing varying based on local climate, elevation, and latitude. Colony size ranges from a few dozen to several hundred individuals. Mating generally takes place in both migratory sites and hibernacula between September or October and February. "Swarming" – a behavior at non-maternity roost sites

where both sexes mix in autumn prior to moving to hibernacula – has been observed during the latter half of September in the Mojave Desert. Females are generally reproductive in their first year, whereas males do not reach sexual maturity until their second year. Gestation length varies with climatic conditions, but generally lasts from 56 to 100 days (Pearson et al. 1952). Some evidence indicates maternity colonies may have up to three different roost sites for given stages of reproduction – one each for pregnancy, birthing, and rearing (Sherwin et al. 2000).

Comment [JMS1]: This may improperly assert causality for movement to reproductive stages. Movements of these and other bats may occur in response to other variables, .e.g., seasonal prey availability and roost conditions. That is, does the Sherwin pub provide evidence that these movements occur specifically for these reproductive stages, or does it just present this observation?

A single pup is born between May and July (Easterla 1973, Pearson et al. 1952, Twente 1955). Townsend's big-eared bat pups average 2.4 g at birth, nearly 25% of the mother's postpartum mass (Kunz and Martin 1982). While adult males are typically solitary during the maternity season, adult females and their pups cluster together in colonial roosts (Pearson et al. 1952). Aggregations in maternity roosts have typical densities of between 100 and 150 adults and young per square foot of roost surface area occupied. Such clustering minimizes heat loss and allows more energy to be used for gestation, milk production (adults) and growth (pups). Young bats are capable of flight at 2.5 to 3 weeks of age and are likely gradually weaned by 2 months (Pearson et al. 1952). Nursery colonies start to disperse in August about the time the young are weaned and break up altogether in September and October (Pearson et al. 1952, Tipton 1983).

Vital Rates (Reproduction, Survival)

Maximum fecundity per adult female is one pup per year. Pearson et al. (1952) estimated an average fecundity for the colonies in their study to be about 0.45 female pups per adult female per year. Examining exit count data from an undisturbed colony where counts were made both before and after young Townsend's big-eared bat became volant, it appears that the number of bats may increase by a factor of 1.5 to 2 (unpublished CDFW analysis of Kentucky Mine counts in 2005 and 2006). Assuming a 50:50 sex ratio of young, this would be equivalent to recruitment rates of 0.25 to 0.5 female young per adult female.

Pearson et al. (1952) estimated annual survival at about 50% for the first year of life and about 80% for adults. The authors determined these survival rates, combined with their estimates of fecundity, were "just sufficient" to maintain a stable population during the years these colonies were studied (Pearson et al. 1952). Ellison (2010) estimated winter survival in a Washington Townsend's big-eared bat population to range between 54% and 76%, with higher survival for females than for males. Band recoveries have yielded individual longevity records of 16 years, 5 months (Paradiso and Greenhall 1967) and 21 years, 2 months (Perkins 1994).

Behavior

Townsend's big-eared bat's susceptibility to disturbance at roost sites is usually cited as a key behavioral characteristic putting the species at conservation risk (Twente 1955, Barbour and Davis 1969, Humphrey 1969, Humphrey and Kunz 1976). As summarized by Pierson et al. (1991):

> Townsend's big-eared bats are so sensitive to human disturbance that simple entry into a nursery roost can be enough to induce the colony to abandon a site (Mohr 1972, Humphry and Kunz 1976). Activities as apparently harmless as recreational caving have

been shown to have negative impacts and have driven Townsend's big-eared bat from a number of their traditional roost sites in California (Graham 1966, Pierson, unpubl. data).

Pearson (1952) documented temporary abandonment of maternity roosts in California as a direct result of his research team entering the roost site to band young. Fellers and Halstead (2015) showed a strong negative relationship between attempted unlawful entries into the Randall House Townsend's big-eared bat maternity roost (coastal Marin County) and overall colony reproductive success on an annual basis.

Contrary to the general pattern of susceptibility to disturbance, one Townsend's big-eared bat maternity colony in California has demonstrated some tolerance to disturbance (Freeman 2012). The Kentucky Mine colony in Sierra County has persisted despite daily tours in the historic stamp mill building where the bats typically roost, though some impacts to the colony and changes in behavior (including temporary roost abandonment) have occurred there over the years (M. Tierney pers. comm. 2015). It should be noted the Kentucky Mine roost site is managed under guidance that emphasizes quiet, predictable disturbance events (tours) and minimizes other, novel types of disturbance. Clark et al. (1997) also noted one of the eastern Townsend's big-eared bat subspecies, the Ozark big-eared bat (*C. townsendii virginianus*) did not abandon roosts or caves despite some human entry and surmised the *virginianus* subspecies may tolerate more human activity than the western subspecies.

Once a roost site has been successfully colonized by Townsend's big-eared bat (whether for the active or hibernation season), it is likely to be used in subsequent years, so long as it remains suitable (Humphrey and Kunz 1976). However, it is not unusual for maternity colonies to switch roosts during the course of the season (Fellers and Pierson 2002, Sherwin et al. 2000, 2003). Disturbance events, as noted above, may trigger a temporary abandonment of the preferred roost. In some cases, different roosts may be used to provide more optimal conditions during different phases of the maternity season (early and late pregnancy, early and late pup-rearing).

Comment [js2]: This an element of COTO biology requiring investigation. We have anecdotal reports of movements purportedly from humans because, well humans were there to see it and report it. We have little understanding of how much they may tend to move around naturally.

Night roosts are used opportunistically during breaks from foraging. Such roosts probably allow the bats to rest and digest meals while minimizing predation risk, and to remain at the foraging area between foraging bouts if the foraging area requires a commuting flight from the day roost. Townsend's big-eared bat appears not to show particularly high fidelity to night roosts (Fellers and Pierson 2002). During early-evening foraging bouts of six light-tagged Townsend's big-eared bat in Oklahoma, Caire et al. (1984) documented their study animals rested between bouts of foraging about 17% of the time under observation. It is likely the overall resting time between foraging bouts in a given night is greater.

Comment [js3]: This may also just indicste how much they mix and change their foraging areas.

Diet

Diet has not been examined in detail for any California population of Townsend's big-eared bat. It is likely that Townsend's big-eared bat here, as elsewhere, is a Lepidopteran specialist, feeding primarily on medium-sized moths, but with occasional captures of other insects, including flies, beetles, and aquatic insects (Ross 1967, Whitaker et al. 1977, 1981, Dalton et al. 1986, Sample and Whitmore 1993, Furford and Lacki 1998, Dodd and Lacki 2007).

Comment [js4]: Their echolocation behavior strongly supports selection as a Lepidopteran specialist, and in particular against tympanic moths.

Vocalizations

Townsend's big-eared bat produces ultrasonic calls that are used for navigating in the dark, and for locating and capturing prey, as well as for social communication. While cruising or searching for prey, a semi-regular pattern of calls is emitted at 10 to 20 calls per second (Kunz and Martin 1982). Search- and cruising calls are usually simple downward sweeps in frequency, typically starting at about 40 to 45 kHz and ending at about 19 to 23 kHz, with the maximum power (volume) produced at about 21 to 26 KHz (J.M. Szewczak, unpublished data 2011). Calls may include sounds produced at the harmonic frequencies at two- and three times the fundamental call frequencies – sometimes with more power applied to a harmonic than to the fundamental call. Townsend's big-eared bat is commonly known as a "whispering" bat, because of the relatively low power of its calls – typically about 40 to 50 dB quieter than those of *Myotis lucifugus* (Kunz and Martin 1982). The relatively low volume of its echolocation calls makes Townsend's big-eared bat difficult to detect with acoustic equipment.

Comment [JMS5]: Szewczak, J.M., Corcoran, A.J., Kennedy, J.K., Ormsbee, P.C. & Weller, T.E. (2011) Echolocation Call Characteristics of Western US Bats. Humboldt State University Bat Lab, Arcata, California. http://www.sonobat.com/download/WesternUS_Acoustic_Table_Mar2011.pdf

Predation

Pearson et al. (1952) discounted predation as a factor limiting Townsend's big-eared bat populations, but individuals may be preyed upon by a variety of native and non-native predators, as has been documented for other bats. Hensley et al. (1995) listed several potential predators of Townsend's big-eared bat in the recovery plan for the endangered Ozark big-eared bat (*C. townsendii virginianus*), including raccoons (*Procyon lotor*), bobcats (*Lynx rufus*), house cats (*Felis catus*), skunks (*Mephitis*, *Spilogale*), and snakes. These and other generalist predators, such as ringtails (*Bassariscus astutus*) likely take Townsend's big-eared bat opportunistically in California.

Fellers and Halstead (2015) stated several owl species known to prey on bats may have influenced Townsend's big-eared bat emergence times at the Randall House maternity roost. These include great horned owls (*Bubo virginianus*), barn owls (*Tyto alba*), and spotted owls (*Strix occidentalis*). Townsend's big-eared bat's tendency to avoid foraging in open grassland and other areas of low vegetation cover has been hypothesized to be a mechanism for avoiding aerial predators such as owls (Pierson and Fellers 1999); however, this behavior may also be driven by the distribution of the bat's prey.

Fellers (2000) also reported that non-native black rats (*Rattus rattus*) preyed upon young Townsend's big-eared bats at the Randall House roost before measures were taken to prevent rat entry into the structure.

Movements

Migration. Townsend's big-eared bat is considered a relatively sedentary species, for which no long-distance migrations have been reported (Barbour and Davis 1969, Humphrey and Kunz 1976, Pearson et al. 1952). The longest movement known for this species in California is 32.2 km (20 mi) (Pearson et al. 1952). There is some evidence of local migration, perhaps along an elevation gradient.

Townsend's big-eared bats in Oregon appear to move from their hibernacula to active season (maternity) roosts over a period of several nights, using interim roosts before settling into the maternity

Comment [js6]: Now 40 km, Morrison and Szewczak, in progress. Summary of data to this time:

Marking began in 2013 and continues to date. We have now marked >500 COTO that are associated with >15 maternity colonies and >100 hibernacula. To date, we have relocated 48 bats one time, 18 two times, and 6 three or more times. Preliminary results show that individuals in a maternity colony select multiple hibernacula, and members of different maternity colonies winter together. Distance moved between maternity and hibernacula range from 0 to 40 km, with an average movement of about 10 km. Site fidelity has been shown during both winter and summer.

0f 576 tagged since 2013, 108 have been relocated at least once.

Distance from maternity to hibernacula

0-5 km	22%
6-10	33%
11-15	19%
16-20	11%
>20 km	15%

Max = 37 km (ad female Townview maternity to Tip Top hibernaculum)

Dispersal: Female born at Poleta, hibernated at Tip Top, and then bred at Deep Springs. There were other females from the Deep Springs maternity hibernating at Tip Top. There was another adult female from Poleta hibernating at Tip Top but she returned to Poleta to breed.

roost (Dobkin et al. 1995). This study recorded a maximum distance between hibernation site and foraging areas of 24 km (15 mi).

Comment [js7]: 40 km

Feeding. Despite its reputation as a sedentary species, Townsend's big-eared bat may cover a lot of ground while foraging each night. As described in one species account for Townsend's big-eared bat (WBWG 2005), "these bats often travel large distances while foraging, including movements of over 150 kilometers during a single evening (R. Sherwin pers. comm.). Evidence of large foraging distances and large home ranges has also been documented in California (E.D. Pierson pers. comm.)."

Thermoregulation and Hibernation

Townsend's big-eared bat, like most mammals, maintains a high body temperature primarily through heat produced by its metabolism. High metabolic rate and elevated (and typically constant) body temperature allow mammals to maintain high aerobic activity levels, which in turn has allowed them to occupy ecological niches only available to highly energetic animals. Like many bat species inhabiting temperate regions, Townsend's big-eared bat uses torpor[2] as a physiological and behavioral strategy in winter to deal with diminished food resources and cool or cold ambient temperatures, which make it energetically costly to maintain normal high body temperature. By allowing body temperature to cool to near ambient, bats in torpor reduce their energy expenditure to a small fraction of what would be used to keep body temperature elevated (Szewczak and Jackson 1992). Despite the energy savings conferred by torpor, hibernating bats may lose more than 50% of their body mass during the hibernation season (Humphrey and Kunz 1976). Townsend's big-eared bat and other bats that use torpor have a suite of physiological adaptations to allow them to remain healthy during torpor and to arouse at the appropriate times (e.g., Szewczak and Jackson 1992, Szewczak 1997).

Comment [js8]: Me-centric, but I know these papers to report metabolic rates during torpor and describe special physiologic adaptions that increase survivability during torpor.

Szewczak, J.M. (1997) Matching gas exchange in the bat from flight to torpor. in: Comparative Aspects of the Control of Arterial Blood Gases: Ventilatory and Cardiovascular Perspectives. American Zoologist. 37:92–100.

Szewczak, J.M. and D.C. Jackson (1992) Apneic Oxygen uptake in the torpid bat, *Eptesicus fuscus*. Journal of Experimental Biology. 173:217–229.

An important behavioral trait of hibernators is the selection of suitable sites for the inactive period. Townsend's big-eared bat hibernation sites are generally caves or mines (Pearson et al. 1952, Barbour and Davis 1969), although animals are occasionally found in buildings (Dalquest 1947). Deep mine adits and shafts, known to provide significant hibernating sites in New Mexico (Altenbach and Milford 1991), may also be important in California. Winter roosting is typically composed of mixed-sexed groups from a single individual to several hundred or several thousand individuals; however, behavior varies with latitude. In areas with prolonged periods of non-freezing temperatures, Townsend's big-eared bat tends to form relatively small hibernating aggregations of single to several dozen individuals (Barbour and

[2] "Torpor" is a general term for reduced metabolic rate and body temperature. For animals adapted to use torpor as described, it can range from "shallow torpor" which occurs when winter temperatures are relatively mild and where the animal may only drop its body temperature a few degrees, to deep hibernation, which occurs in more extreme cold. In hibernation, ambient temperatures may be near or below freezing and the torpid animal will allow its body temperature to equilibrate with the ambient temperature but regulate its temperature just above freezing should ambient temperatures fall below freezing. Bats in hibernation may appear almost completely inanimate with no visible sign of breathing. Arousal from deep torpor may take many minutes to over an hour. Bats in shallow torpor may respond to handling or other stimuli by slowly moving and visibly breathing, and will often arouse in several minutes.

Deleted: may

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Davis 1969, Pierson et al. 1991, Pierson and Rainey 1998). Larger aggregations (75-460) are confined to areas that experience prolonged periods of freezing temperatures (Pierson and Rainey 1998).

Studies in the western U.S. have shown that Townsend's big-eared bat selects winter roosts with stable, cold temperatures, and moderate air flow (Humphrey and Kunz 1976, Kunz and Martin 1982). Individuals roost on walls or ceilings, often near entrances (Humphrey and Kunz 1976, Twente 1955). If undisturbed, individuals will frequently roost less than 3 m (10 ft) off the ground (Perkins et al. 1994), and have been found in air pockets under boulders on cave floors (E. Pierson pers. obs.). Temperature appears to be a limiting factor in roost selection. Recorded temperatures in Townsend's big-eared bat hibernacula range from -2.0°C to 13.0°C (28°F to 55°F) (Humphrey and Kunz 1976, Genter 1986, Pearson et al. 1952, Pierson et al. 1991, Twente 1955), with temperatures below 10°C (50°F) being preferred (Perkins et al. 1994, Pierson and Rainey 1998). Within a hibernaculum, Townsend's big-eared bat most frequently hibernates singly, but pairs and small clusters of torpid individuals are observed. In the White and Inyo mountains, larger groups were observed in sites where air temperature was around 5°C (41°F) while smaller groups occurred at locations with air temperatures that were colder (Szewczak et al. 1998). In the Mojave Desert in the winter, hibernating Townsend's big-eared bat have been found at temperatures of 15.5°C (60°F) as these might be the coolest temperatures available (P. Brown pers. obs.).

The period of hibernation is shorter at lower elevations and latitudes. Coastal populations of Townsend's big-eared bat, which experience particularly mild winters, may use shallow torpor on a daily basis and may be active at any time to take advantage of warm weather and prey availability (Pearson et al. 1952).

Thermoregulation is also an important aspect of the active season for Townsend's big-eared bat, especially for the energetically-demanding processes of pregnancy and lactation. Adult females form maternity colonies in the warmest available suitably-protected roost sites. Such warm locations minimize the energy lost as heat during pregnancy and help newborn and young pups conserve energy for growth. Clustering behavior of females and their young further enhances energy conservation and cluster size has been observed to increase and decrease based on the ambient temperature of the roost site (Betts 2010).

Habitat Utilization

Habitat associations for Townsend's big-eared bat in California include the inland deserts, cool, moist coastal redwood forests, oak woodlands of the inner Coast Ranges and Sierra Nevada foothills, and lower to mid-elevation mixed coniferous-deciduous forests. Townsend's big-eared bat has also been observed hibernating in the bristlecone-limber pine habitat (Szewczak et al. 1998) of the White Mountains (Inyo County). Distribution is patchy within these types and is strongly correlated with the availability of caves and cave-like roosting habitat, with population centers occurring in areas dominated by exposed, cavity forming rock and/or historic mining districts (Genter 1986, Graham 1966, Humphrey and Kunz 1976, Kunz and Martin 1982, Perkins et al. 1994, Pierson and Rainey 1998). The species' habit of roosting on open surfaces within roost sites makes it readily detectable and it is often the species

most frequently observed (but often in low numbers) in caves and abandoned mines throughout its range.

Roosting Habitat. Townsend's big-eared bat prefers open surfaces of caves or cave-like structures, such as mine adits and shafts (Barbour and Davis 1969, Graham 1966, Humphrey and Kunz 1976). It has also has been reported in such structures as buildings, bridges, and water diversion tunnels that offer a cavernous environment (Barbour and Davis 1969, Dalquest 1947, Howell 1920, Kunz and Martin 1982, Pearson et al. 1952, Perkins and Levesque 1987, Brown et al. 1994, Pierson and Rainey 1998). It has been found in rock crevices and, like a number of bat species (Gellman and Zielinksi 1996), in large hollow trees (Fellers and Pierson 2002, Mazurek 2004). Roosting structures often contain multiple openings. The species seems to prefer dome-like areas, possibly where heat or cold is trapped (warm pockets for maternal roosting, cold pockets for hibernation).

Specific roosts may be used at only one time of year or may serve different functions throughout the year, such as for maternity roosts, hibernation, or other uses (Sherwin et al. 2000, 2003). Roosting surfaces often occur in locations with partial light during the day; however, some roost surfaces have been found very deep inside caves or mines. Of 54 maternity roost sites tabulated by Pierson and Fellers (1998), 43% were in caves, 39% were in mines, and 18% were in buildings.

Townsend's big-eared bat appears to have fairly restrictive roost requirements (Humphrey and Kunz 1976, Perkins et al. 1994, Pierson et al. 1991). Roost temperature appears to be critical (Lacki et al. 1994, Pearson et al. 1952, Pierson and Rainey 1998). Temperatures vary in maternity roosts throughout California from 19°C (66°F) in cooler regions to 30°C (86°F) in warmer southern regions (Pierson et al. 1991). Some colonies are known to change roosts during the maternity season, using cooler roosts earlier in the year (Pierson et al. 1991, P. Brown pers. comm., V. Dalton pers. comm.) and using warmer roosts while pup-rearing. Roost dimensions are also important. The majority of the roosts examined in California are fairly spacious, at least 30 m (100 ft) in length, with the roosting surface located at least 2 m (6.5 ft) above the ground, and a roost opening at least 15 cm by 62 cm (6 inches by 24 inches) (Pierson et al. 1991). Maternity clusters are always situated on open surfaces, often in roof pockets or along the walls just inside the roost entrance, within the twilight zone.

Night roosts include caves, rock shelters, open buildings, mines and bridges. They may be smaller than typical day roosts and are almost always singly occupied (Pierson and Fellers 1998).

Foraging Habitat. Foraging associations include edge habitats along streams and areas adjacent to and within a variety of wooded habitats (Brown et al. 1994, Fellers and Pierson 2002, Pierson et al. 2002). Radiotracking and light-tagging studies have found Townsend's big-eared bat foraging in a variety of habitats, including within collapsed lava tubes and trenches (Pierson and Fellers 1998). Brown et al. (1994) showed that on Santa Cruz Island in California, Townsend's big-eared bat avoided the lush introduced vegetation near their day roost, and traveled up to 5 km (3 mi) to feed in native oak and ironwood forest. P. Brown (pers. comm.) also documented Townsend's big-eared bat foraging in desert canyons with water on the west slopes of the Panamint Mountains (Inyo County).

Radiotracking and light-tagging studies in northern California have found Townsend's big-eared bat foraging within forested habitat, within the canopy of oaks (Pierson and Rainey unpubl. data), and along heavily vegetated stream corridors, avoiding open, grazed pasture land (Fellers and Pierson 2002). In Oklahoma, *C. townsendii ingens* more frequently used edge habitats (along intermittent streams) and open areas (pastures, agricultural fields, native grass) compared to wooded habitat (Clark et al. 1993), but also tended to focus foraging along canyon walls (Caire et al. 1984).

Light-tagging studies in West Virginia (V. Dalton pers. comm.) showed a bimodal foraging pattern for *C. t. virginianus*, with animals foraging over hayfields during the first part of the night, and within the forest later in the night, traveling up to 13 km (8 mi) from the day roost. They foraged as long as weather permitted in the fall, and were periodically active in winter (Pierson et al. 1991). Townsend's big-eared bats have been observed flying in a snowstorm (G. Tatarian pers. comm.).

CONSERVATION STATUS

Despite the long-standing designation of Townsend's big-eared bat as a Species of Special Concern in California (Williams 1986), there has not been a statewide effort to assess the conservation status of the species since Pierson and Rainey's work in the late 1980s and early 1990s (Pierson and Rainey 1998). CDFW is working with a contract team from Humboldt State University and Texas A & M University to survey maternity roosts and hibernacula over the next two years. This effort will serve as a comprehensive update to the Pierson and Rainey effort, but the results of this new project will not be available until 2017.

In the meantime, and in the interest of informing the Commission's decision on whether to list Townsend's big-eared bat according the statutory schedule required by CESA, CDFW offers the following summary of the conservation status of the species. This summary is based on a variety of recent and on-going efforts to study and monitor Townsend's big-eared bat in California and elsewhere.

Regulatory Status

State, federal and non-governmental organizations designate "at risk" species (e.g., threatened and endangered species, Species of Special Concern, Species of Greatest Conservation Need, etc.) and assess and rank their conservation needs. Status designations for Townsend's big-eared bat are summarized below by jurisdiction or organization:

State of California Status. The Fish and Game Commission designated Townsend's big-eared bat a "candidate" for listing as endangered or threatened under CESA, effective December 27, 2013. With the notice of its candidacy for listing, the CESA prohibition against unauthorized "take" of Townsend's big-eared bat is currently in effect. (Fish & G. Code, §§ 2080, 2085). "Take" is defined in the Fish & G. Code as to hunt, pursue, catch, capture, or kill, or to attempt to engage in any of these activities. (*Id.*, § 86.) Take of species protected by CESA, including Townsend's big-eared bat, may be authorized under certain circumstances.

"Species of Special Concern" (SSC) is a Department administrative designation intended to alert biologists, land managers, and others to a species' declining status and to encourage additional management considerations for these species to ensure population viability and to preclude the need for listing. SSCs are defined as species, subspecies, or distinct populations of an animal native to California that currently satisfies one or more of the following (not necessarily mutually exclusive) criteria: extirpated from the State or, in the case of birds, in its primary seasonal or breeding role; listed under the federal Endangered Species Act (but not CESA) as threatened or endangered; meets the State definition of threatened or endangered but has not been formally listed; is experiencing, or formerly experienced, serious (noncyclical) population declines or range retractions (that have not been reversed) that, if continued or resumed, could qualify it for State threatened or endangered status; has naturally small populations exhibiting high susceptibility to risk from any factor(s), that if realized, could lead to declines that would qualify it for State threatened or endangered status (Comrack et al. 2008).

Townsend's big-eared bat has been designated as a Mammal Species of Special Concern (MSSC) since the list was established in 1986 (Williams 1986). The MSSC list is now undergoing a formal update and

revision using an objective, criterion-based method developed by CDFW (see Shuford and Gardali 2008 for a recent published example of the current method). As part of the update process, Townsend's big-eared bat has been evaluated, scored, and ranked using eight criteria along with all other terrestrial mammal taxa naturally occurring in California. Based on current information, it is likely Townsend's big-eared bat will be on the updated MSSC list (assuming it is not CESA-listed as threatened or endangered first).

Projects carried out on state and private lands that are funded or authorized by public agencies (such as highway construction, residential and commercial development, and energy development projects) are subject to the provisions of California Environmental Quality Act (California Public Resources Code, Division 13, section 21000 *et seq*. and Guidelines published under the California Code of Regulations, Title 14, section 150000 *et seq*.). CEQA requires that actions that may substantially reduce the habitat, decrease the number, or restrict the range of any species that can be considered rare, threatened, or endangered (regardless of status under state or federal law) must be identified, disclosed, considered, and mitigated or justified. (Cal. Code Regs., tit. 14, §§ 15065(1), 15380.) Impacts to species identified as SSCs should be carefully evaluated in CEQA planning documents.

In summary, as a Candidate for CESA listing, Townsend's big-eared bat enjoys a high-level of assessment and disclosure of potential impacts of proposed CEQA projects. The standard "no-take" requirement for projects helps ensure that population-level impacts do not occur when a project is implemented. Should the species not be listed, then the SSC designation should still ensure that proposed projects include assessment and disclosure of potential impacts, but protection from impacts is less certain and take of individuals may occur.

Federal Status. Townsend's big-eared bat is not currently listed as endangered or threatened nor is it a candidate for listing under the federal Endangered Species Act. However, several federal land management agencies (e.g., U.S .Forest Service, Bureau of Land Management) have special management designations for the species. See the EXISTING MANAGEMENT, MONITORING, AND RESEARCH ACTIVITIES section below for additional information on federal agency management of Townsend's big-eared bat.

Status in Surrounding States.

Oregon – The Oregon Department of Fish and Wildlife (ODFW) designates Townsend's big-eared bat as a Sensitive/Critical species.[3] Sensitive species are "naturally-reproducing fish and wildlife species, subspecies, or populations which are facing one or more threats to their populations and/or habitats. Implementation of appropriate conservation measures to address the threats may prevent them from declining to the point of qualifying for threatened or endangered status." The Critical designation indicates ODFW has determined that Townsend's big-eared bat is a species "imperiled with extirpation from a specific geographic area of the state because of small population sizes, habitat loss or

[3] http://www.dfw.state.or.us/wildlife/diversity/species/sensitive_species.asp

degradation, and/or immediate threats. Critical species may decline to point of qualifying for threatened or endangered status if conservation actions are not taken."

Nevada – The Nevada Department of Wildlife (NDOW) does not have a special status designation for Townsend's big-eared bat. However, the Nevada Bat Conservation Plan (Bradley et al. 2006), which was adopted by a variety of state agencies and federal agency offices in Nevada, including NDOW, designates the species as "Sensitive." The Nevada Bat Conservation Plan designates the conservation risk to Townsend's big-eared bat as "High" (Bradley et al. 2006). According to the plan, "A far more broad-scaled and complete monitoring effort is needed in Nevada to truly discern the status and trend of this species."

Arizona – The Arizona Game and Fish Department (AGFD) published the Arizona Bat Conservation Strategic Plan (AGFD 2003). The plan outlines the current status of all 28 bat species occurring in Arizona. For Townsend's big-eared bat, the plan states that population trends and conservation status of the species is unclear, though some losses of maternity roost sites are known to have occurred. AGDF published an update to its State Wildlife Action Plan (SWAP) in 2011 (AGFD 2011), in which it designates Townsend's big-eared bat as a Tier 1B Species of Greatest Conservation Need. That status is based primarily on AGDF's determination that the species is in a "demographically poor situation: Unusually low birth rates or high death rates combined with small or declining population size. Demographic rates are affected by known stressors likely causing a worsening situation in parts of Arizona." The Arizona SWAP also notes the species' vulnerability due to its concentration at certain points in its life cycle (colonial roosting habits) and an unknown population trend in the state.

Non-governmental Organization Designations. NatureServe, a non-profit conservation organization whose mission is to provide the scientific basis for effective conservation action through its network of natural heritage programs, ranks Townsend's big-eared bat as a whole and each of the two non-listed subspecies (*pallescens* and *townsendii*) as "G3G4/T3T4" throughout their respective geographic ranges This designation indicates uncertainty regarding conservation status, which may be characterized as either Apparently Secure (G4/T4) or Vulnerable (G3/T3).

NatureServe defines "Vulnerable" as "at moderate risk of extinction or elimination due to a restricted range, relatively few populations, recent and widespread declines, or other factors" and "Apparently Secure" as "Uncommon but not rare; some cause for long-term concern due to declines or other factors." (http://explorer.natureserve.org/granks.htm).

International Union for the Conservation of Nature (IUCN). The current version of the IUCN Red List (http://www.iucnredlist.org/details/17598/0) designates Townsend's big-eared bat as a 'Least Concern' species based on the latest assessment of the species range-wide. The IUCN had previously designated the species in 1996 as 'Vulnerable.' The Least Concern designation is based on "its wide distribution, presumed large population, occurrence in a number of protected areas and because it is unlikely to be declining at nearly the rate required to qualify for listing in a threatened category."

The Western Bat Working Group (WBWG) is a consortium of agency biologists, consultants, academic researchers, and other interested persons throughout the western states and Canada working to ensure

a coordinated approach to bat conservation in western North America (http://wbwg.org/). Based on its initial assessment of the conservation status of western bat species in 1998, WBWG rated Townsend's big-eared bat as "high" priority (the highest conservation concern designation). According to the WBWG website, this designation "represents those species considered the highest priority for funding, planning, and conservation actions. Information about status and threats to most species could result in effective conservation actions being implemented should a commitment to management exist. These species are imperiled or are at high risk of imperilment."

Bat Conservation International (BCI) is a not-for-profit organization dedicated to the conservation of "the world's bats and their ecosystems to ensure a healthy planet." BCI does not have an assessment of the conservation status of Townsend's big-eared bat on its website, but has published articles related to the importance of proper mine and cave management to ensure successful roosting of this and other cave/mine-dwelling bat species.

Current Distribution

Based on recent records, Townsend's big-eared bat appears to be fairly well distributed throughout much of its historic range in California. Figure 3 displays Townsend's big-eared bat observations in California symbolized by time period of observation. The observations are from a number of sources, including museum specimens, observations submitted to the California Natural Diversity Database (CNDDB), and capture and acoustic records from biologists permitted by CDFW to study Townsend's big-eared bat. No obvious pattern of a reduction in distribution is apparent in Figure 3, though it is likely that occurrences are now rarer in the South Coast and Bay Area than before urbanization.

Comment [js9]: Likely? I think we could safely say "certainly" with regard to urbanization in these areas.

Population Trends

Summary of Pierson and Rainey (1998) Statewide Assessment and Other Information Cited in the Petition

To describe Townsend's big-eared bat population trend in California, the Petition relied heavily on the work conducted by Pierson and Rainey (1998) for the Department of Fish and Game. Pierson and Rainey conducted surveys of Townsend's big-eared bat maternity colonies and hibernacula throughout much of the species' range in California during the period 1987 to 1991. Their study focused primarily on maternity colonies to assess population status and reproductive capacity. In addition to visiting and counting the numbers of bats at all known large (> 30 females) Townsend's big-eared bat maternity colony roost sites in California, the authors also searched for additional or alternate roost sites within 15 km (9.3 mi) of the known sites. The authors also visited five known Townsend's big-eared bat hibernation sites in California and described the observations of other researchers at several other hibernation sites. The authors developed several measures of population status and trend in their study, including total estimated number of adult females at maternity colonies in the state, total number of colonies, average size of maternity colonies, and average and total size of hibernation colonies.

The work by Pierson and Rainey (1998) showed a marked decline in the population size of Townsend's big-eared bat over the period between the original surveys of the maternity colony roost sites and the

re-surveys conducted by the authors. Eighteen historically known maternity colonies with population counts were assessed in the study. The original dates of detection ranged from 1918 to 1974, with most of the original surveys conducted in the 1930s through 1960s. Six of the colonies appeared to have been extirpated, five had declined in number of females by more than 20%, four had remained relatively constant in numbers, and three colonies had increased by more than 20%. The authors lumped all 18 colonies' original population counts to get a historical-period population estimate of 3,004 adult females. Based on their counts during the 1987-1991 surveys, they estimated these colonies had declined by 55% to a total of 1,365 adult females.

The authors also found a decline in the total number of colonies known from the historical period to the resurveys. Of 46 historically-known maternity colonies (many without population counts), the authors could not find 24 (either at the original site or within 15 km (9.3 mi) of the original site), which represented a 52% decrease in the number of historically-known colonies.

Additional maternity colonies were located in the period after 1980, either by the authors or reliably reported to the authors by other researchers. These colonies were sufficiently distant from historically-known colonies for the authors to conclude they were not part of the historical set. Although no conclusion about population trend could be made based on the inclusion of the additional colonies, Pierson and Rainey's (1998) point estimate for the total known adult female Townsend's big-eared bat population size in California was 4,252 individuals, which distributed among 39 maternity colonies. The authors cited reliable reports of four other colonies of unknown size. The Petition cites reports and personal communications of an additional four maternity colonies known as of 2003, as well as observations of lactating females in areas without known colonies, suggesting there are additional maternity colonies not yet discovered.

Pierson and Rainey (1998) also compared the average size of the 18 historically-known maternity colonies to the 38 colonies with population estimates known at the time of their study. They found average number of adult females in the historical colonies to be 164, while the currently-known colonies averaged 112 females. Thus, the recent colony size was 32% smaller than the historical colony size.

Pierson and Rainey (1998) also assessed the size of five historically-known hibernation colonies in California. One of the colonies (at Lava Beds National Monument) had remained stable at approximately 30 individuals. The other four, which had original counts of between 55 and 177 bats, showed dramatic declines of between 70% and 94%. These sites were in Shasta, Lake, and Napa counties.

The Petition also cited observations by Williams (1986), who was an active researcher of the conservation status of mammals in California in the latter half of the 20th century. As mentioned in the Petition, Williams (1986) stated his impression that Townsend's big-eared bat had been common in central California through the 1960s, but had dramatically declined by the early 1970s. Williams (1986) mentioned that he had only captured one individual Townsend's big-eared bat during his 14 years of work in central California in the 1970s and 1980s. Townsend's big-eared bat has been recently observed in the central coast area of California, on Department lands and Vandenberg Air Force Base (R. Stafford

2014, 2015 pers. comm.; R. Evans 2014 pers. comm.). These observations, which included a maternity roost site for both of the jurisdictions, as well as a large extant maternity colony at Hearst San Simeon State Historical Monument, indicate the species continues to occur in the region, although no information on population or range trend is available for this area.

Other published observations of declines in Townsend's big-eared bat colonies in the Sierra Nevada and lower Colorado River area (Graham 1966, Stager 1939) were mentioned in the Petition.

In summary, the best quantitative information on the population status of Townsend's big-eared bat cited in the Petition is Pierson and Rainey's (1998) statewide assessment, which showed that, of the 18 historically-known maternity roost sites with population counts, six of the colonies had been extirpated by the time the authors conducted their work. Another six colonies showed a decline in the number of adult female Townsend's big-eared bat present. Although five colonies had increased in size (and one remained stable at 50 females), the overall decline in numbers from the historical period appeared to be substantial.

These comparisons between historical and recent colony numbers, colony size, and total population counts suggested that, as of the early 1990s, there had been a decline in the total population of Townsend's big-eared bat in California since the early 20th century. This decline may have been substantial, but the historical data set was limited and therefore the magnitude of the population decline could not be exactly determined. In combination with other aspects of the species' biology and observations of human disturbance at Townsend's big-eared bat roost sites, the trend information collated by Pierson and Rainey (1998) led to the inference that the California Townsend's big-eared bat population had declined over the several decades before their study.

CDFW is aware of ongoing efforts to monitor or revisit several important Townsend's big-eared bat maternity and hibernation roosts in California. These efforts include monitoring at both hibernation and maternity colonies at Lava Beds National Monument (S. Thomas 2013 pers. comm.), revisiting known Townsend's big-eared bat hibernacula in the White and Inyo mountains (Szewczak et al. 1999, M. Morrison 2013 pers. comm.), long-term annual counts of a maternity colony in a historical building in Sierra County (W. Copren 2013 pers. comm.), as well as at other sites. The following section summarizes recent results from these ongoing monitoring efforts.

Townsend's Big-Eared Bat Roost Site Monitoring Case Studies

To assess Townsend's big-eared bat population trends since Pierson and Rainey's (1998) work, CDFW has compiled information from a number of maternity and hibernation roost sites from around California. The following is a summary of studies that assess the population trend at specific sites. While this summary does not comprise a statistically valid estimate of the Townsend's big-eared bat population size or trend statewide, it does illustrate how population status varies around the state, as well as how management of roost sites directly affects the population status in an area. Locations referenced here are depicted in Figure 4.

Randall House Maternity Roost (Marin County). Fellers and Halstead (2015) reported results from 25 years of monitoring the Randall House maternity roost site in Marin County. The Randall House is a two-story late 19th Century ranch house situated in a valley at Point Reyes National Seashore. It was last used by humans in the 1970s and in 1987 was discovered to be the site of a Townsend's big-eared bat maternity colony. At that time, the colony numbered 95 adult females. The site had been subject to repeated break-ins by local teenagers prior to 1987, but upon discovery of the Townsend's big-eared bat colony, the National Park Service fortified the house against unauthorized entry and has since maintained the house for use by the bats.

Using night-vision equipment, Fellers and his collaborators conducted 178 exit counts of Townsend's big-eared bat during the maternity season between 1988 and 2012. In addition to information on the number of adult females and young present at the site, this long-term monitoring study also yielded important information on the effects of human disturbance on colony status, effects of season and environmental factors on emergence time from the roost, and other natural history aspects of the species.

Over the course of the 25-year study, the Randall House Townsend's big-eared bat maternity colony increased in size (see Figure 5B). Adult female maximum number recorded increased from 95 in 1988 to 395 in 2012. The maximum recorded number of adult females plus volant young increased from 176 to 512. The annual rate of increase was estimated to be 8.7% for adult females and 5.3% for volant young.

Attempted and successful break-ins to the roost building occurred occasionally during the study period, despite increased security at the site. These disturbance events were documented and the authors found a significant negative correlation between disturbance events and subsequent numbers of adult females and volant young (compare Figures 5A and 5B). In other words, there were fewer Townsend's big-eared bat adults and young at the roost site in years with human disturbance events.

The authors note the Randall House is one of the most important remaining Townsend's big-eared bat maternity roost sites in coastal California. Because of the NPS commitment to maintaining the Randall House for Townsend's big-eared bat use, it is one of the few maternity roosts classified by Pierson and Rainey (1998) as "secure." Prior to its discovery in 1987, two other nearby historical roost sites (the Olema Inn and an old barn near Inverness) had already been lost. Fellers and Halstead (2015) note that only one other Townsend's big-eared bat maternity roost is known in the area and, although also located on NPS land, it is structurally dilapidated and its long-term suitability for Townsend's big-eared bat use is questionable. Like other old wooden buildings used by Townsend's big-eared bat around the state, these structures are vulnerable to degradation and loss over time. Replacement structures tend to be made of materials and use designs less suitable for bats.

Nevertheless, the Randall House is an example of how management of a roost structure may allow Townsend's big-eared bat to continue to occupy an area and even expand in numbers over time.

Kentucky Mine Maternity Roost (Sierra County). The Kentucky Mine Historic Park and Museum is located in Sierra City, Sierra County, at an elevation of 1340 m (4400 ft). The Kentucky Mine Townsend's

big-eared bat maternity colony was not known at the time of Pierson and Rainey's 1980s and early 1990s statewide assessment. The colony primarily roosts in a historical mine building (a stamp mill used to crush ore excavated from the nearby mine), but the bats appear to also use the nearby mine itself as an alternate roost site (M. Tierney 2015 pers. comm.).

As described by Freeman (2012), unlike most Townsend's big-eared bat maternity colonies, "this colony has acclimated to a level of disturbance typically considered intolerable for *C. townsendii*. The Sierra County Historical Society leads tours twice a day through the stamp mill throughout the maternity period. During these tours, guides wind up a massive iron stamp and let it pound down to demonstrate how it crushes rocks to remove the gold. This noisy activity frequently occurs directly beneath the roosting bats and causes the entire building to quiver. The grounds surrounding the stamp mill permit daily public use. On weekends, human disturbance continues into the night. An outdoor amphitheater located less than 50 meters from the colony is used for concerts during the nursery season. This colony persists despite these disturbances."

The U.S. Forest Service prepared a management plan for the colony in 2007 (Tierney and Freeman 2007) and the Sierra County Historical Society, which operates the park and museum, cooperates with the U.S. Forest Service to manage the risk of disturbance to the colony by following the recommendations of the plan (W. Copren 2012 pers. comm.; M. Tierney 2015 pers. comm.). Among the plan's guidelines are measures to make the on-going human activities at the roost site consistent and predictable to allow the bats to acclimate to disturbance.

Exit counts from the stamp mill during the maternity season have been conducted by the U.S. Forest Service and others since 1994, along with occasional roost counts within the stamp mill and exit counts from the shafts of the mine itself. Data are available for the period 1994 through 2005 (Tierney, unpublished data). Depending on year, the counts at the stamp mill were conducted at various times during the maternity season (and therefore may include either adult females only or adult females and their young). The counts were sometimes conducted on nights when the colony was apparently roosting at an alternative site. The exit count data at first glance is irregular (Figure 6A).

Removing exit counts at the stamp mill roost with anomalously low numbers suggesting the bats were roosting at an alternative site (counts with fewer than 20 bats in years with other counts of 40 or more bats) and by separating the counts into the pre-volancy and volancy periods of the young (before mid-July and after the third week of July), a clearer pattern develops (Figures 6A and 6B).

Early season counts (consisting of adult females only) at the Kentucky Mine have generally been in the range of 30 to 50 bats since the first count of 66 bats was made in late June 1994. After young achieve flight starting around the last week of July, counts have varied between lows of around 35 in the late 1990s to between 50 and about 100 in the early 2000s (Figure 6A). Exit count data at the mine shaft roost site in late August and early September 2003 totaled 140 and 168 bats, but it is possible these very late counts included adult males as well as females and young of the year (Figure 6B).

CDFW does not have access to more recent exit count data from Kentucky Mill, but the U.S. Forest Service's estimate from data collected subsequent to 2005 is that the colony size has been fairly stable at or near 100 adult females (M. Tierney 2015 pers. comm.; K. Freeman 2015 pers. comm.).

Lava Beds National Monument Maternity Roosts (Siskiyou and Modoc counties). Lava Beds National Monument (LBNM) is located in northeastern California. The monument contains the largest concentration of lava caves in the contiguous United States; LBNM staff had identified more than 750 caves by 2013. The extensive network of caves at Lava Beds National Monument in Siskiyou and Modoc counties is considered a major population center for California's Townsend's big-eared bat population (Pierson and Rainey 1998). During the last statewide assessment of the species, it was estimated that a quarter of the state's breeding female population occurred at LBNM (Pierson and Rainey 1998). These caves have been monitored for Townsend's big-eared bat presence during the maternity season over the past couple of decades, but because of Townsend's big-eared bat's known sensitivity to disturbance, most surveys during the active season have been limited to quick checks for presence or absence of bats (T. Weller 2014 pers. comm.). Counts of bats were infrequently made during these surveys and only rough estimates of bat numbers are available. In accordance with cave resource management guidelines, caves where Townsend's big-eared bats were observed during the active season were then subsequently closed to recreational access.

Efforts to monitor the Townsend's big-eared bat population at LBNM during the maternity season take a light-touch approach to minimize the risk of disturbance at the roost sites. Three Townsend's big-eared bat maternity colonies are monitored for presence/absence and to collect cave microclimate data (temperature and relative humidity). Depending on staff availability, the monitoring occurs on a variable schedule of between once per week to once per month (Katrina Smith 2015 pers. comm.). Exit counts have also been conducted, but conditions are not conducive to accurate counts (Katrina Smith 2015 pers. comm.).

As part of his analysis of recent (1990s and later) Townsend's big-eared bat monitoring data from LBNM, Weller attempted to discern patterns of occupancy by date and location during the active season (T. Weller 2014 pers. comm.). Apart from very general conclusions about the timing of the maternity season, no pattern of occupancy in particular caves at particular dates, nor trend in bat population size, may be discerned from these data (T. Weller 2014 pers. comm.). Weller concluded the known roost-switching behavior of Townsend's big-eared bat during the maternity season and the opportunistic and infrequent attempts to monitor Townsend's big-eared bat at LBNM during the active season preclude inferences about active season population trends using existing data. He advocated instead the use of Townsend's big-eared bat counts at hibernacula, where individual bats may reliably be counted during the inactive season (and without undue disturbance of the bats) as the preferred method to estimate population size and trend. See below for a summary of results of LBNM hibernaculum monitoring (Weller et al. 2014).

Lava Beds National Monument Hibernacula (Modoc and Siskiyou counties). The Lava Beds area of northern California is home to one of the most important populations of Townsend's big-eared bat in California (Pierson and Rainey 1996). The National Park Service at Lava Beds National Monument

(LBNM) has monitored winter bat use of the lava tubes and caves for many years (Weller et al. 2014). Townsend's big-eared bat are the most commonly encountered bat species in winter because of their habit of roosting in the open, but Myotis bats (*Myotis* sp.) and big brown bats (*Eptesicus fuscus*) are also occasionally observed (Katrina Smith 2015 pers. comm.).

NPS considers the period from November 15 to March 15 to encompass the Townsend's big-eared bat hibernation season at LBNM. Any bat survey completed in caves during this period is included in the LBNM bat database and is considered hibernacula monitoring data. In recent years, a focused effort to monitor the hibernating bat population at LBNM has been conducted, with one entire week in mid-winter devoted to completing as many bat hibernacula surveys as possible. NPS staff and collaborators use a stratified random sampling method to select caves for survey based on the number of bats seen there in previous years. This allows collection of annual data on large known hibernacula and also to survey sites that have never been visited in winter. Using this method, in the past few years NPS has discovered four new hibernation sites with more than 30 bats, plus several sites with smaller numbers of Townsend's big-eared bat.

Winter bat surveys at LBNM use headlamps and other caving gear to enter caves to tally all visually observed hibernating bats. Townsend's big-eared bats typically hibernate singly or in small groups, generally consisting of fewer than 20 individuals, though larger clusters are occasionally observed. Along with counts of bats by species and location within the caves, cave microclimate data (air temperature, ceiling temperature, and relative humidity) are also recorded (Katrina Smith 2015 pers. comm.).

Weller et al. (2014) analyzed the results of NPS Townsend's big-eared bat hibernacula monitoring data from a 22-year period (1991-2012) at LBNM to determine if a trend in the number of Townsend's big-eared bat hibernating could be discerned. Over this period, bats were counted in a total of 52 caves. Although a concerted effort was made by NPS to monitor hibernating bats each year, the number of caves visited and number of surveys conducted varied based on staff availability. These analyses were also used to design a flexible yet statistically robust monitoring program in future years.

Weller et al. (2014) used regression analysis to model the changes and trend in Townsend's big-eared bat numbers at each cave that had at least four surveys conducted from 1991 and 2012, and for which at least half of the surveys had at least one bat recorded. Using these models, the authors generated predicted numbers of Townsend's big-eared bat for each cave in non-survey years, as well as for 2012. The 2012 predictions were compared to the actual counts for that year. They also estimated the total number of Townsend's big-eared bat hibernating in all the caves each year by combining actual counts and estimated numbers.

Seventeen of the 22 caves monitored during at least four years had a positive trend in the number of hibernating Townsend's big-eared bat during the 22-year study period (Figure 6), although not all of these were statistically significant. Most of these caves had large numbers of hibernating Townsend's big-eared bat. The decreasing trends for the other five caves were not statistically significant, nor did any of these caves ever have more than 10 Townsend's big-eared bat observed in a count.

The authors estimated the number of hibernating bats in the 52 surveyed caves increased from 834 bats in 1991 to 1,427 bats in 2012 (Figure 7). The estimated cumulative annual growth rate for the 52 caves over the period 1991–2012 was about 1.8% (Figure 8). The estimated annual population growth rate for the caves surveyed most often was about 4%. Estimates based on data from 1991 to 2011 generally predicted the 2012 counts well; however, the actual bats counted in most caves exceeded the predicted numbers in 2012. Seven caves had their highest count in 2012 and another three equaled their previous high count.

Although 52 caves among the 97 surveyed during the 22-year study period were observed to have hibernating Townsend's big-eared bats during one or more years, Cave L970 stands out as an especially important site. In 1990, 376 bats were counted there and it has consistently held the majority of bats counted each year (see Table 1 from Weller et al. 2014).

Although the authors list a number of caveats regarding their results, they are "confident that the number of bats in the 52 surveyed caves has increased or, at the least, remained stable." They state "the increasing number of hibernating individuals reaffirms LBNM as a population stronghold for Townsend's big-eared bats in a state (Pierson and Rainey 1998) and region (Pierson et al. 1999) where it is considered imperiled. Potential ecological explanations for the increase in hibernating bats are unclear but could be related to changes in management policy at LBNM. Beginning in 1991, approximately 10 caves were closed during the maternity period to limit disturbance of maternity colonies by visitors. Lava Beds National Monument also closed winter hibernation sites to visitors, starting with a few sites in the 1990s and increasing to nearly 20 caves by 2012."

Pinnacles National Park Maternity and Hibernation Roosts (San Benito County). Pinnacles National Park, located about 65 km (40 mi) east of Monterey, encompasses approximately 9,700 ha (24,000 acres). Pinnacles National Monument (later Park) was established to protect and allow public use of the unique talus cave systems found there, which are formed from the remnants of a 23-million-year-old volcano. The Townsend's big-eared bat maternity colony that occurs in the cave system at Pinnacles National Park was not known at the time of Pierson and Rainey's statewide survey in the 1980s and early 1990s. Following its discovery in 1997, NPS closed the cave to the public for 4 years to allow the bats undisturbed use of the cave and to determine how best to manage the site (NPS 2002). The Pinnacles roost site is used by the local Townsend's big-eared bat population both for hibernation and for the maternity season. Portions of the cave are warm enough during the maternity season for gestation and pup-rearing, while other sections are cool enough in the winter to provide a suitable environment for hibernation. After the period of study, NPS adopted a management policy for the site that allows park visitors to seasonally access the portions of the caves not in use by the bats (NPS 2002, Paul Johnson 2015 pers. comm.).

NPS conducts annual monitoring of the Townsend's big-eared bat population, usually during both the maternity and hibernation seasons, to determine the effectiveness of this management strategy as well as to verify the dates for shifting visitor access. Because of the porous nature of the talus caves at Pinnacles, it is not possible to conduct exit counts at one or a few entrances to the roosts. Instead, NPS staff attempt to conduct visual counts of the maternity colony and hibernating bats within the roosts.

Precise counts are not always possible due to limited access by humans to areas used by the bats, as well as the importance of minimizing disturbance to the roosting bats.

Over the period from 1997 to 2014, the total maternity colony size (sometimes including pups) has ranged from about 150 to possibly as high as 1000 individuals; though in most years the total maternity colony size ranges between 200 and 400 individuals (Table 2). The hibernaculum counts are generally lower than the maternity roost counts (possibly due to dispersed winter roosting habits), ranging from about 15 to 400 individuals, with many years having counts of around 200 individuals (Table 2). The annual count data shows an early increase in the total numbers of Townsend's big-eared bat individuals counted in both the maternity and hibernation seasons. This apparent increase in colony size may be attributed to the public cave closure from 1997 to 2002, followed by the adoption of the current management strategy of seasonal public access to the caves. Additional factors affecting the data are the intensity and frequency of survey effort in a given year. According to the NPS staff familiar with the surveys, the later years reported here had fewer survey visits to the roost site, which made it less likely that peak numbers would be detected in a given year (Paul Johnson 2015 pers. comm.). Despite the apparent decline in colony size since 2005-2006, NPS considers the Pinnacles Townsend's big-eared bat population to be relatively stable (Paul Johnson 2015 pers. comm.).

Hearst Castle Maternity Roost (San Luis Obispo County). The Townsend's big-eared bat maternity colony at Hearst San Simeon State Historical Monument was not known at the time of Pierson and Rainey's (1998) statewide survey. The Townsend's big-eared bat roost site was discovered during an assessment by Department of Parks and Recreation (DPR) of the bats occurring at Hearst Castle in 2000 (K. Miner 2015 pers. comm.). The maternity roost site is located in a cavernous space within the reinforced concrete stair and landing structure at the main entrance to the complex of mansions that comprise Hearst Castle. Prior to the survey, the space was regular inspected for structure integrity and used for closed-space rescue training by park staff during the maternity season, who reported that bats were disturbed by their presence. Once discovered that it was being used by Townsend's big-eared bats, DPR limited entry during the maternity season to only necessary safety inspections. Prior to 2003, Townsend's big-eared bats entered and exited the roost space through a narrow space below a screened door, forcing the bats to crawl on the ground. In 2003, the site was modified by adding two openings to the roost at more typical locations above the ground and sized to accommodate flying Townsend's big-eared bats accessing the site (R. Orr 2015 pers. comm.). DPR also developed management guidance to ensure maintenance and repair activities at the site have minimal impact on roosting bats, including Townsend's big-eared bat (DPR 2003).

Comment [JMS10]: I'll attach the survey report I did on this with the recommendation for improving the door when I send this back.

Exit counts conducted by DPR staff since 2000 suggest the management of the site has enabled the colony to thrive. Most of the exit counts at the Townsend's big-eared bat roost have been conducted during late August, at which time the counts would likely include both adult females and their volant young and possibly adult males, as well. Late summer exit counts ranged from 60 to 95 total individuals prior to the roost entrance modification work. Since the modification and adoption of the bat protection policy in 2003, total counts of Townsend's big-eared bat during the late summer have

increased fairly steadily through the years (Figure 9). Over the period 2012-2014, late summer counts ranged from 413 to 813 total Townsend's big-eared bat individuals at the site.

Santa Cruz Island Maternity Colony (Channel Islands National Park). Santa Cruz Island is the largest and most habitat-diverse of California's Channel Islands and it is the only Channel Island known to harbor a reproductive colony of Townsend's big-eared bat (Brown et al. 1994). Because of its distance to the mainland, it is thought that the Santa Cruz Island Townsend's big-eared bat population may be isolated from other Townsend's big-eared bat populations. If so, it is possible the island population may have unique genetic characteristics. The Santa Cruz Island colony was first described in 1939 as roosting in a 2-story ranch house at Prisoners Harbor on the north-central side of the island. At that time, it was estimated to number more than 300 individuals, which were likely both adult females and their volant young (Brown et al. 1994). A total of 246 individuals were collected for scientific collections during this and two subsequent collection trips in 1949 and 1964 (Brown et al. 1994). Pierson and Rainey (1998) cited Museum of Vertebrate Zoology records as stating the colony in 1948 numbered 150 adult females.

At some point between the mid-1960s and 1974, the Prisoners Harbor ranch house was demolished. Despite extensive searches, Townsend's big-eared bat roosting in substantial numbers on Santa Cruz Island were not observed again until 1991, when they were reported to Pat Brown as occurring in the Bakery in an old adobe building at Scorpion Ranch on the northeast end of the island (Brown et al. 1994). It is not clear whether the Scorpion Ranch site was colonized by Townsend's big-eared bat displaced from Prisoners Harbor or if it was already in use prior to the loss of the Prisoners Harbor site. The National Park Service has since then assumed management of the entire island, including the Scorpion Ranch buildings, as part of the Channel Islands National Park.

NPS and others have conducted regular exit counts at the maternity roost site during the spring (adult females only) and late summer (adult females and their young). Exit count data available to CDFW suggest the number of Townsend's big-eared bats at Scorpion Ranch have never been as high as at the Prisoners Harbor roost site. Spring counts in the early 2000s ranged from about 50 to 105 adult females, while fall counts ranged from about 75 to 165 adult females and their young.

Work was conducted in 2009 to renovate and reoccupy other portions of the old adobe building. Exit counts by NPS personnel at the bakery roost site continued during maternity season during this time (T. Coonan 2014 pers. comm.). During the 4-year period from 2010 to 2013, the bakery roost site was abandoned, either temporarily (2010 and 2011) or for the remainder of the maternity season (2012 and 2013). The latter abandonment events resulted in the known death of pups at the caves to which the adult females had moved. Early season counts suggest between 60 and 90 adult females arrived at the roost site each year. The cause(s) and exact dates of abandonment are not known, but could include public visitor entrance over the half-door into the roost site or other activity in and around the building, including use of other rooms within the building by NPS personnel.

Proposals have been made to increase monitoring activity at the maternity roost site to more closely track human activity and bat numbers (T. Coonan 2014 pers. comm.), as well as to exclude human

entrance into the roost site with a bat-friendly gate. These proposals have not been implemented due to lack of funding (T. Coonan 2014 pers. comm.).

In summary, the Santa Cruz Island Townsend's big-eared bat population has fared relatively poorly since it was first described in 1939. Repeated collections for scientific purposes, demolition or reconfiguration of roost sites, and disturbance have all impacted the population, which had its highest recorded number (more than 300) reported when it was first counted. Although the failed or reduced recruitment that occurred during 2010 through 2013 may not yet have significantly reduced the population size of this long-lived species, repeated reproductive failures will impact the age structure of the population. If reproductive failure of this colony continues, it is possible the Santa Cruz Island Townsend's big-eared bat population may become extirpated.

White-Inyo Mountains Hibernacula (Tulare and Mono counties). Szewczak et al. (1998) conducted an extensive survey program for bats in the White and Inyo Mountains from 1990 through 1996. As part of that survey effort, many observations of Townsend's big-eared bat were made, along with counts of Townsend's big-eared bat in individual hibernacula, which typically were in caves and abandoned mines. The authors have revisited many of the hibernation roosts since the original study was completed (M. Morrison 2014 pers. comm.). Some hibernation sites were repeatedly surveyed over multiple years while others were surveyed only once.

Morrison and Szewczak conducted 92 surveys of 47 sites within 28 different mines and caves in the study area from 1991 to 2014 (M. Morrison 2014 pers. comm.). Counts of hibernating Townsend's big-eared bat ranged from 0 to 80 individuals per site. The median count per site for all Townsend's big-eared bat surveys was 4 individuals. Of the 47 sites, 33 were surveyed more than once. Of these, 62% of the sites had a decrease in the number of hibernating Townsend's big-eared bat, 19% showed an increase in numbers, 16% showed an initial increase but then decreased in recent years, and 3% showed an initial decrease and then increase in recent years. A mean decrease of 3 individuals per site was recorded among the revisited sites.

These data from Townsend's big-eared bat hibernacula in the White and Inyo mountains are preliminary and do not lend themselves to strong conclusions. However, the preliminary data suggest that, unlike the situation at Lava Beds National Monument, the Townsend's big-eared bat population in the southeastern part of the state may be decreasing.

Summary of Population Monitoring Studies. Table 3 summarizes the results of monitoring of Townsend's big-eared bat hibernation and maternity colonies at the aforementioned sites. Two of the sites (one hibernation and one maternity) had statistically significant increases in total population size over two-plus decades of monitoring. At the other sites, no statistical conclusions could be made about population trend.

Because the total current Townsend's big-eared bat population size and the status of many roost sites in California are unknown, CDFW applied for and received a State Wildlife Grant from the U.S. Fish and Wildlife Service to conduct a two-year study to address this information need. This study, which is being

conducted in collaboration with researchers from Humboldt State University and Texas A&M University, will provide a current snapshot of the species' population size relative to the estimates made by Pierson and Rainey (1998) for the historical period (pre-1980) as well as the estimates made by Pierson and Rainey based on their own survey work in the 1980s and 1990s. It is hoped that the current study will provide CDFW and the Fish and Game Commission a much clearer picture of the species' status in California than do the isolated case studies summarized here. The results of the two-year study are expected to be available by June 2017

Threats

CDFW has identified the following factors as potential threats to the continued existence of Townsend's big-eared bat in California: loss, degradation, and disturbance at roost sites; loss and degradation of foraging habitat; disease; mining; environmental contaminants; climate change and drought; and overexploitation. Each of these topics is addressed below. Competition for resources (such as prey, water, and cover habitat) with other native or introduced species was considered as a potential threat but eliminated from further consideration due to lack of evidence that it may pose a threat to the continued existence of the species.

Roosting Site Loss, Structural Degradation, and Disturbance.

The availability of suitable roosting habitat is often posited as a limiting factor for western bat populations. For example, Pierson (1998) stated "considerable evidence suggests that roosts are limiting for many bat species." Hayes (2003) cites several authors that "hypothesized [roosts] to be the primary factor" limiting bat populations. That roosts may limit bat populations, including Townsend's big-eared bat, is a reasonable conclusion, given bats may use multiple roost sites with different characteristics during the year; that roost site suitability may be based on a narrow range of suitable temperatures, relative humidity, physical dimensions, and so on; and that such sites may occur in low numbers on the landscape.

Impacts to roost sites are an important threat to Townsend's big-eared bat. Such impacts include both physical loss/modification of the roost site as well as disturbance of bats at the roost site.

Within the North Coast region of California, the loss of old-growth conifers with large, cavernous basal hollows during late 19th and early to mid-20th century industrial-scale logging is presented as a likely explanation for the apparent decline of Townsend's big-eared bat populations in the coastal forest of northern and central California (Pierson and Rainey 1998). The association of Townsend's big-eared bat with large basal hollows has been demonstrated by the work of Pierson and Fellers (1998) and Mazurek (2004).

More recent and ongoing forestry practices that could impact Townsend's big-eared bat include harvest of remnant old-growth trees with suitable roosting cavities, as well as disturbance associated with timber operations, increased access to roost sites by human visitors, loss of oak woodlands (which may provide roost sites and certainly provide foraging habitat), conversion of forest to agriculture such as vineyards, and application of chemicals.

New and renewed mining operations have the potential to impact Townsend's big-eared bat roosting in old shaft/adit mines, either through disturbance of roosting bats or by destroying the old mine by conversion to open pit-style mining, or through natural collapse of abandoned mines. Four examples of the destruction or loss of Townsend's big-eared bat roost sites are described in the Petition.

Dam construction or modification can result in the inundation of Townsend's big-eared bat roost sites. The Petition mentions one large colony that was displaced by construction of the New Melones Dam on the Stanislaus River. As stated in the Petition, much of the dam-building, reconstruction, and license renewal in California occurs at the same elevations in the foothills of the Sierra Nevada and Klamath and Trinity mountains that are optimal for Townsend's big-eared bat roost sites.

Although generally considered a cave/mine roosting bat, Townsend's big-eared bat also roosts in large spaces in old buildings and in cavernous spaces in bridges and dams. Bats in such sites are subject to disturbance when humans enter for inspections or other activities. The roost sites themselves are subject to eventual deterioration or demolition. Pierson and Rainey (1998) documented the loss of several Townsend's big-eared bat roost sites found in buildings.

There is an ongoing interest among recreational explorers in caves and abandoned mines. There is also a collectible market for mining artifacts. People entering mines can disturb bats during the critical maternity and hibernation seasons. Townsend's big-eared bat appears to be particularly susceptible to such disturbance. Recreationists and homeless persons may also enter old buildings used as roosts and disturb bats. A house at the CDFW Chorro Creek Wildlife Area has provided a roost site for a Townsend's big-eared bat maternity colony off and on for several years. The site has been repeatedly abandoned by the bats after break-ins followed by subsequent re-occupancy after the house is resealed (R. Stafford 2014 pers. comm.). The same pattern of partial or complete abandonment has been observed at the Randall House maternity roost site (Fellers and Halstead 2015) and other sites.

While it is certainly true that natural roosting habitat for Townsend's big-eared bat has been impacted by humans over the past 150 years, it is important to consider that historical mining and building construction also added to the total available roost habitat in the state in the late 1800s and early 1900s. Assuming roost habitat is a limiting factor for Townsend's big-eared bat, it is likely that the carrying capacity for the species actually increased in the historical mining districts of California with the advent of historical mining and construction of buildings. It is unknown, however, to what degree the documented populations losses at natural roost sites of caves and large old trees with basal hollows have been offset by presumed historical population increases at "artificial" roost sites. Many of these old buildings and mines themselves have been subsequently impacted, and in many cases lost, since the historical period. Moreover, with the documented loss of approximately 95% of old-growth coastal redwood forest on California's North Coast (Fox 1989), it is likely that this region has suffered a substantial decrease in roost site availability during the historical period.

In summary, CDFW considers loss, degradation, and disturbance at roost sites to be an important threat to Townsend's big-eared bat in California. Given the species' known susceptibility to disturbance, its reliance on roost sites with a relatively narrow range of suitability, and the colonial nature of the

species, especially during the maternity season, it is possible that population-level or even statewide impacts could occur to the species from the loss or disturbance at relatively few roost sites.

Loss of Foraging Habitat (including water)

Loss of suitable foraging habitat has previously been identified as a threat to Townsend's big-eared bat (Pierson and Rainey 1998, Pierson and Fellers 1998). Ideal habitat for foraging likely includes a mix of edge and continuous vegetation cover. Land management practices that create large openings of low shrub or grass cover in forest and woodland areas, such as agricultural development and extensive clear-cutting probably reduce foraging habitat suitability for the species. Likewise, residential and urban development reduce available foraging habitat. This is especially true in the extensive, highly-developed regions along California's South Coast and Bay Area. Although individual Townsend's big-eared bats may still make forays into these areas, it is unlikely that populations could be supported in urbanized areas.

It has been estimated that 95 percent of California's riparian habitat, which is important for foraging Townsend's big-eared bats, has been lost to vegetation clearing or conversion and inundation behind dams (Katibah 1984). Climate change, including the effects of protracted or severe drought, may also negatively affect foraging habitat suitability and insect prey availability, both through vegetation changes and reductions in free surface water availability.

In summary, CDFW considers loss of foraging habitat to be a potential threat to Townsend's big-eared bat in California.

White Nose Syndrome and other Disease

White Nose Syndrome (WNS) is a disease that has killed more than 6 million bats in eastern North America (USFWS 2012). It is caused by *Pseudogymnoascus destructans* (Pd), a cold-loving fungus that is thought to have been introduced into northeastern North America from Europe sometime in the early 2000s. The fungus grows in the skin and other tissues of hibernating bats and may affect multiple physiological systems of the bats during the winter period. The most obvious effect on hibernating bats is that infected individuals arouse from deep torpor much more frequently and for longer periods than non-infected bats, which drastically reduces the fat reserves needed to sustain the bats until insect prey is available in the spring. Most affected bats die of starvation, with mortality rates for some species (e.g., *Myotis lucifugus*, the little brown bat) approaching 100% in some eastern hibernacula.[4]

Deleted: .

WNS has not yet been detected in western North America west of Nebraska. Surveillance studies to sample for the Pd fungus have yet to detect it California (W. Frick 2012 pers. comm.). Pd has been detected from swabs taken from the fur of Townsend's big-eared bats in WNS-affected areas in the eastern United States, but so far WNS (the disease) has not been observed to manifest in this species (A. Ballmann 2015 pers. comm.).

[4] https://www.whitenosesyndrome.org/

Little is known about the occurrence of other diseases, such as rabies, in Townsend's big-eared bat. Based on recent submissions of bats to state and county public health test labs, there is nothing to suggest Townsend's big-eared bat populations in California have been subject to recent disease outbreaks (CDPH unpublished data 2015).

CDFW considers WNS an important potential threat to California populations of Townsend's big-eared bat. Based on observations in the eastern U.S., the species' susceptibility to the disease is unclear. Continued monitoring of hibernating bats (as at Lava Beds National Monument), surveillance for the fungal agent of WNS, and incorporation of measures to reduce the risk of introducing or transmitting the fungus to hibernation sites in California are all important measures to reduce the risk of WNS to California populations. CDFW does not consider other diseases such as rabies to be a threat to the Townsend's big-eared bat in California.

Environmental Contaminants

Environmental contaminants include both naturally occurring and human-generated toxins that may affect the health of plants or animals. Naturally occurring toxins, such as heavy metal minerals, sulfur oxides, ammonia, and carbon dioxide, generally do not naturally occur in sufficient concentrations to impact Townsend's big-eared bat populations and will not be addressed here. Human-produced toxins may be released or applied to the environment in many forms. Of greatest potential impact to Townsend's big-eared bat are toxins used for control of agricultural and other pests (pesticides), byproducts of mining and ore processing, and air quality contaminants.

Pesticides. The California Department of Pesticide Regulation publishes an annual Pesticide Use Report for California (available at www.cdpr.gov). These reports provide information on the types, amounts, and general location of pesticides used each year in the state. According to the 2013 annual report (CDPR 2015), a total of about 88 million kg of all types of pesticides were applied in California. Figure 10 (based on data provided in CDPR 2015, Table 1), depicts the 2013 average application (kg/ha) of all pesticides for each county in California. Pesticide use appears to be greatest in the San Joaquin Valley, an area with relatively few recorded observations of Townsend's big-eared bat. However, as noted in the Petition, drift of agricultural pesticides is known to occur – for example, pesticide chemicals applied in the Central Valley have been detected in frogs living in the Sierra Nevada (Sparling et al. 2001).

The most recent Pesticide Use Report (PUR-2013, CDPR 2015), which reports annual pesticide use for many classes of pesticides, states "regression analyses on use from 1996 to 2013 do not indicate a significant trend of either increase or decrease in total pesticide use." However, inspection of the report's figures suggests that total use of certain classes of pesticides has decreased over the period 1995-2013, while others have remained roughly the same or increased. In particular, the most heavily used classes of pesticides (Fungicide/Insecticide, Insecticide) have shown a fairly marked decrease over the period (see Figure 1 of the PUR-2013). CDPR also tracks use of various pesticide chemical classes, including "reproductive toxicity" chemicals, carcinogens, cholinesterase-inhibiting chemicals (organophosphates and carbamates), groundwater-impacting chemicals, toxic air contaminants, fumigants, and biopesticides (microorganisms and naturally-occurring chemicals used in lieu of synthetic chemicals). Some classes, such as the "reproductive toxic" chemicals, cholinesterase-inhibiting

chemicals, and groundwater-impacting chemicals, have clearly decreased in usage (see Figures 6, 7, and 8 of PUR-2013). Others, such as carcinogens (PUR Figure 6), air contaminants (PUR Figure 9), and Fumigants (PUR Figure 10) have varied somewhat over the years but do not show a trend in use. Biopesticides (PUR Figure 12) have shown a steady increase in use over the report period.

The extent pesticide use in California impacts Townsend's big-eared bat populations is unknown; however, it is likely that some Townsend's big-eared bat individuals, at least, are impacted where these toxins are concentrated, either by ingestion of prey (including the potential for bioaccumulation within prey or bat) or water contaminated by pesticides, or by absorption through the skin after contact with pesticides in the air or on surfaces. These impacts may result from both lethal and sub-lethal exposure effects on survival and reproduction. While it is encouraging that use of some of the most environmentally damaging pesticides has decreased over the past two decades, it is unknown what level of threat the current and future levels of application pose to Townsend's big-eared bat populations.

Comment [js11]: Apart from direct toxic effects, it is perhaps worth mentioning that broad scale use of pesticides also reduces overall insect abundance and this can affect COTO populations.

Mine Toxins. Mineral extraction can result in pools of water contaminated with toxic chemicals. Such toxic pools have long been recognized as a threat to wildlife, including bats that may drink from them (Clark and Hothem 1991). The rising price of gold in the 1980s led to the renewal of mining using cyanide leaching as an extraction method in gold fields previously considered depleted. See the section on Mining for more information on renewed mining). The research and publicizing of the threat to wildlife of open cyanide ponds resulted in greater attention to this problem by federal and state regulators (S. Reeves 2015 pers. comm.), as well as industry-led measures to reduce the environmental hazards associated with cyanide leach fields (SME 2014).

The "International Cyanide Management Code for the Manufacture, Transport, and Use of Cyanide In the Production of Gold" is an industry voluntary program for gold mining companies. It is intended to provide for the safe management of cyanide and cyanidation mill tailings and leach solutions. Companies that adopt the code must have their mining operations that use cyanide to recover gold audited by an independent third party to determine the status of code implementation. Those operations that meet the code requirements can be certified. The code was developed by a multi-stakeholder steering committee under the guidance of the United Nations Environmental Program and the International Council on Metals and the Environment (http://www.cyanidecode.org/about-cyanide-code#sthash.4jbDJ744.dpuf).

According to available information, the largest gold mines in California are certified under the code (S. Reeves 2015 pers. comm.). Although toxic leach fields and ponds remain a potential threat to Townsend's big-eared bat, CDFW believes that oversight of the mining industry by BLM, regional Water Quality Control Boards, and the California Geological Survey minimize the risks associated with mine toxins to an acceptably low level.

Air Quality. As described in the Petition, poor air quality on a local or regional basis may result from human transportation, energy production and manufacturing activities, ground disturbance, and erosion and loss of native vegetation cover. Although it is reasonable to conclude that Townsend's big-eared bat (and bats in general) may be affected by poor air quality due to their high metabolic rate when

active, CDFW is not aware of any research indicating an impact of air pollutants in bat populations in California.

Climate Change

As described in CDFW's document outlining the agency's plans to address climate change (CDFG 2011), "a growing body of scientific research indicates California's remarkable diversity of habitats and wildlife is threatened by climate change. Ecological changes, including changes in species' distributions, timing of life cycles, and abundance, have already occurred in California over the past century in concert with increases in average temperature and changes in precipitation patterns (California Natural Resources Agency 2009). Existing stressors such as human population growth and associated land use changes, water management conflicts, invasive species, and other widespread stressors will be exacerbated by climate change, and could increase negative impacts to ecosystems beyond the effects of individual stressors."

To assess the potential for future climate change to affect the distribution of Townsend's big-eared bat, Stewart (J. Stewart, unpublished data) conducted MaxEnt modeling using climatic variables to model the current and possible future distribution of the species under several projections of future climate during the period 2070 to the end of the 21st Century. This method uses the concept of a "climate envelope", the geographic area with a climate suitable for a species' survival. Such "envelopes" are generally expected to move up in elevation and north in latitude in the future with a warming climate.

The best predictors of Townsend's big-eared bat distribution in California were temperature and snowpack, with average amount of snowpack providing the most parsimonious model – that is, the species is less likely to occur in areas with greater snowpack (J. Stewart 2015 pers. comm.). Under four different future climate change projections (generally described as Warm-Wet and Hot-Dry) and two greenhouse gas emission scenarios (High and Low), Townsend's big-eared bat is projected to fare reasonably well, in terms of availability of climatically suitable habitat in California (see Figure 11). Although under some scenarios the species' suitable range is projected to retract in some areas (red areas in the figure), most of the currently-suitable modeled habitat is projected to remain suitable. Some areas, notably in the northern and higher elevations areas of the state, are projected to increase in suitability in the future. Under the worst-case scenario for Townsend's big-eared bat, 88% of current known locations for the species are projected to remain suitable. Other scenarios indicated 90% to 95% of current locations would remain suitable.

Stewart (2015 pers. comm.) suggests these results are not surprising, given the generally wide distribution of Townsend's big-eared bat in California, as well as its broad distribution in North America, including south through much of Mexico to the edge of the tropics. While such modeling may not accurately or precisely predict future habitat suitability for a species, and additional work is needed to ensure that future climate does not substantially impact Townsend's big-eared bat (for example, though loss of surface water and suitable foraging habitat, or de-coupling of suitable roost site structures from suitable climate areas), at this time CDFW has determined that climate change does not pose a significant threat to the species.

Mining

California has a long history of mining due to its variety of mineral and geologic resources. California ranks second nationwide in production of minerals other than fossil fuels (Department of Conservation 2000). Starting even before the Gold Rush era of the mid-1800s, tens of thousands of mines have been excavated in the state. The Abandoned Mine Lands Unit (AMLU) of the California Department of Conservation (Department of Conservation 2009) estimates that there are approximately 47,000 abandoned mine sites in California. Although mines exist throughout the state, the majority of these mines are concentrated in the desert regions and western Sierra Nevada foothills (see Figure 12). Approximately two-thirds of abandoned mine sites are on federal land, 31% are on private land, and 2% are on state and local government land.

Mines provide important shelter for Townsend's big-eared bat and other bat species that evolved to roost in natural caves and crevices. Historic mining has created habitat for bats and other wildlife. Eighty percent of the mines in the western U.S. show some evidence of bat activity (Tuttle and Taylor 1998). Mines may be used by Townsend's big-eared bat year round for their roosting needs. These include critically important maternity and hibernation seasons. Large, structurally diverse mines may provide both warm roosts for maternity colonies and the cool or cold temperatures during hibernation (Pierson and Fellers 1998, Pierson and Rainey 1991, 1998; Pierson et al. 1999).

Mines may also offer prey such as moths and other insects and open water for drinking in chambers that intercept ground water. Such water resources are especially important in desert regions where surface water may be uncommon.

Because of the importance of historical and abandoned mines to Townsend's big-eared bats, several management issues related to mines and mining may pose a threat to the species. These include: closure of mines, renewed mining, environmental contamination, and human disturbance at mine roosts. The latter two topics are discussed elsewhere in the Threats section of this report.

Abandoned Mine Lands (AML) programs are tasked with the closure of open mines hazardous to human safety. To determine the appropriate closure method at a mine, it is necessary to determine through surveys what species may be using the mine. Permanent abandoned mine closure methods have resulted in the destruction of roosting habitat and have also caused direct mortality of bats by trapping them within the closed mine without exclusion at the appropriate season (Brown 1995b; Altenbach and Pierson 1995). Bat conservationists have advocated for assessment and planning for the appropriate mine closure method (fences, bat gates, cupolas, large grates) that allow bats to pass through openings too small for humans, while maintaining air flow patterns crucial for internal habitat conditions (Sherwin *et al.* 2009).

California's Department of Conservation has an AML unit that is actively engaged in reducing the hazards associated with open mines. It works with state and private mine owners to ensure that wildlife-compatible closure methods are implemented. It also coordinates with federal land management agencies for closures on BLM and other federal lands. See

http://www.conservation.ca.gov/omr/abandoned_mine_lands for more information on AML issues in California.

Modern methods of mineral extraction have allowed mining companies to renew mining in historical areas previously abandoned. For example, the use of chemical extraction methods for gold from open pit mines often occurs directly in areas with abandoned shaft mines. Renewed mining in historical mine districts has the potential to impact Townsend's big-eared bat and other bat species where the modern mine obliterates the previous underground mine (Pierson et al. 1991). In addition, renewed mining may impact native vegetation and water sources used for foraging around the mine, and may introduce chemical contaminants used for mineral extraction to the environment. See the section on Environmental Contaminants for more information on this aspect of mining impacts to bats.

In summary, CDFW considers the impacts associated with mine closures and renewed mining to be important potential threats to Townsend's big-eared bats. Active AML programs at the state and federal level should minimize the threat of mine closures to sensitive species. Environmental review of proposed mining projects through CEQA and NEPA should ensure adequate assessment and disclosure of potential impacts to Townsend's big-eared bat of such projects. Provided such programs are adequately funded by state and federal agencies, it is likely that population-level impacts associated with legacy mines and renewed mining would not occur. However, there is less certainty that important roost sites and Townsend's big-eared bat populations would be adequately protected in the absence of a listing of the species as threatened or endangered.

Overexploitation (for Scientific Use)

As a nongame mammal (defined in Fish and Game Code section 4150), Townsend's big-eared bat is not harvested or collected for commercial or personal use. Collection of Townsend's big-eared bat does occur in California on a limited basis for bona fide scientific and educational purposes. Such collection is regulated according to Fish and Game Code (sections 1002 *et seq*.), which is administered by CDFW.

In the past, scientific collections were made on a much greater scale than occurs today. The mammal collections at the Museum of Vertebrate Zoology, Los Angeles County Museum of Natural History, and at many other museums and universities in the western U.S. were established through the lethal taking of representative specimens of California's mammalian fauna. Such collections remain an important resource for scientific investigations of the phylogeny, evolution, taxonomy, diet, morphology, physiology of California's fauna (Pyke and Ehrlich 2010).

For long-lived/low fecundity species such as Townsend's big-eared bat, it is possible that repeated scientific collection may have a population impact. As documented by Brown et al. (1994), the Townsend's big-eared bat maternity colony at Prisoners Harbor (Santa Cruz Island) was subjected to three collecting episodes over a period of 25 years in which a total of 246 individuals were taken. The Santa Cruz Island colony, which apparently numbered "more than" 300 individuals (which probably included both adult females and their young) in 1939, has never recovered to its historical size, though other impacts, including roost loss and disturbance have been contributing factors.

Non-collecting scientific study may also impact Townsend's big-eared bat populations through disturbance of roosts. Before Townsend's big-eared bat's susceptibility to roost site disturbance was well documented, Pearson et al. (1952) conducted investigations of the basic ecology and reproductive biology of Townsend's big-eared bat in California. These studies included occasional entry into maternity and hibernation roosts at multiple sites around California to collect information and to place wing-bands on bats. In one case, the authors banded 75 young Townsend's big-eared bats during the early night while the adult females were foraging. By the next morning, the young had been carried by their mothers to another roost site, presumably in response to the disturbance at the original roost site (Pearson et al. 1952). The authors did not document whether there was an impact in terms of growth or survival of the young from this disturbance event.

Placement of wing bands on bats is a long-standing method used to mark individual bats (Barclay and Bell 1988, Gannon et. al. 2007). Recapture of banded bats can provide information on movements, survival, and population size. Based on available information, it appears Townsend's big-eared bat does not handle wing-banding as well as other bat species. Ellison (2010) summarized results from her own and others' studies suggesting a relatively high proportion of banded Townsend's big-eared bat suffer from perforated wing membranes, scarring, tissue-swelling, infection, and irritation. Moreover, the banding activity may have disturbed some individuals sufficiently to cause them to move to different roost sites (Ellison 2010).

Because of the concerns related to over-collection, disturbance at roosts, and wing-banding, CDFW carefully controls the activities of scientific researchers working on Townsend's big-eared bat in California. All persons who may take[5] Townsend's big-eared bat for scientific or educational purposes are required to possess a current Scientific Collecting Permit and, while a candidate for listing, a CESA Memorandum of Understanding issued under the authority of Fish & G. Code § 2081(a). Among the standard conditions of research permits are: a prohibition on entry into known roost sites (unless specifically authorized for a particular study), immediate departure from sites discovered to be maternity roosts, and measures to minimize the risk of introducing the fungus that causes White Nose Syndrome to hibernacula. Wing-banding is not currently authorized for any researcher working on Townsend's big-eared bat. No collection of Townsend's big-eared bat specimens is currently authorized for any individual. Prior to Townsend's big-eared bat's designation as a Candidate for listing, Scientific Collecting Permits that authorized work with Townsend's big-eared bat had similar provisions for the protection of Townsend's big-eared bat individuals and populations.

Given the level of control exerted by CDFW on scientific researchers working with bats, overexploitation for scientific purposes is not considered to be a threat to the continued existence of Townsend's big-eared bat in California.

[5] "Take" is defined in Fish and G. Code §86 as "to hunt, pursue, catch, capture, or kill" or to attempt to do so.

Habitat Essential for Continued Existence of the Species (FISH & G. CODE § 2074.6)

In 1952, after intensive study of Townsend's big-eared bat at several maternity and hibernation roosts at both coastal low elevation sites and interior high-elevation sites, Pearson and his co-authors considered factors that may be limiting Townsend's big-eared bat populations in California. They dismissed predation as a limiting factor, as they had never observed a predation event or evidence of such, nor were they aware of any important natural predators of Townsend's big-eared bat.[6] Disease was likewise discounted in importance due to lack of observation. Pearson et al. (1952) considered the availability of food and water as a possible limiting factor, but could not address this factor given a lack of data on prey availability. Regarding roost site availability, the authors noted that each maternity and hibernation roost site in their study seemed large enough to house many more Townsend's big-eared bat individuals than were observed. They reasoned that at the local scale food or water may be limiting, but on a regional scale appropriate roost sites may be limiting the total population size. Appropriate roost sites not only must have suitable size and other structural and microclimate characteristics, but also must be near suitable foraging habitat, including safe and accessible sources of open water for drinking.

With these considerations in mind, and with the apparent loss of historical roost sites documented by Pierson and Rainey (1998) and others, and the expected continued degradation and loss of old buildings suitable for use as roost sites (Fellers and Halstead 2015, G. Tatarian 2014 pers. comm.), CDFW considers any structure, or set of structures, used by Townsend's big-eared bat as a maternity or hibernation roost to be habitat essential for the continued existence of the species. The essential characteristics of these suitable roost sites extend to the nearby foraging, commuting, and night-roosting habitat and therefore these adjacent habitats are also considered essential.[7]

It may be possible on a case-specific basis to identify alternative or replacement roost structures, or set of structures (to allow for roost-switching), and adjacent habitat that would serve a local Townsend's big-eared bat population. The suitability of such alternative or replacement roost sites would need to be demonstrated (through comparable use by the local Townsend's big-eared bat population) prior to considering any occupied roost unnecessary for the population. CDFW is not aware of any replacement roost structure having been purpose-built for use by Townsend's big-eared bat, but this is a management action that should be explored on an experimental basis.

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[6] But see Fellers's 2000 report of black rats, *Rattus rattus*, preying upon non-volant young Townsend's big-eared bat at the Randall House maternity roost, as well as his description of the possible effect of owl presence on roost departure times of Townsend's big-eared bat at the same site (Fellers 2014).

[7] In particular, as noted by Tatarian (2015 pers. comm.), structures used for roosting by single Townsend's big-eared bats in the vicinity of maternity roosts and hibernacula may be essential to allow population-level behaviors essential to reproduction. These behaviors include socialization between adult females and males in the fall leading to mating at mixed-sex overwintering roost sites, as well as fledging and dispersal of young at the end of the maternity season.

EXISTING MANAGEMENT, MONITORING, AND RESEARCH ACTIVITIES

CDFW

The California Department of Fish and Wildlife is the state trustee agency for fish, wildlife, and botanical resources. In addition to its current status as a Candidate for CESA listing, CDFW designates Townsend's big-eared bat as a Species of Special Concern (Williams 1986). The SSC designation does not confer any legal protection on the species, but rather is intended to ensure management, conservation, and research activities are implemented to prevent future declines and the need for listing under the California Endangered Species Act (Comrack et al. 2008). As an SSC, Townsend's big-eared bat is also designated as a Species of Greatest Conservation Need (SGCN) in California's State Wildlife Action Plan (SWAP, CDFG 2007). This designation provides additional focus on the species by CDFW, as well as funding opportunities for research and conservation actions from the State Wildlife Grant program of the U.S. Fish and Wildlife Service.

As part of CDFW's general mission to monitor wildlife resources, known Townsend's big-eared bat roosts on CDFW lands (Wildlife Areas and Ecological Reserves) are monitored. This includes the maternity colony that occurs on the Chorro Creek Ecological Reserve in CDFW's Central Region. Through on-going monitoring, CDFW has documented the impact of human disturbance at this site and has implemented measures to reduce the threat of disturbance to the colony (R. Stafford 2014, 2015 pers. comms.).

Townsend's big-eared bat is currently a Candidate for listing as threatened or endangered under the California Endangered Species Act. As such, the prohibition on "take" of listed and candidate species of CESA applies to Townsend's big-eared bat. Regulatory programs of CDFW now review proposed CEQA, timber harvesting plans, and scientific research applications to ensure that no take of the species would occur, unless authorized by one of the statutory exemptions allowing such take, such as the Incidental Take Permit and Safe Harbor mechanisms of CESA, or through a Memorandum of Understanding for take for scientific or educational purposes. All such take may only be authorized if it is fully mitigated and would not jeopardize the continued existence of the species in California. As mentioned above, should the species not be listed then it would revert to the Species of Special Concern designation. SSCs typically receive some attention during CEQA review, but protection from take and population-level impacts is less certain. This applies not only to projects for which CDFW is the lead or responsible agency, but for CEQA projects for which other state agencies (such as CDPR and CalFire, see below) or counties or cities are the lead agency.

CDFW is currently implementing three projects relevant to Townsend's big-eared bat that are funded by the State Wildlife Grant (SWG) program. The California Bat Conservation Plan (CBCP) was initially funded by SWG in the mid-2000s and, after several years of development is now nearing completion, thanks in part to a new SWG to complete final edits. The CBCP addresses the management and conservation of all bat species occurring in California, including Townsend's big-eared bat, and will provide specific recommendations for the management, policy development, and research for all species, all ecoregions, and all the major conservation issues affecting bats in the state. Included in the

CBCP is a relative ranking of the species for conservation concern – Townsend's big-eared bat consistently was rated by the authors as among the greatest concern bat species.

The second SWG-funded project directly addresses the current conservation status of Townsend's big-eared bat in California. Previously, the California Department of Fish and Game funded a statewide survey for Townsend's big-eared bat in the 1980s by Elizabeth Pierson and William Rainey (Pierson and Rainey 1998). The new statewide survey effort is being conducted over a two-year period and is targeting known and highly-suitable locations for maternity and hibernation roosts. This project is being contracted to researchers from Humboldt State University and Texas A&M University (Joe Szewczak and Michael Morrison) and should provide an updated snapshot of the species' status as of 2015-2017.

SWG funding was also provided to CDFW to implement a project to expand bat monitoring in California according to the North American Bat Monitoring Program (Loeb et al. 2015). This project is initially focused on acoustic monitoring of bat activity around the state, which probably will not provide a lot of data on Townsend's big-eared bat due to its quiet echolocation calls. However, CDFW plans to increase efforts to monitor important roosts for this and other species in the future as the NABat program continues to develop.

CDPR

The California Department of Parks and Recreation manages state parks throughout California. As with other land management agencies, CDPR manages sensitive biological resources, such as Townsend's big-eared bat, both through review of proposed project impacts under the environmental review process, as well as through focused monitoring efforts at known roosts (such as at Hearst San Simeon State Historical Monument).

CalFire

The California Department of Forestry and Fire Protection (CalFire) is the lead agency in California for timber harvest projects on private and state forest lands. Timber harvest review is a CEQA-equivalent environmental review process and, as such, requires proposed timber management projects to assess and disclose potential impacts on the environment, including to biological resources. Since the designation of Townsend's big-eared bat as a candidate for listing under CESA, CalFire has been proactive in working with timber companies and registered professional foresters to ensure significant impacts to the species, as well as "take," are avoided.

NPS

The National Park Service lands in California include several known Townsend's big-eared bat roost sites, including the large number of caves at Lava Beds National Monument, the Randall House maternity colony at Point Reyes National Seashore, the hibernacula and maternity roosts at Pinnacles National Park, and the Scorpion Ranch maternity roost on Santa Cruz Island. In general, the NPS approach to sensitive biological resources, such as Townsend's big-eared bat and its habitat, is to survey, monitor, manage, and to conduct research on the species.

In addition to the monitoring and management of the aforementioned sites, work by E.D. Pierson and others in Yosemite National Park (Pierson and Heady 1996, Pierson and Rainey 1997, and Pierson et al. 2006) provided baseline information on bat use of the Yosemite area, including on Townsend's big-eared bat (S. Stock 2014 pers. comm.).

BLM

The Bureau of Land Management designates Townsend's big-eared bat as a sensitive species. This designation requires land use plans to address the species and its habitat and to incorporate the species' needs in a manner to reduce potential conflicts with other multiple use activities. On BLM-administered lands, BLM manages a sensitive species and its habitat to minimize or eliminate threats affecting the status of the species or to improve the condition of the species' habitat. BLM assists, as funding allows, in determining distribution, abundance, and condition of the species, and to manage the habitat in such a manner to improve the conservation status of the species and ensure that BLM actions do not move the species towards needing to be listed (A. Fesnock 2015 pers. comm.).

Based on information gathered for this status review report (A. Fesnock 2015 pers. comm.), Townsend's big-eared bats are known to occur on BLM lands throughout much of California. As with other lands, most records for the species are from roost structures, including mostly abandoned mines. The BLM has an active survey and assessment program that evaluates abandoned mines for public safety hazards, wildlife and historical resources, and recommended closure methods. Evaluations of abandoned mines conducted over the past 15 years indicate many such mines are used by Townsend's big-eared bats. Few repeat visits or monitoring programs have been implemented, however, and therefore inferences about population status or trend cannot be made. Many of the BLM roost sites surveyed since 1999 are being re-visited as part of the current CDFW-funded statewide survey project.

All of the BLM field offices in California consider Townsend's big-eared bat roost sites (both hibernacula and maternity roosts) to be important resources to protect and manage. Many such sites have been gated in the past two decades to allow bats to use the sites without human disturbance (BLM unpublished data). The BLM expects to continue with gating abandoned mines to protect bat habitat and for public safety (A Fesnock 2015 pers. comm.).

USFS

The U.S. Forest Service in California lists Townsend's big-eared bat on its Regional Foresters Sensitive Species list. As such, the species is given almost as much protection as a species listed as threatened or endangered under the federal Endangered Species Act (L. Angerer 2015 pers. comm.). USFS projects and management actions are evaluated to ensure project effects do not put the species on a trend towards endangered or threatened status.

In particular, the USFS completes Biological Evaluations for all Sensitive Species prior to implementing projects and management actions. Each Biological Evaluation includes management recommendations for the Sensitive Species. In general, Townsend's big-eared bat colonies are protected. When a project is proposed that may impact a roost site (such as a mine closure or historical building removal) measures

are implemented to replace the lost structure or to improve the use of the structure by bats after project completion.

Most known Townsend's big-eared bat roost sites on Forest Service lands are not consistently monitored (though with some exceptions, such as the Kentucky Mine colony in the Sierra National Forest). The overall strategy implemented by the USFS has been to protect and avoid impacts (L. Angerer 2015 pers. comm.).

SUMMARY OF LISTING FACTORS (14 California Code of Regulations 670.1)

CESA directs CDFW to prepare this report regarding the status of Townsend's big-eared bat based upon the best scientific information available to CDFW. CESA's implementing regulations identify key factors that are relevant to the CDFW's analyses. Specifically, a "species shall be listed as endangered or threatened ... if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors: (1) present or threatened modification or destruction of its habitat; (2) overexploitation; (3) predation; (4) competition; (5) disease; or (6) other natural occurrences or human-related activities." (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A)).

The definitions of endangered and threatened species in the Fish and G. Code provide key guidance to CDFW's scientific determination. An endangered species under CESA is one "which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease" (Fish & G. Code, § 2062). A threatened species under CESA is one "that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by [CESA]" (*Id.*, § 2067).

The following summarizes CDFW's determination regarding the factors to be considered by the Commission in making its decision on whether to list Townsend's big-eared bat. This summary is based on the best available scientific information, as presented in the foregoing sections of the report.

Present or threatened modification or destruction of its habitat

Disturbance, degradation, and loss of suitable roost sites is a recognized threat to Townsend's big-eared bat populations, both in natural roost sites such as large, old trees and caves, as well as in artificial roosts such as old buildings and mines. Although recent examples of disturbance at roost sites are relatively rare compared to such events in the historical period, lacking the protections of CESA it is possible the species could be impacted at multiple roost sites in the future, which could lead to population-level impacts. However, there is no current indication disturbance of roost sites is a significant threat at this time. Additionally, although impacts to foraging habitat could also affect the species, there is no current indication that impacts to foraging habitat poses a significant threat at this time. Therefore, CDFW does not consider modification and destruction of habitat to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Overexploitation

CDFW does not consider overexploitation to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Predation

CDFW does not consider predation to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Competition

CDFW does not consider competition to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Disease

White Nose Syndrome is an important potential threat to Townsend's big-eared bat in California. Monitoring and research to determine the species' susceptibility to the disease as well as its occurrence in western North American are needed to assess the actual level of this threat. As discussed above, however, this disease is not currently impacting Townsend's big-eared bat in California. Therefore, CDFW does not consider disease to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Other Natural Events or Human-Related Activities

Mining (including renewed mining), agricultural development and pesticide use, restoration or demolition of old buildings and other anthropogenic structures used as roosts, forest management, and recreational caving and mine exploration all have the potential to impact Townsend's big-eared bat populations. State and federal environmental review programs typically include assessment and disclosure of potential impacts to the species in the CEQA/NEPA process. Adequate environmental review should prevent such activities from affecting Townsend's big-eared bat at the population or statewide level.

Climate change, especially more frequent and severe drought, has the potential impact Townsend's big-eared bat in California. Continued and increased monitoring of the species' abundance and distribution should help determine the actual impact of these threats to the species.

MANAGEMENT RECOMMENDATIONS

These recommendations were developed by CDFW in accordance with the requirements of Fish & G. Code, § 2074.6. This list includes some recommendations developed by other authors, including Johnston (2004), Ellison et al. (2003), Tigner and Stukel (2003), Hinman and Snow (2003), and Bradley et al. (2006). CDFW recommends these actions be implemented regardless of the Commission's decision on listing Townsend's big-eared bat as threatened or endangered. This list includes recommendations for actions that could be undertaken by CDFW as well as by other public agencies, non-governmental organizations, and private land owners.

Research and Monitoring Needs

- Complete comprehensive statewide population assessment of Townsend's big-eared bat by 2017.
- Implement consistent long-term monitoring at representative Townsend's big-eared bat roost sites in California.
- Design and test artificial structures suitable for use by Townsend's big-eared bat during the maternity and hibernation seasons.
- Create standardized procedures for monitoring Townsend's big-eared bat populations. Ensure all such studies will not adversely impact the subject populations.
- Conduct additional analyses of the possible effects of climate change and drought on Townsend's big-eared bat and determine best approaches to address possible adverse effects.
- Conduct research on the role environmental contaminants play in the health of Townsend's big-eared bat populations.
- Develop methods to create basal hollows in suitable large old trees.
- Conduct genetic studies to determine the population genetic structure of Townsend's big-eared bat in California, with special attention to the degree of divergence and isolation of populations on Santa Cruz Island relative to the mainland and between coastal and interior populations.

Comment [js12]: We could add on to this, or add another entry for a formalized study of the frequency of roost shifting and movements. This would provide vital guidance to calibrate the degree to which monitoring initiatives (and other disturbances) elicit movements. It would also help to calibrate the detection probability for roost surveys, and perhaps guide the number of visits needed to determine confidence levels for occupancy.

CDFW Administrative Actions

- If results of current statewide Townsend's big-eared bat survey indicate a decline in the population status is occurring that may lead to endangerment, prepare a staff recommendation to list the species as Threatened or Endangered for consideration by the Fish and Game Commission.
- Working with partners at state and federal agencies, as well as private landowners, ensure that management of Townsend's big-eared bat roost sites is consistent with continued site occupancy at or above existing population levels.
- Attempt to secure new funding and position resources as a priority to establish a full-time permanent bat specialist position within the Nongame Wildlife Program of CDFW to address data assimilation and conservation of bats in California, including Townsend's big-eared bat.
- Support research on the design and effectiveness of artificial structures suitable for use by Townsend's big-eared bat during the maternity and hibernation seasons.
- Create interagency and other stakeholder cooperation in, and public support for, conservation efforts for Townsend's big-eared bat. Partner with non-governmental organizations such as Bat Conservation International, The Nature Conservancy, and local NGOs in such efforts.
- Develop greater awareness of Townsend's big-eared bat and other bat conservation and management issues within CDFW.
- Direct fiscal and position resources to complete the draft California Bat Conservation Plan.

Management of Known Roost Sites

- Prior to changing management of caves, mines, or buildings that could be used by Townsend's big-eared bat or other bat species, such sites should be evaluated and/or surveyed during appropriate seasons for their use by Townsend's big-eared bat.
- Existing roosts should be left undisturbed and occupied roosts should only be entered for management or research purposes.
- Bat-friendly gates should be installed at Townsend's big-eared bat roosts where other methods of controlling human entrance are not effective. Special consideration should be given to gate design to minimize risk of injury or unsuitability for Townsend's big-eared bat.
- Abandoned mines suitable for use by Townsend's big-eared bat should not be collapsed or closed in a manner to prevent bat use.
- Effectiveness monitoring (use of data loggers to passively record bat use and human disturbance) should be implemented at gated roost sites and other roost sites actively managed for bat resources (as through signage, information for visitors, etc.).
- Ensure foraging habitat, including access to open water, within the vicinity of maternity roosts remains suitable for use by Townsend's big-eared bat. Analysis of habitat suitability should be made on a site-specific basis, but start with using the area within a 24-km radius of the roost site.
- Where a Townsend's big-eared bat or other bat roost site has a history of recreational use by humans, implement a management plan to ensure new impacts from human use do not occur. The Kentucky Mine Stamp Mill management plan (Tierney and Freeman 2007) is a good example of such a plan that appears to be successful.

Landscape Management Practices

- Developed springs and other water sources should be kept available for in-flight drinking as outlined in various "wildlife-friendly" water facility publications.
- If protracted drought poses a threat to Townsend's big-eared bat, develop additional water sources for drinking in areas where open water limits population size.
- Restore or enhance riparian habitat.
- Implement basal hollow creation projects to increase opportunities for Townsend's big-eared bat to use tree roosts in coastal redwood forests (and possibly in interior forests where large tree species, such as giant sequoia, have the potential to serve as roost sites)

CEQA Review of Proposed Projects

- Ensure direct and cumulative impacts from projects proposed under CEQA and CEQA-equivalent regulatory programs are not likely to result in a substantial reduction in population or range of Townsend's big-eared bat and other bat species.

Public Education and Outreach

- Conduct and cooperate with other agencies on public outreach events about Townsend's big-eared bat and other bat species.
- Disseminate the California Bat Conservation Plan to the public, when complete.

- Encourage citizen participation, as appropriate, in bat monitoring projects.
- Promote bat-friendly exclusions where it is necessary to remove bats from buildings and other structures.

Health and Disease

- Continue and expand surveillance for WNS by state and federal agencies and researchers.
- Support research on the etiology and epidemiology of WNS on *Corynorhinus* species, including Townsend's big-eared bat.
- Continue and expand, if necessary, decontamination requirements for persons entering hibernacula for Townsend's big-eared bat and other hibernating bat species to minimize the risk of introducing the fungus that causes WNS.
- Work with other state and federal regulatory agencies to prevent the introduction of environmental contaminants that may affect the health of Townsend's big-eared bat and other bats. These may include aerial pesticide application and chemicals used in processing mined minerals.

LISTING RECOMMENDATION

CESA directs CDFW to prepare this report regarding the status of Townsend's big-eared bat in California based upon the best scientific information. CESA also directs CDFW based on its analysis to indicate in the status report whether the petitioned action is warranted. (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).) CDFW includes and makes its recommendation in its status report as submitted to the Commission in an advisory capacity based on the best available science. In consideration of the scientific information contained herein, CDFW has determined that the petitioned action is or is not warranted at this time.

PROTECTION AFFORDED BY LISTING

It is the policy of the State to conserve, protect, restore and enhance any endangered or any threatened species and its habitat (Fish & G. Code, § 2052.). If listed as an endangered or threatened species, unauthorized "take" of Townsend's big-eared bat will be prohibited, making the conservation, protection, and enhancement of the species and its habitat an issue of statewide concern. As noted earlier, CESA defines "take" as to hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill. (*Id.*, § 86.) Any person violating the take prohibition would be punishable under State law. As to authorized take, the Fish & G. Code provides CDFW with related authority under certain circumstances. (*Id.*, §§ 2081, 2081.1, 2086, 2087 and 2835.) In general and even as authorized, however, impacts of the taking on Townsend's big-eared bat caused by the activity must be minimized and fully mitigated according to State standards.

Additional protection of Townsend's big-eared bat following listing is also likely with required public agency environmental review under CEQA and its federal counterpart, the National Environmental Policy Act (NEPA). CEQA and NEPA both require affected public agencies to analyze and disclose project-related environmental effects, including potentially significant impacts on endangered, rare, and

threatened special status species. Under CEQA's "substantive mandate," for example, state and local agencies in California must avoid or substantially lessen significant environmental effects to the extent feasible. With that mandate and CDFW's regulatory jurisdiction generally, CDFW expects related CEQA and NEPA review will likely result in increased information regarding the status of Townsend's big-eared bat in California as a result of, among other things, updated occurrence and abundance information for individual projects. Where significant impacts are identified under CEQA, CDFW expects required project-specific avoidance, minimization, and mitigation measures will also benefit the species. State listing, in this respect, and required consultation with CDFW during state and local agency environmental review under CEQA, would also be expected to benefit the species in terms of related impacts for individual project that might otherwise occur absent listing.

Listing Townsend's big-eared bat increases the likelihood that State and federal land and resource management agencies will allocate funds towards protection and recovery actions. Funding for species recovery and management is limited, however, and there is a growing list of threatened and endangered species.

ECONOMIC CONSIDERATIONS

CDFW is charged in an advisory capacity in the present context to provide a written report and a related recommendation to the Commission based on the best scientific information available regarding the status of Townsend's big-eared bat in California. The topic areas and related factors CDFW is required to address as part of that effort are biological and not economic. (See Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).)

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Townsend's big-eared bat CESA Status Review – Figures

Captions

1. Map showing geographic ranges of species and subspecies of North American long-eared bats as described by Handley (1959). Adapted from Piaggio and Perkins (2005, Figure 1).

2. COTO CWHR geographic range map, with occurrence locations.

3. COTO CWHR range map, with occurrence locations symbolized by time period.

4. Locations mentioned in the Population Trend section.

5. From Fellers and Halstead (2014, Figure 1). (A) Attempts to break into the Randall House, site of a *Corynorhinus townsendii* roost at Point Reyes National Seashore, California. (B) Annual number of adults (maximum count during May or June) and total *C. townsendii* (adults plus volant young; maximum count during July or August) emerging from roost at Point Reyes National Seashore.

6. COTO exit count data at Kentucky Mine maternity colony (Sierra County), 1996 - 2005. A. All counts. B. Early maternity season counts (before late July), without counts when the colony likely roosted elsewhere. C. Late maternity season counts (late July and later), without counts when the colony was likely roosting elsewhere. (source: Marilyn Tierney, unpublished data, and Freeman 2012).

7. From Weller et al. (2014, Figure 2). Estimated trend (solid line), upper and lower 95% prediction intervals (dotted lines), and number of Townsend's bigeared bats (*Corynorhinus townsendii*) counted (solid circles) during hibernacula surveys at 22 caves in Lava Beds National Monument, Siskiyou County, California, during 1991–2012. Caves are ordered top left to bottom right as largest to smallest observed counts.

8. From Weller et al. (2014, Figure 4). Estimates, with 95% prediction intervals, for the total number of Townsend's big-eared bats (*Corynorhinus townsendii*) hibernating in 52 caves at Lava Beds National Monument, Siskiyou County, California, during 1991–2012. The total number of caves surveyed each year is denoted as n on the x-axis.

9. Late summer (August – mid-September) exit counts for the COTO maternity colony site at Hearst San Simeon State Park, 2000 – 2014 (R. Orr, pers. comm.). For years with more than one count was conducted during the late summer season, the date with the highest count is depicted.

10. Average application of pesticides (kg/ha) for California counties, 2013, plotted with Townsend's big-eared bat occurrence locations.

11. Current and future projected climatically-suitable areas for Townsend's big-eared bat in California (J.Stewart, unpublished data) under four projections of future climate. Climatically-suitable areas were modelled using MaxEnt and existing occurrence records. For the period 2070-2099, areas shown in dark blue remain suitable, areas shown in red are suitable under current climate conditions but are projected to become unsuitable, and areas in light blue are modelled as currently unsuitable but would become suitable in the future.

12. California abandoned mines.

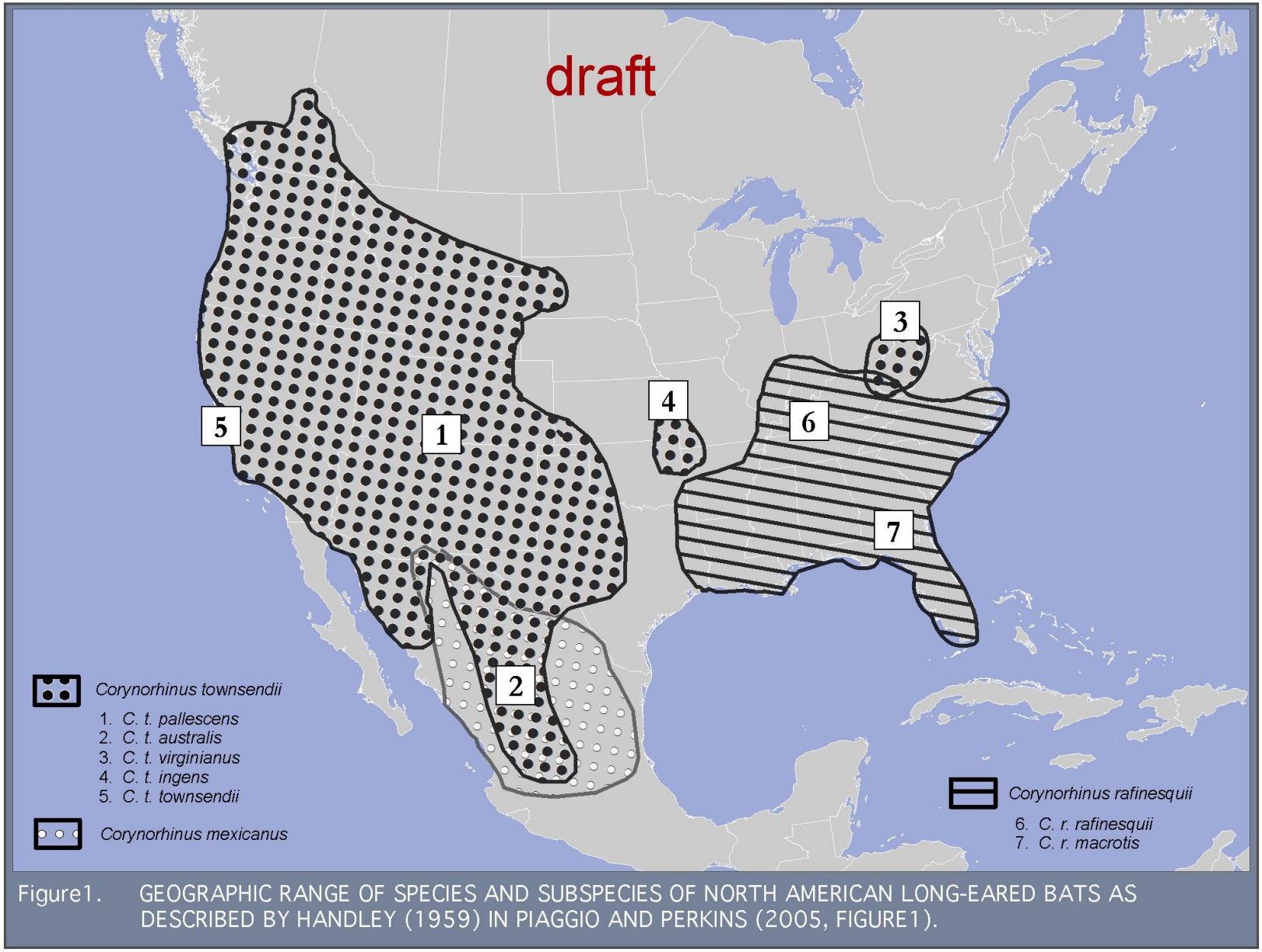


Figure1. GEOGRAPHIC RANGE OF SPECIES AND SUBSPECIES OF NORTH AMERICAN LONG-EARED BATS AS DESCRIBED BY HANDLEY (1959) IN PIAGGIO AND PERKINS (2005, FIGURE1).

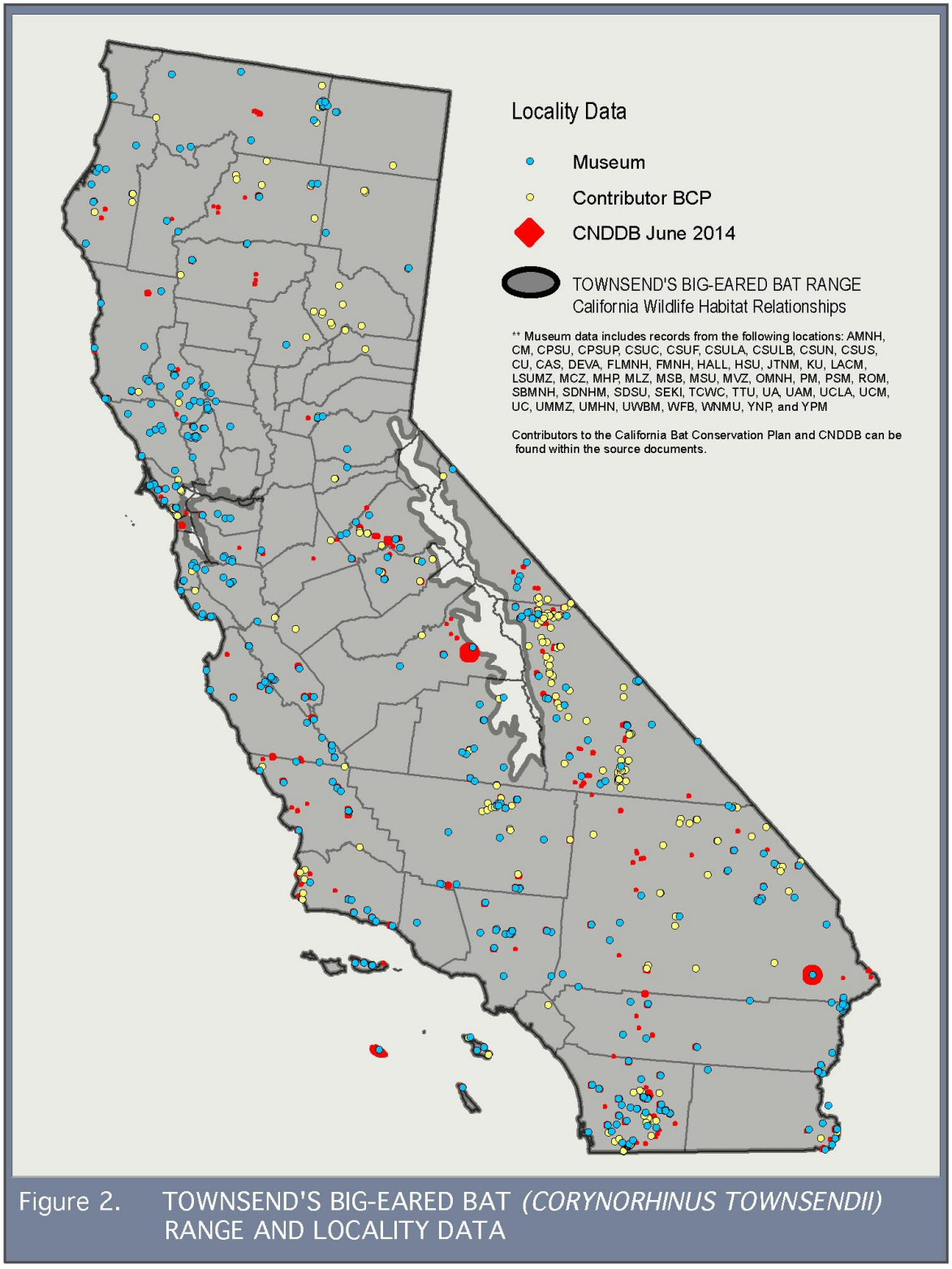


Figure 2. TOWNSEND'S BIG-EARED BAT *(CORYNORHINUS TOWNSENDII)* RANGE AND LOCALITY DATA

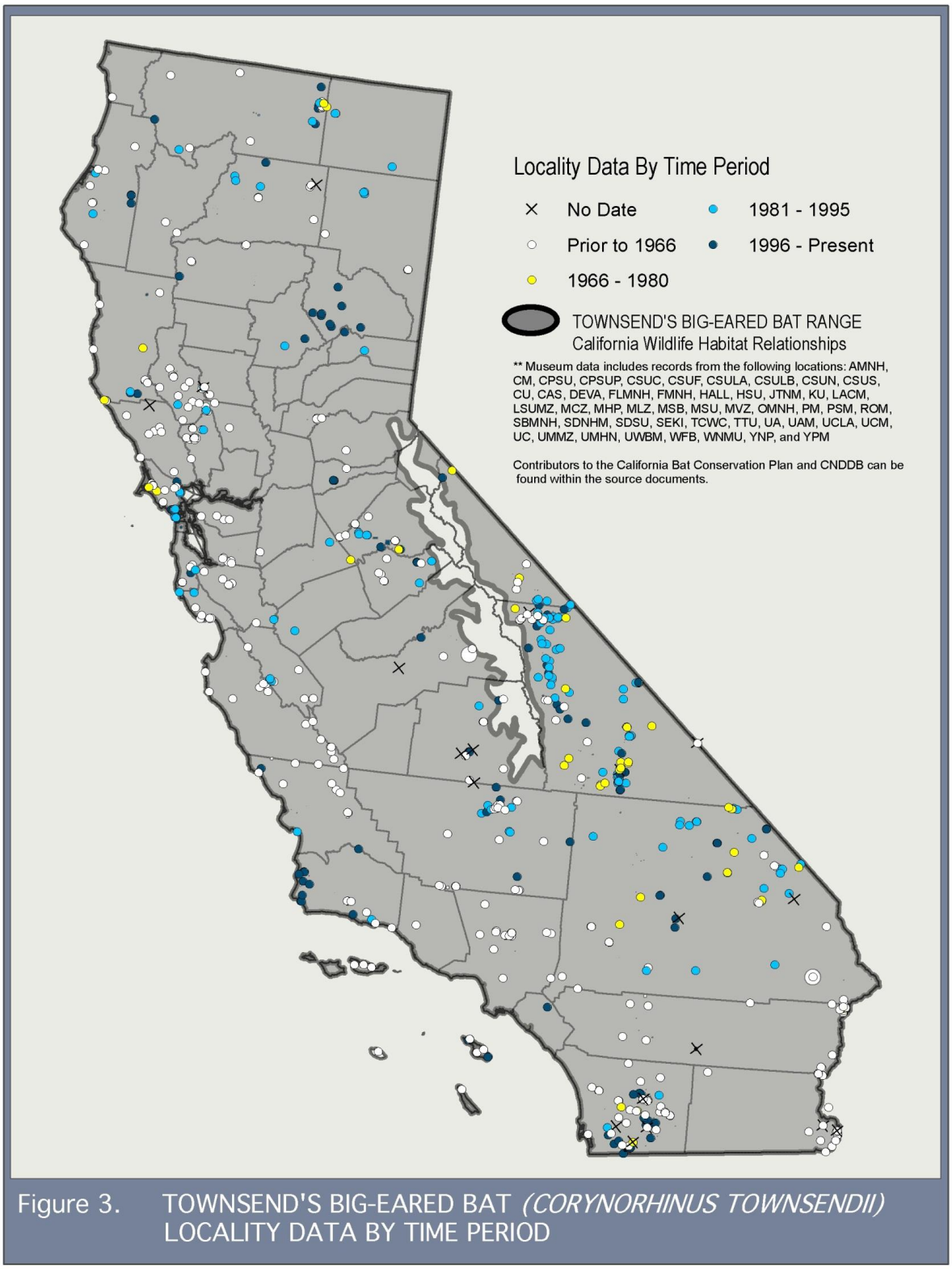


Figure 3. TOWNSEND'S BIG-EARED BAT *(CORYNORHINUS TOWNSENDII)* LOCALITY DATA BY TIME PERIOD

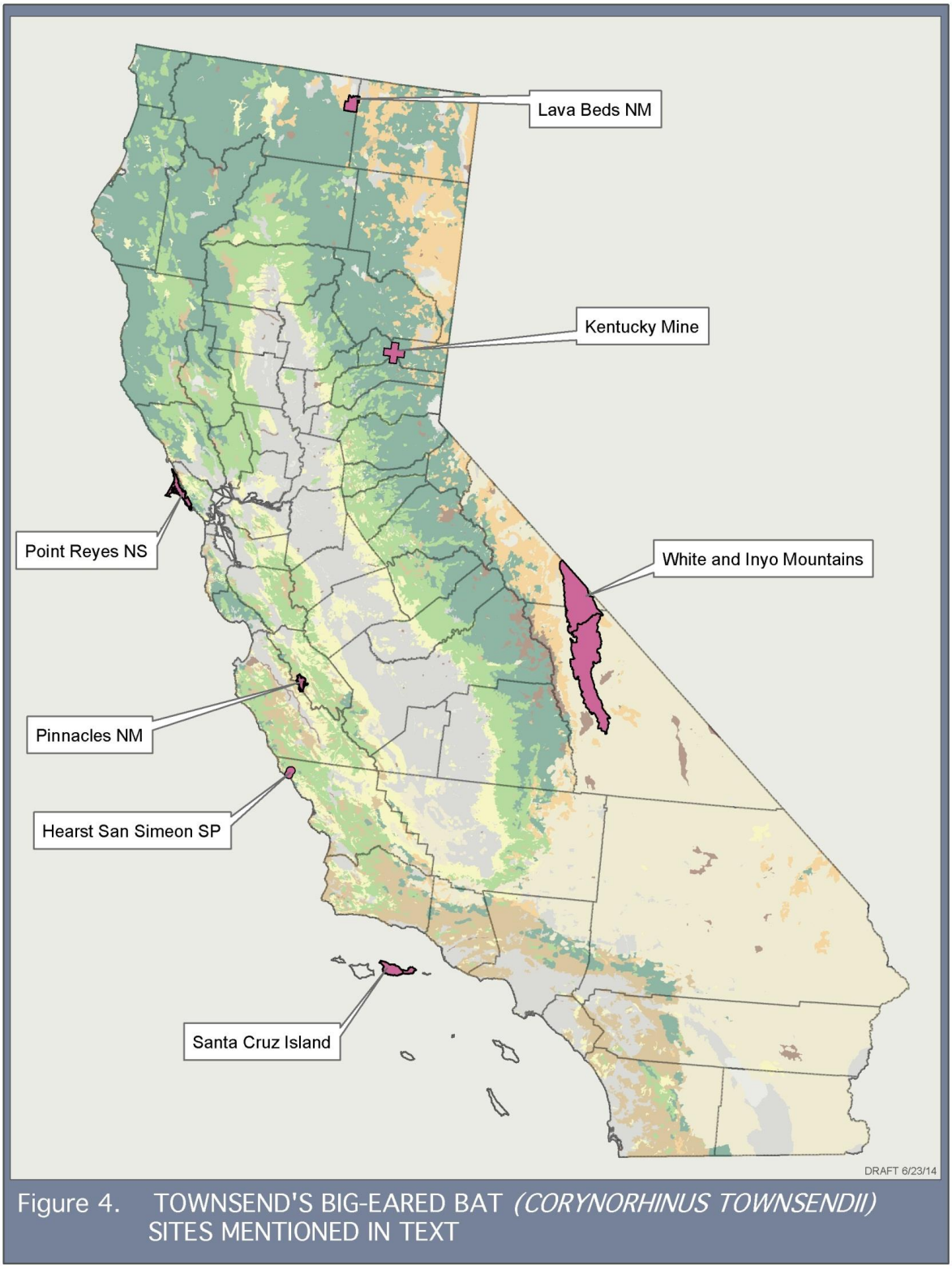
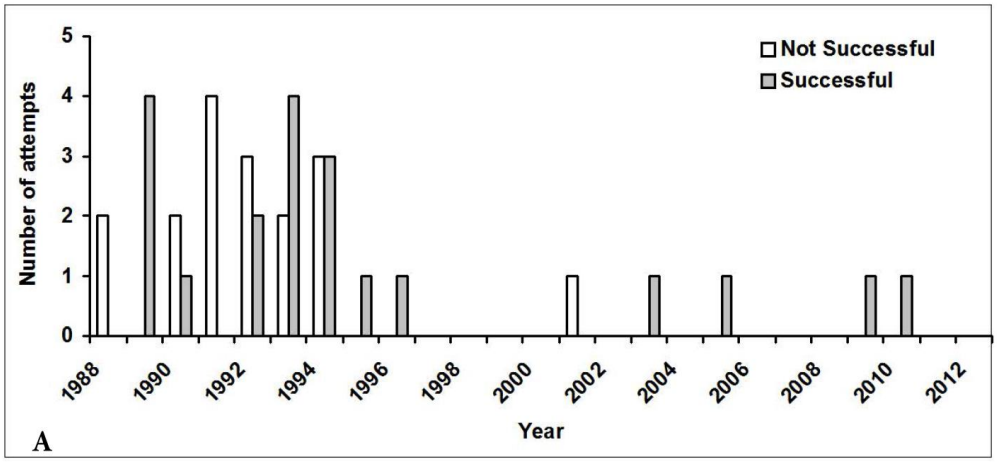


Figure 4. TOWNSEND'S BIG-EARED BAT *(CORYNORHINUS TOWNSENDII)* SITES MENTIONED IN TEXT

Figure 5.


Not Successful
Successful
Number of attempts
0
1
2
3
4
5
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Year
A

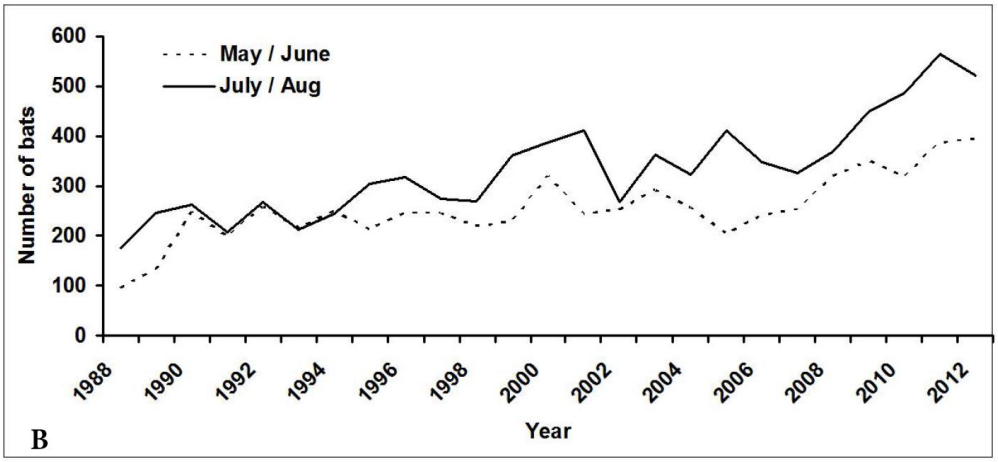

May / June
July / Aug
Number of bats
0
100
200
300
400
500
600
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Year
B

Figure 6. (A)

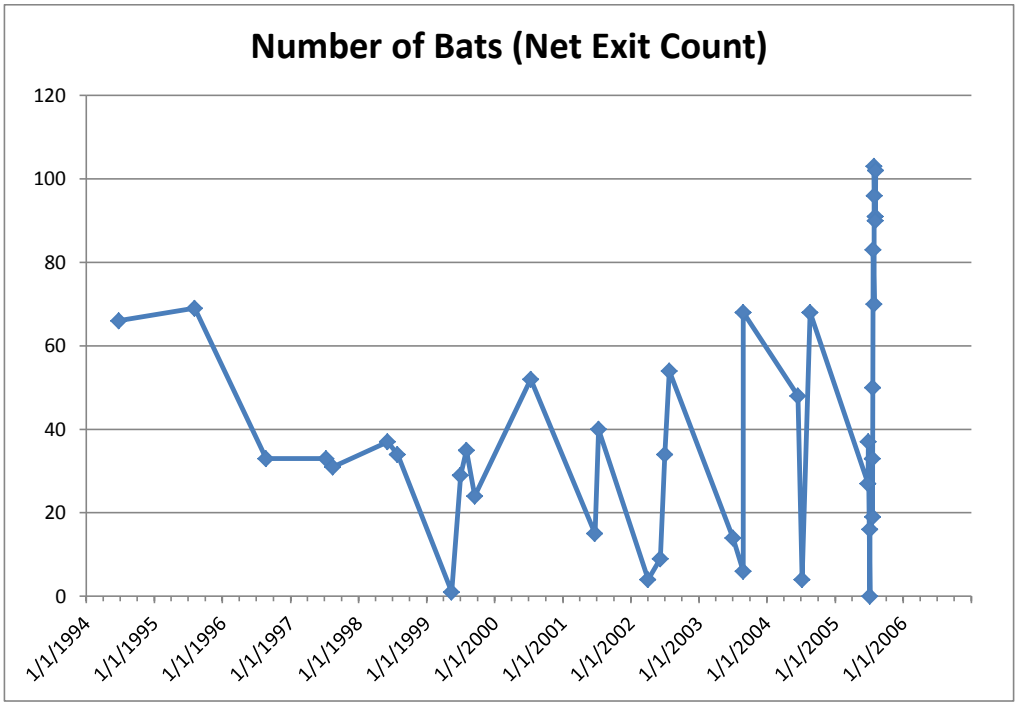

Number of Bats (Net Exit Count)
120
100
80
60
40
20
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004
1/1/2005
1/1/2006

Figure 6. (B, C)

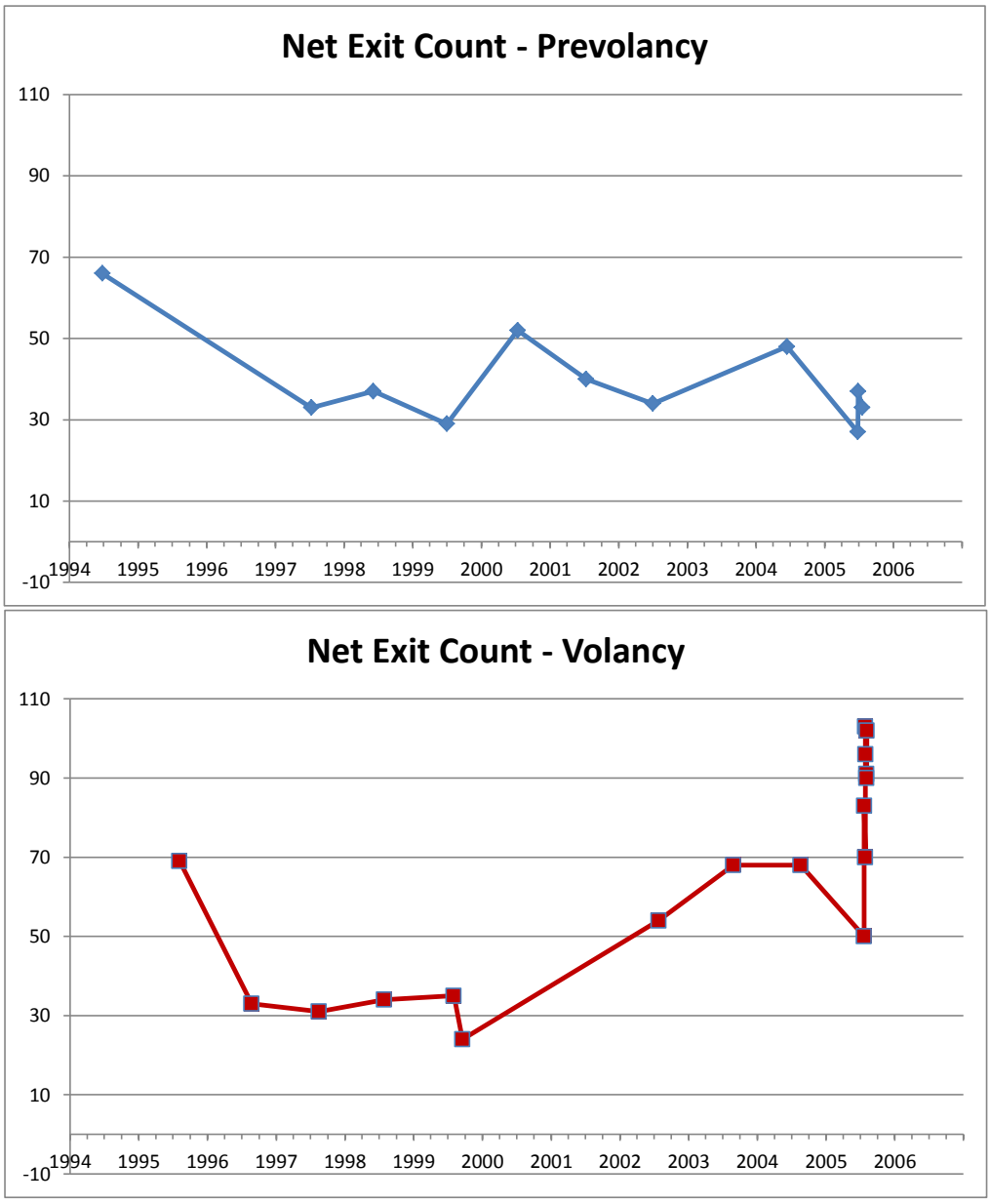

Net Exit Count - Prevolancy
110
90
70
50
30
10
-10
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
Net Exit Count - Volancy
110
90
70
50
30
10
-10
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006

Figure 7.

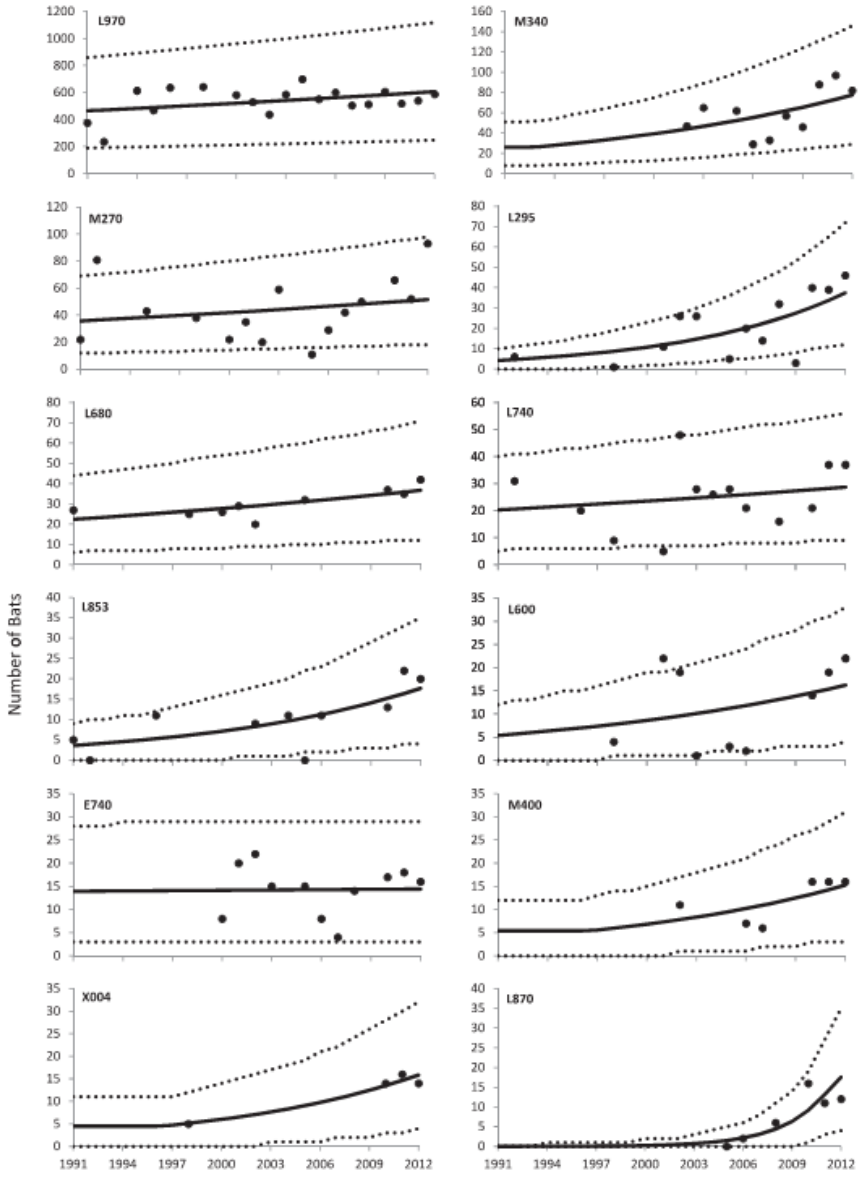

L970
M340
M270
L295
L680
L740
L853
L600
E740
M400
X004
L870
Number of Bats
1991
1994
1997
2000
2003
2006
2009
2012

Figure 7 (continued).

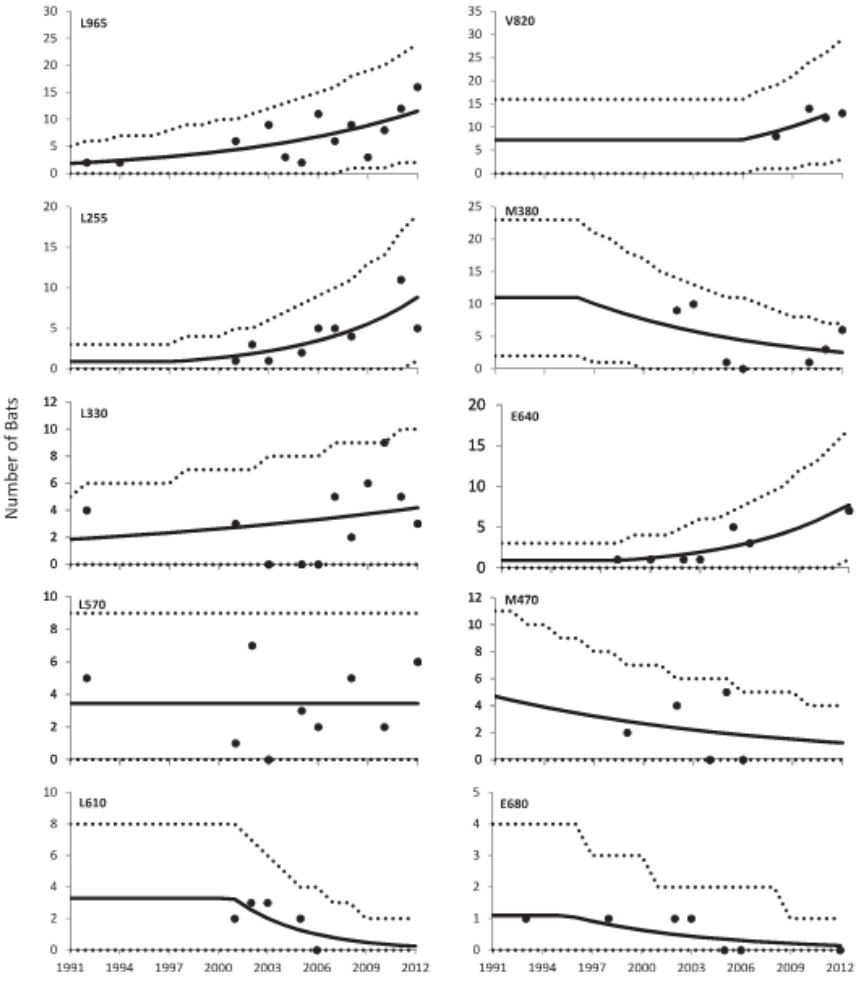


Figure 8.

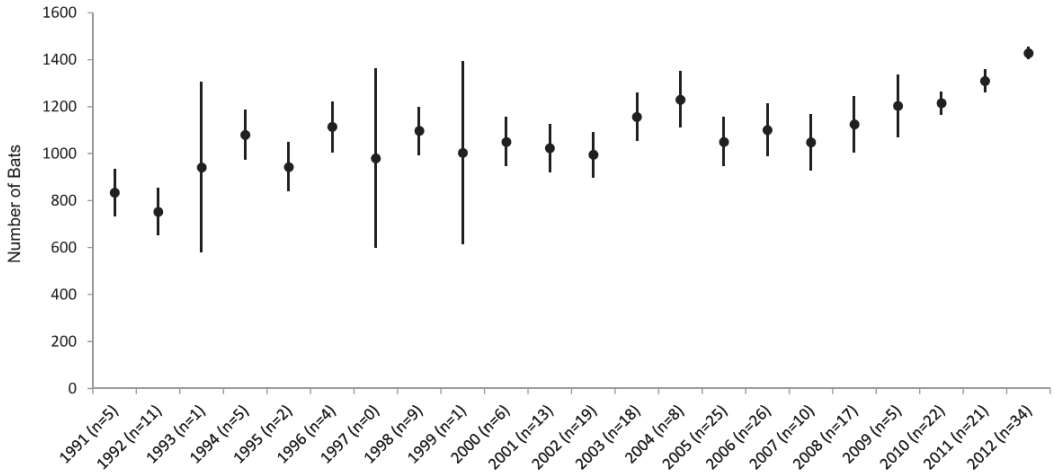
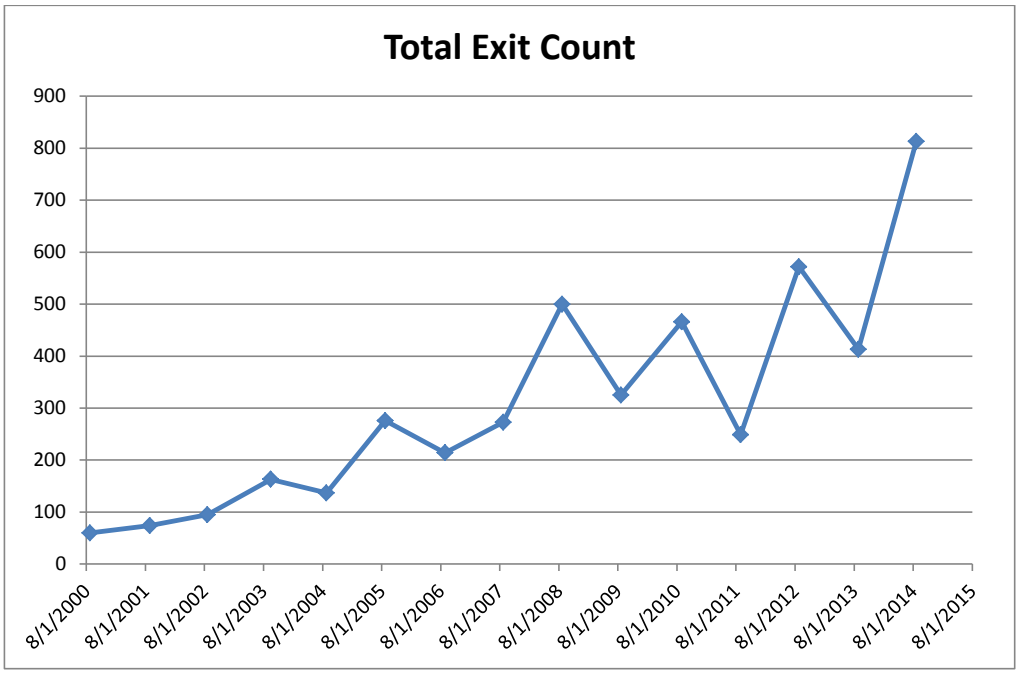

Number of Bats
1600
1400
1200
1000
800
600
400
200
0
1991 (n=5)
1992 (n=11)
1993 (n=1)
1994 (n=5)
1995 (n=2)
1996 (n=4)
1997 (n=0)
1998 (n=9)
1999 (n=1)
2000 (n=6)
2001 (n=13)
2002 (n=19)
2003 (n=18)
2004 (n=8)
2005 (n=25)
2006 (n=26)
2007 (n=10)
2008 (n=17)
2009 (n=5)
2010 (n=22)
2011 (n=21)
2012 (n=34)

Figure 9.


Total Exit Count
900
800
700
600
500
400
300
200
100
0
8/1/2000
8/1/2001
8/1/2002
8/1/2003
8/1/2004
8/1/2005
8/1/2006
8/1/2007
8/1/2008
8/1/2009
8/1/2010
8/1/2011
8/1/2012
8/1/2013
8/1/2014
8/1/2015

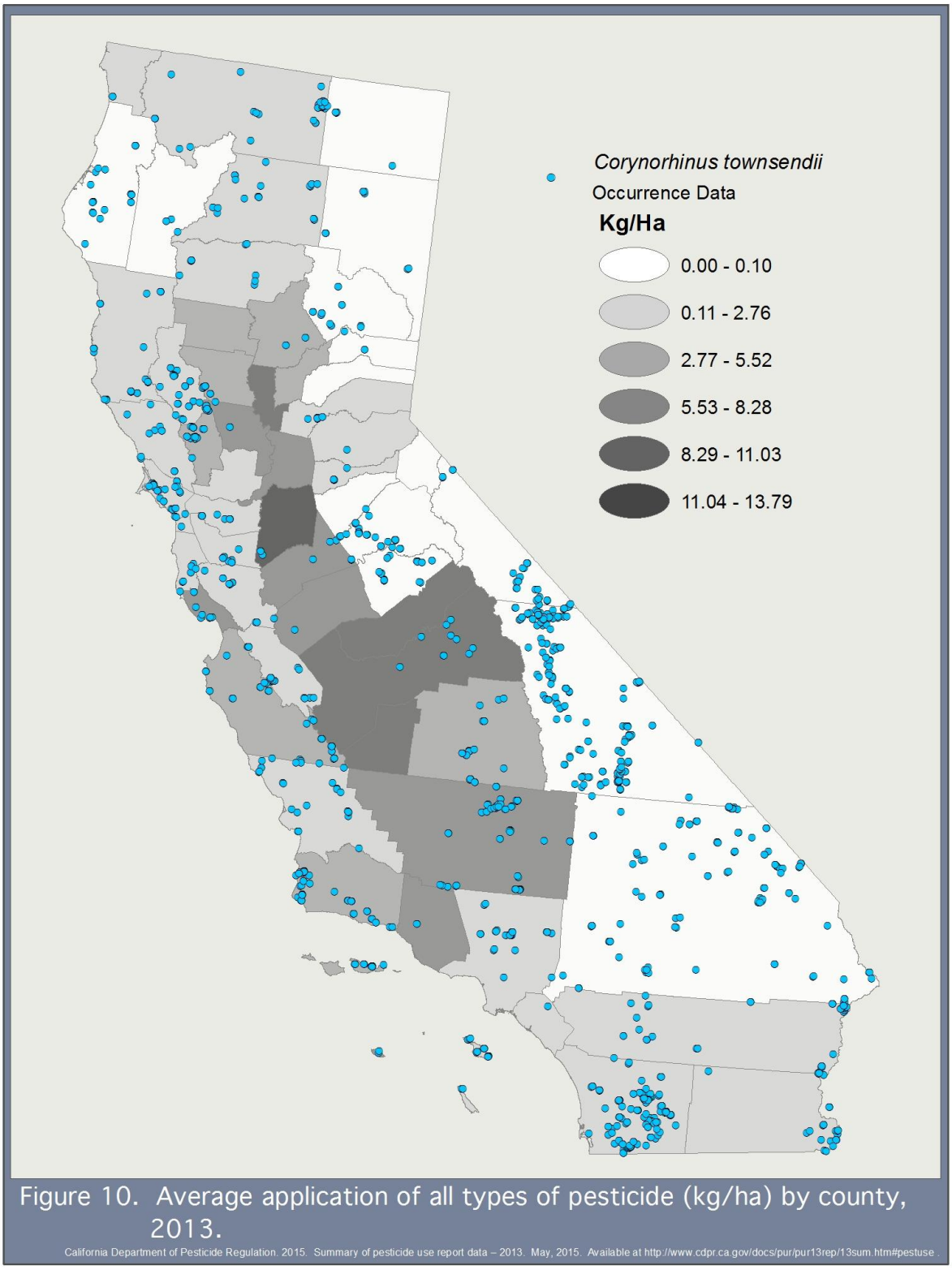


Figure 10. Average application of all types of pesticide (kg/ha) by county, 2013.

California Department of Pesticide Regulation. 2015. Summary of pesticide use report data – 2013. May, 2015. Available at http://www.cdpr.ca.gov/docs/pur/pur13rep/13sum.htm#pestuse .

Figure 11.

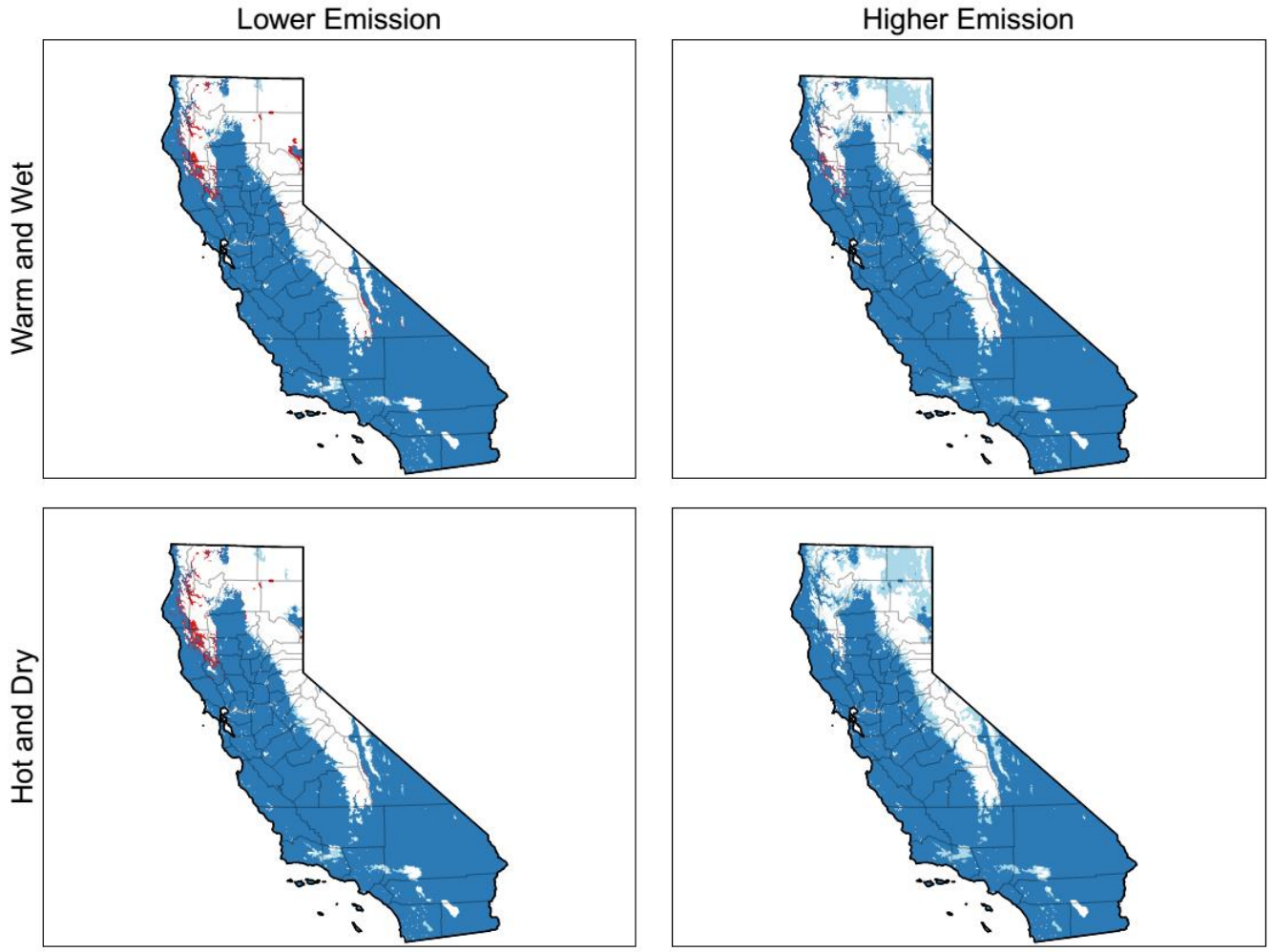


Figure 12.


EDMUND G. BROWN, JR., GOVERNOR, STATE OF CALIFORNIA
JOHN LAIRD, SECRETARY, NATURAL RESOURCES AGENCY
DAVID BUNN, DIRECTOR, DEPARTMENT OF CONSERVATION
OFFICE OF MINE RECLAMATION, ABANDONED MINE LANDS PROGRAM
CALIFORNIA ABANDONED MINES
POTENTIAL, INVENTORIED AND REMEDIATED
MINE FEATURE LOCATIONS
Physical Hazard Remediations*
* Remediations are AMLP data only.
Other agency closures exist, but are not shown on this map
USGS Mapped Mine Features*
* Based on USGS 7.5 minute topographical map mine symbols
AML Program Inventoried Features
Map produced by the Department of Conservation
Abandoned Mine Lands Program (AMLP), July 2015

Townsend's big-eared bat CESA Status Review – Tables

Captions

1. From Weller et al. (2014, Table 1). Number of caves searched and total number of Townsend's big-eared bats ( ) counted between November 15 and March 15 at Lava Beds National Monument, Siskiyou County, California, during the years 1991-2012. Cave L970 contained, by far, the largest number of hibernating bats in the monument.

2. Pinnacles National Park COTO maternity and hibernation roost count summary (NPS unpublished data). Visual counts made during one or more visits during the maternity and hibernation seasons. Where clusters of bats were observed, the number of bats were estimated from the area occupied, assuming between 100 and 150 COTO individuals per square-foot of ceiling area. In years when more than one survey was made in a season, the highest count is reported here. To avoid excessive disturbance to roosting bats in some years, presence only of the maternity colony was noted, or a minimum number of bats was estimated.

3. Summary of Townsend's big-eared bat monitoring studies referenced in the report.

Table 1.

Year	No. of Caves Surveyed	Cave L970 Count	Total Count
1991	5	376	438
1992	11	236	384
1993	1	—	1
1994	5	614	643
1995	2	469	512
1996	4	637	672
1997	0	—	—
1998	9	643	727
1999	1	—	2
2000	6	582	640
2001	13	530	665
2002	19	437	702
2003	18	586	811
2004	8	699	739
2005	25	551	733
2006	26	601	756
2007	10	505	620
2008	17	513	723
2009	5	607	665
2010	22	519	1,026
2011	21	541	1,117
2012	34	588	1,346

Table 2.

Year	Total Maternity*	Total Hibernacula
1997	150-200 (including pups)	60
1998	300-400 (including pups)	114
1999	320 (including pups)	254
2000	200-300	252
2001	300-600 (including pups)	282+
2002	Present	50++
2003	150+	364
2004	300-450	378
2005	100+	409
2006	600-1000 (4 clusters)	384
2007	Unknown/Not surveyed at peak of maternity season	261
2008	200-300	396
2009	125-160+	75
2010	240-290+	44
2011	Present	15
2012	225-235++	51
2013	Present	40
2014	~250+	43
2015	440-615	

Table 3.

Hibernation	
Lava Beds National Monument	Statistically significant population increase over 22 years
White-Inyo Mountains	No statistical inference possible; many repeat visits had lower counts than initial visits 10-plus years earlier
Pinnacles National Park	No inference possible based on uneven monitoring effort
Maternity	
Randall House	Statistically significant population increase over 25 years
Kentucky Mine	Statistical tests not conducted, but colony appears to be stable
Lava Beds National Monument	No inference possible
Pinnacles National Park	Statistical tests not conducted, but colony appears to be stable or increasing
Hearst Castle	Statistical tests not conducted, but colony appears to be stable or increasing
Santa Cruz Island	No statistical tests conducted, but colony has decreased from historical size

APPENDICES [to be completed for the final following external review]

1. **Public Comment Summary**
2. **List of Peer Reviewers and Invitation Letters**
3. **Peer Reviewer Comments**

Review comments by Gary Fellers

STATE OF CALIFORNIA
NATURAL RESOURCES AGENCY
DEPARTMENT OF FISH AND WILDLIFE

EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE

REPORT TO THE FISH AND GAME COMMISSION

A STATUS REVIEW OF TOWNSEND'S BIG-EARED BAT (*CORYNORHINUS TOWNSENDII*) IN CALIFORNIA

CHARLTON H. BONHAM, DIRECTOR
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

Draft Date: January 7, 2016

Add USGS

same states as *C. t. townsendii*, plus in more interior portions of the continent in Arizona, Colorado, New Mexico, Texas, and Wyoming (Handley 1959, Piaggio and Perkins 2005). Throughout much of their range in California, Idaho, Nevada, Oregon and Washington there are extensive zones of intergradation for the two subspecies and it is often not possible to assign individuals to one subspecies or the other.

Population Genetics

Genetic studies can inform our understanding of animal populations, including the amount of mixing between subpopulations and level of genetic variability among and between individuals or subpopulations. Smith (2001) demonstrated the Townsend's big-eared bat populations in Oklahoma show high movement (high gene flow) of males across her study area (nuclear microsatellite DNA results) but low movement of females (mitochondrial DNA results). This suggests high site fidelity of females to their natal roosts relative to males. The female subpopulations were highly differentiated from each other, but also highly variable within the subpopulations.

Miller's (2007) study of Townsend's big-eared bat population genetics in southeastern Idaho used nuclear DNA to show most individuals within hibernacula were not closely related to each other, contrary to an earlier suggestion by Pearson (1959) that Townsend's big-eared bats within a hibernaculum should be closely related, since Townsend's big-eared bat mate at their hibernacula and have high fidelity to these sites. Miller (2007) suggested that "juveniles may disperse from natal colonies before settling and becoming philopatric to a single [hibernation] site, which could create these communities of unrelated individuals." Alternatively, it is possible that Townsend's big-eared bats in her study area are either not loyal to a single hibernaculum or do not mate at the hibernacula in which they over winter. She also found that adult females in maternity colonies are more closely related to each other than are juveniles, which is consistent with males dispersing longer distances than females.

The study by Piaggio and others (2009) of populations structure, genetic diversity, and dispersal among three subspecies of Townsend's big-eared bat in the Rocky Mountains region (*townsendii*, *pallescens*), and in the southeastern U.S. (the endangered *virginianus* subspecies) used both nuclear and mitochondrial DNA analyses. Their study indicated significantly lower genetic diversity in *virginianus*, compared to the other two subspecies, which is expected due to the lower overall population size of *virginianus*. Their study also indicated relatively low levels of gene flow among populations of the *townsendii* and *pallescens* subspecies, which tend to be isolated. On the other hand, some gene flow can occur at distances of 310 km between roosts, which (with other recent data) suggests that Townsend's big-eared bat may move greater distances than typically thought. These genetic results are consistent with the observation that a simple geographic demarcation between the *pallescens* and *townsendii* subspecies is not sufficient to differentiate between individuals of the two subspecies.

Reproduction and Development

Townsend's big-eared bat is a colonial species. Maternity colonies form between March and June, with the timing varying based on local climate, elevation, and latitude. Colony size ranges from a few dozen to several hundred individuals. Mating generally takes place in both migratory sites and hibernacula between September or October and February. "Swarming" – a behavior at non-maternity roost sites

Vocalizations

Townsend's big-eared bat produces ultrasonic calls that are used for navigating in the dark, and for locating and capturing prey, as well as for social communication. While cruising or searching for prey, a semi-regular pattern of calls is emitted at 10 to 20 calls per second (Kunz and Martin 1982). Search- and cruising calls are usually simple downward sweeps in frequency, typically starting at about 40 to 45 kHz and ending at about 19 to 23 kHz, with the maximum power (volume) produced at about 21 to 26 KHz (J.M. Szewczak, unpublished data 2011). Calls may include sounds produced at the harmonic frequencies at two- and three times the fundamental call frequencies – sometimes with more power applied to a harmonic than to the fundamental call. Townsend's big-eared bat is commonly known as a "whispering" bat, because of the relatively low power of its calls – typically about 40 to 50 dB quieter than those of *Myotis lucifugus* (Kunz and Martin 1982). The relatively low volume of its echolocation calls makes Townsend's big-eared bat difficult to detect ~~with acoustic equipment~~ acoustically.

Predation

Pearson et al. (1952) discounted predation as a factor limiting Townsend's big-eared bat populations, but individuals may be preyed upon by a variety of native and non-native predators, as has been documented for other bats. Hensley et al. (1995) listed several potential predators of Townsend's big-eared bat in the recovery plan for the endangered Ozark big-eared bat (*C. townsendii virginianus*), including raccoons (*Procyon lotor*), bobcats (*Lynx rufus*), house cats (*Felis catus*), skunks (*Mephitis, Spilogale*), and snakes. These and other generalist predators, such as ringtails (*Bassariscus astutus*) likely take Townsend's big-eared bat opportunistically in California.

Fellers and Halstead (2015) stated several owl species known to prey on bats may have influenced Townsend's big-eared bat emergence times at the Randall House maternity roost. These include great horned owls (*Bubo virginianus*), barn owls (*Tyto alba*), and spotted owls (*Strix occidentalis*). Townsend's big-eared bat's tendency to avoid foraging in open grassland and other areas of low vegetation cover has been hypothesized to be a mechanism for avoiding aerial predators such as owls (Pierson and Fellers 1999); however, this behavior may also be driven by the distribution of the bat's prey.

Fellers (2000) also reported that non-native black rats (*Rattus rattus*) preyed upon young Townsend's big-eared bats at the Randall House roost before measures were taken to ~~prevent rat entry into the structure~~ eliminate rats from the roost site.

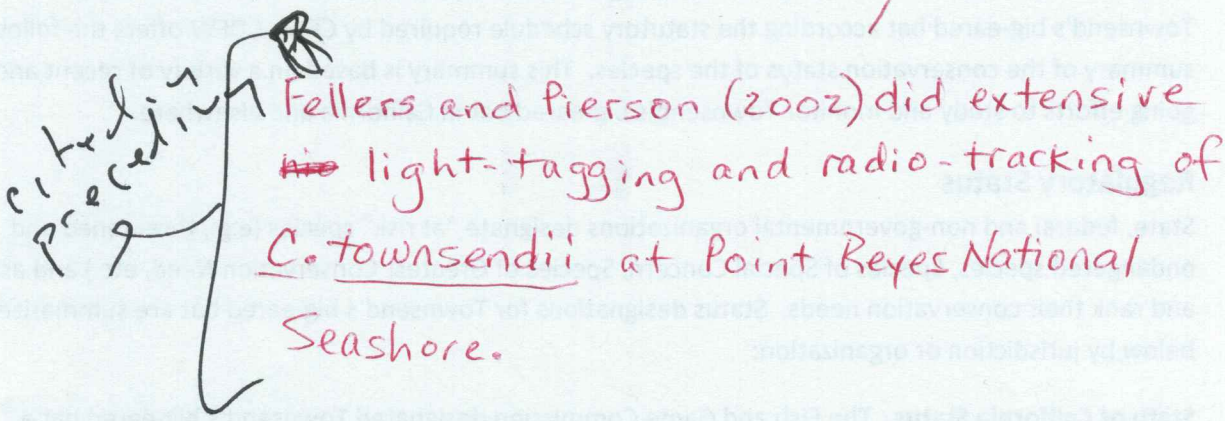
Movements

Migration. Townsend's big-eared bat is considered a relatively sedentary species, for which no long-distance migrations have been reported (Barbour and Davis 1969, Humphrey and Kunz 1976, Pearson et al. 1952). The longest movement known for this species in California is 32.2 km (20 mi) (Pearson et al. 1952). There is some evidence of local migration, perhaps along an elevation gradient.

Townsend's big-eared bats in Oregon appear to move from their hibernacula to active season (maternity) roosts over a period of several nights, using interim roosts before settling into the maternity

Oklahoma, *C. townsendii ingens* more frequently used edge habitats (along intermittent streams) and open areas (pastures, agricultural fields, native grass) compared to wooded habitat (Clark et al. 1993), but also tended to focus foraging along canyon walls (Caire et al. 1984).

Light-tagging studies in West Virginia (V. Dalton pers. comm.) showed a bimodal foraging pattern for *C. t. virginianus*, with animals foraging over hayfields during the first part of the night, and within the forest later in the night, traveling up to 13 km (8 mi) from the day roost. They foraged as long as weather permitted in the fall, and were periodically active in winter (Pierson et al. 1991). Townsend's big-eared bats have been observed flying in a snowstorm (G. Tatarian pers. comm.).



2014, 2015 pers. comm.; R. Evans 2014 pers. comm.). These observations, which included a maternity roost site for both of the jurisdictions, as well as a large extant maternity colony at Hearst San Simeon State Historical Monument, indicate the species continues to occur in the region, although no information on population or range trend is available for this area.

Other published observations of declines in Townsend's big-eared bat colonies in the Sierra Nevada and lower Colorado River area (Graham 1966, Stager 1939) were mentioned in the Petition.

In summary, the best quantitative information on the population status of Townsend's big-eared bat cited in the Petition is Pierson and Rainey's (1998) statewide assessment, which showed that, of the 18 historically-known maternity roost sites with population counts, six of the colonies had been extirpated by the time the authors conducted their work. Another six colonies showed a decline in the number of adult female Townsend's big-eared bat present. Although five colonies had increased in size (and one remained stable at 50 females), the overall decline in numbers from the historical period appeared to be substantial.

These comparisons between historical and recent colony numbers, colony size, and total population counts suggested that, as of the early 1990s, there had been a decline in the total population of Townsend's big-eared bat in California since the early 20th century. This decline may have been substantial, but the historical data set was limited and therefore the magnitude of the population decline could not be exactly determined. In combination with other aspects of the species' biology and observations of human disturbance at Townsend's big-eared bat roost sites, the trend information collated by Pierson and Rainey (1998) led to the inference that the California Townsend's big-eared bat population had declined over the several decades before their study.

CDFW is aware of ongoing efforts to monitor or revisit several important Townsend's big-eared bat maternity and hibernation roosts in California. These efforts include monitoring at both hibernation and maternity colonies at Lava Beds National Monument (S. Thomas 2013 pers. comm.), revisiting known Townsend's big-eared bat hibernacula in the White and Inyo mountains (Szewczak et al. 1999, M. Morrison 2013 pers. comm.), long-term annual counts of a maternity colony in a historical building in Sierra County (W. Copren 2013 pers. comm.), as well as at other sites. The following section summarizes recent results from these ongoing monitoring efforts. Also, Fellers and Halstead (2015) monitored bats at a maternity roost for 25 years.

Townsend's Big-Eared Bat Roost Site Monitoring Case Studies

To assess Townsend's big-eared bat population trends since Pierson and Rainey's (1998) work, CDFW has compiled information from a number of maternity and hibernation roost sites from around California. The following is a summary of studies that assess the population trend at specific sites. While this summary does not comprise a statistically valid estimate of the Townsend's big-eared bat population size or trend statewide, it does illustrate how population status varies around the state, as well as how management of roost sites directly affects the population status in an area. Locations referenced here are depicted in Figure 4.

Randall House Maternity Roost (Marin County). Fellers and Halstead (2015) reported results from 25 years of monitoring the Randall House maternity roost site in Marin County. The Randall House is a two-story late 19th Century ranch house situated in a valley at Point Reyes National Seashore. It was last used by humans in the 1970s and in 1987 was discovered to be the site of a Townsend's big-eared bat maternity colony. At that time, the colony numbered 95 adult females. The site had been subject to repeated break-ins by local teenagers prior to 1987, but upon discovery of the Townsend's big-eared bat colony, the National Park Service fortified the house against unauthorized entry and has since maintained the house for use by the bats.

Using night-vision equipment, Fellers and his collaborators conducted 178 exit counts of Townsend's big-eared bat during the maternity season between 1988 and 2012. In addition to information on the number of adult females and young present at the site, this long-term monitoring study also yielded important information on the effects of human disturbance on colony status, effects of season and environmental factors on emergence time from the roost, and other natural history aspects of the species.

Over the course of the 25-year study, the Randall House Townsend's big-eared bat maternity colony increased in size (see Figure 5B). Adult female maximum number recorded increased from 95 in 1988 to 395 in 2012. The maximum recorded number of adult females plus volant young increased from 176 to 512. The annual rate of increase was estimated to be 8.7% for adult females and 5.3% for volant young.

Attempted and successful break-ins to the roost building occurred occasionally during the study period, despite increased security at the site. These disturbance events were documented ~~and the authors~~ by Fellers and Halstead (2015) who found a significant negative correlation between disturbance events and subsequent numbers of adult females and volant young (compare Figures 5A and 5B). In other words, there were fewer Townsend's big-eared bat adults and young at the roost site in years with human disturbance events.

The authors note the Randall House is one of the most important remaining Townsend's big-eared bat maternity roost sites in coastal California. Because of the NPS commitment to maintaining the Randall House for Townsend's big-eared bat use, it is one of the few maternity roosts classified by Pierson and Rainey (1998) as "secure." Prior to its discovery in 1987, two other nearby historical roost sites (the Olema Inn and an old barn near Inverness) had already been lost. Fellers and Halstead (2015) note that only one other Townsend's big-eared bat maternity roost is known in the area and, although also located on NPS land, it is structurally dilapidated and its long-term suitability for Townsend's big-eared bat use is questionable. Like other old wooden buildings used by Townsend's big-eared bat around the state, these structures are vulnerable to degradation and loss over time. Replacement structures tend to be made of materials and ~~use~~ designs less suitable for bats.

Nevertheless, the Randall House is an example of how management of a roost structure may allow Townsend's big-eared bat to continue to occupy an area and even expand in numbers over time.

Kentucky Mine Maternity Roost (Sierra County). The Kentucky Mine Historic Park and Museum is located in Sierra City, Sierra County, at an elevation of 1340 m (4400 ft). The Kentucky Mine Townsend's

Precise counts are not always possible due to limited access by humans to areas used by the bats, as well as the importance of minimizing disturbance to the roosting bats.

Over the period from 1997 to 2014, the total maternity colony size (sometimes including pups) has ranged from about 150 to possibly as high as 1000 individuals; though in most years the total maternity colony size ranges between 200 and 400 individuals (Table 2). The hibernaculum counts are generally lower than the maternity roost counts (possibly due to dispersed winter roosting habits), ranging from about 15 to 400 individuals, with many years having counts of around 200 individuals (Table 2). The annual count data shows an early increase in the total numbers of Townsend's big-eared bat individuals counted in both the maternity and hibernation seasons. This apparent increase in colony size may be attributed to the public cave closure from 1997 to 2002, followed by the adoption of the current management strategy of seasonal public access to the caves. Additional factors affecting the data are the intensity and frequency of survey effort in a given year. According to the NPS staff familiar with the surveys, the later years reported here had fewer survey visits to the roost site, which made it less likely that peak numbers would be detected in a given year (Paul Johnson 2015 pers. comm.). Despite the apparent decline in colony size since 2005-2006, NPS considers the Pinnacles Townsend's big-eared bat population to be relatively stable (Paul Johnson 2015 pers. comm.).

Hearst Castle Maternity Roost (San Luis Obispo County). The Townsend's big-eared bat maternity colony at Hearst San Simeon State Historical Monument was not known at the time of Pierson and Rainey's (1998) statewide survey. The Townsend's big-eared bat roost site was discovered during an assessment by Department of Parks and Recreation (DPR) of the bats occurring at Hearst Castle in 2000 (K. Miner 2015 pers. comm.). The maternity roost site is located in a cavernous space within the reinforced concrete stair and landing structure at the main entrance to the complex of mansions that comprise Hearst Castle. Prior to the survey, the space was regular inspected for structure integrity and used for closed-space rescue training by park staff during the maternity season, who reported that bats were disturbed by their presence. Once discovered that it was being used by Townsend's big-eared bats, DPR limited entry during the maternity season to only necessary safety inspections. Prior to 2003, Townsend's big-eared bats entered and exited the roost space through a narrow space below a screened door, forcing the bats to crawl on the ground. In 2003, the site was modified by adding two openings to the roost at more typical locations above the ground and sized to accommodate flying Townsend's big-eared bats accessing the site (R. Orr 2015 pers. comm.). DPR also developed management guidance to ensure maintenance and repair activities at the site have minimal impact on roosting bats, including Townsend's big-eared bat (DPR 2003).

Exit counts conducted by DPR staff since 2000 suggest the management of the site has enabled the colony to thrive. Most of the exit counts at the Townsend's big-eared bat roost have been conducted during late August, at which time the counts would likely include both adult females and their volant young and possibly adult males, as well. Late summer exit counts ranged from 60 to 95 total individuals prior to the roost entrance modification work. Since the modification and adoption of the bat protection policy in 2003, total counts of Townsend's big-eared bat during the late summer have

increased fairly steadily through the years (Figure 9). Over the period 2012-2014, late summer counts ranged from 413 to 813 total Townsend's big-eared bat individuals at the site.

Santa Cruz Island Maternity Colony (Channel Islands National Park). Santa Cruz Island is the largest and most habitat-diverse of California's Channel Islands and it is the only Channel Island known to harbor a reproductive colony of Townsend's big-eared bat (Brown et al. 1994). Because of its distance to the mainland, it is thought that the Santa Cruz Island Townsend's big-eared bat population may be isolated from other Townsend's big-eared bat populations. If so, it is possible the island population may have unique genetic characteristics. The Santa Cruz Island colony was first described in 1939 as roosting in a 2-story ranch house at Prisoners Harbor on the north-central side of the island. At that time, it was estimated to number more than 300 individuals, which were likely both adult females and their volant young (Brown et al. 1994). A total of 246 individuals were collected for scientific collections during this and two subsequent collection trips in 1949 and 1964 (Brown et al. 1994). Pierson and Rainey (1998) cited Museum of Vertebrate Zoology records as stating the colony in 1948 numbered 150 adult females.

At some point between the mid-1960s and 1974, the Prisoners Harbor ranch house was demolished. Despite extensive searches, Townsend's big-eared bat roosting in substantial numbers on Santa Cruz Island were not observed again until 1991, when they were reported to Pat Brown as occurring in the Bakery in an old adobe building at Scorpion Ranch on the northeast end of the island (Brown et al. 1994). It is not clear whether the Scorpion Ranch site was colonized by Townsend's big-eared bat displaced from Prisoners Harbor or if it was already in use prior to the loss of the Prisoners Harbor site. The National Park Service has since then assumed management of the entire island, including the Scorpion Ranch buildings, as part of the Channel Islands National Park.

NPS and others have conducted regular exit counts at the maternity roost site during the spring (adult females only) and late summer (adult females and their young). Exit count data available to CDFW suggest the number of Townsend's big-eared bats at Scorpion Ranch have never been as high as at the Prisoners Harbor roost site. Spring counts in the early 2000s ranged from about 50 to 105 adult females, while fall counts ranged from about 75 to 165 adult females and their young.

and encourage bats to

Work was conducted in 2009 to renovate and reoccupy other portions of the old adobe building. Exit counts by NPS personnel at the bakery roost site continued during maternity season during this time (T. Coonan 2014 pers. comm.). During the 4-year period from 2010 to 2013, the bakery roost site was abandoned, either temporarily (2010 and 2011) or for the remainder of the maternity season (2012 and 2013). The latter abandonment events resulted in the known death of pups at the caves to which the adult females had moved. Early season counts suggest between 60 and 90 adult females arrived at the roost site each year. The cause(s) and exact dates of abandonment are not known, but could include public visitor entrance over the half-door into the roost site or other activity in and around the building, including use of other rooms within the building by NPS personnel.

Proposals have been made to increase monitoring activity at the maternity roost site to more closely track human activity and bat numbers (T. Coonan 2014 pers. comm.), as well as to exclude human

New and renewed mining operations have the potential to impact Townsend's big-eared bat roosting in old shaft/adit mines, either through disturbance of roosting bats or by destroying the old mine by conversion to open pit-style mining, or through ~~natural~~ collapse of abandoned mines. Four examples of the destruction or loss of Townsend's big-eared bat roost sites are described in the Petition.

Dam construction or modification can result in the inundation of Townsend's big-eared bat roost sites. The Petition mentions one large colony that was displaced by construction of the New Melones Dam on the Stanislaus River. As stated in the Petition, much of the dam-building, reconstruction, and license renewal in California occurs at the same elevations in the foothills of the Sierra Nevada and Klamath and Trinity mountains that are optimal for Townsend's big-eared bat roost ~~sites~~.

Although generally considered a cave/mine roosting bat, Townsend's big-eared bat also roosts in large spaces in old buildings and in cavernous spaces in bridges and dams. Bats in such sites are subject to disturbance when humans enter for inspections or other activities. The roost ~~sites~~ themselves are subject to eventual deterioration or demolition. Pierson and Rainey (1998) documented the loss of several Townsend's big-eared bat roost sites found in buildings.

There is an ongoing interest among recreational explorers in caves and abandoned mines. There is also a collectible market for mining artifacts. People entering mines can disturb bats during the critical maternity and hibernation seasons. Townsend's big-eared bat appears to be particularly susceptible to such disturbance. Recreationists and homeless persons may also enter old buildings used as roosts and disturb bats. A house at the CDFW Chorro Creek Wildlife Area has provided a roost site for a Townsend's big-eared bat maternity colony off and on for several years. The site has been repeatedly abandoned by the bats after break-ins followed by subsequent re-occupancy after the house is resealed (R. Stafford 2014 pers. comm.). The same pattern of partial or complete abandonment has been observed at the Randall House maternity roost site (Fellers and Halstead 2015) and other sites.

While it is certainly true that natural roosting habitat for Townsend's big-eared bat has been impacted by humans over the past 150 years, it is important to consider that historical mining and building construction also added to the total available roost habitat in the state in the late 1800s and early 1900s. Assuming roost habitat is a limiting factor for Townsend's big-eared bat, it is likely that the carrying capacity for the species actually increased in the historical mining districts of California with the advent of historical mining and construction of buildings. It is unknown, however, to what degree the documented populations losses at natural roost sites of caves and large old trees with basal hollows have been offset by presumed historical population increases at "artificial" roost sites. Many of these old buildings and mines themselves have been subsequently impacted, and in many cases lost, since the historical period. Moreover, with the documented loss of approximately 95% of old-growth coastal redwood forest on California's North Coast (Fox 1989), it is likely that this region has suffered a substantial decrease in roost site availability during the historical period.

In summary, CDFW considers loss, degradation, and disturbance at roost sites to be an important threat to Townsend's big-eared bat in California. Given the species' known susceptibility to disturbance, its reliance on roost sites with a relatively narrow range of suitability, and the colonial nature of the

species, especially during the maternity season, it is possible that population-level or even statewide impacts could occur to the species from the loss or disturbance at relatively few roost sites.

Loss of Foraging Habitat (including water)

Loss of suitable foraging habitat has previously been identified as a threat to Townsend's big-eared bat (Pierson and Rainey 1998, Pierson and Fellers 1998). Ideal habitat for foraging likely includes a mix of edge and continuous vegetation cover. Land management practices that create large openings of low shrub or grass cover in forest and woodland areas, such as agricultural development and extensive clear-cutting ~~probably~~ reduce foraging habitat suitability for the species. Likewise, residential and urban development reduce available foraging habitat. This is especially true in the extensive, highly-developed regions along California's South Coast and Bay Area. Although individual Townsend's big-eared bats may still make forays into these areas, it is unlikely that populations could be supported in urbanized areas.

It has been estimated that 95 percent of California's riparian habitat, which is important for foraging Townsend's big-eared bats, has been lost to vegetation clearing or conversion and inundation behind dams (Katibah 1984). Climate change, including the effects of protracted or severe drought, may also negatively affect foraging habitat suitability and insect prey availability, both through vegetation changes and reductions in ~~free~~ surface water availability.

In summary, CDFW considers loss of foraging habitat to be a potential threat to Townsend's big-eared bat in California.

White Nose Syndrome and other Disease

White Nose Syndrome (WNS) is a disease that has killed more than 6 million bats in eastern North America (USFWS 2012). It is caused by *Pseudogymnoascus destructans* (Pd), a cold-loving fungus that is thought to have been introduced into northeastern North America from Europe sometime in the early 2000s. The fungus grows in the skin and other tissues of hibernating bats and may affect multiple physiological systems of the bats during the winter period. The most obvious effect on hibernating bats is that infected individuals arouse from deep torpor much more frequently and for longer periods than non-infected bats, which drastically reduces the fat reserves needed to sustain the bats until insect prey is available in the spring. Most affected bats die of starvation, with mortality rates for some species (e.g., *Myotis lucifugus*, the little brown bat) approaching 100% in some eastern hibernacula[4].

WNS has not yet been detected in ~~western~~ North America west of Nebraska. Surveillance studies to sample for the Pd fungus have yet to detect it in California (W. Frick 2012 pers. comm.). Pd has been detected from swabs taken from the fur of Townsend's big-eared bats in WNS-affected areas in the eastern United States, but so far WNS (the disease) has not been observed to manifest in this species (A. Ballmann 2015 pers. comm.).

[4] https://www.whitenosesyndrome.org/

Mining

California has a long history of mining due to its variety of mineral and ~~geologic~~ geological resources. California ranks second nationwide in production of minerals other than fossil fuels (Department of Conservation 2000). Starting even before the Gold Rush era of the mid-1800s, tens of thousands of mines have been excavated in the state. The Abandoned Mine Lands Unit (AMLU) of the California Department of Conservation (Department of Conservation 2009) estimates that there are approximately 47,000 abandoned mine sites in California. Although mines exist throughout the state, the majority of these mines are concentrated in the desert regions and western Sierra Nevada foothills (see Figure 12). Approximately two-thirds of abandoned mine sites are on federal land, 31% are on private land, and 2% are on state and local government land.

Mines provide important shelter for Townsend's big-eared bat and other bat species that evolved to roost in natural caves and crevices. Historic mining has created habitat for bats and other wildlife. Eighty percent of the mines in the western U.S. show some evidence of bat activity (Tuttle and Taylor 1998). Mines may be used by Townsend's big-eared bat year round for their roosting needs. These include critically important maternity and hibernation seasons. Large, structurally diverse mines may provide both warm roosts for maternity colonies and the cool or cold temperatures during hibernation (Pierson and Fellers 1998, Pierson and Rainey 1991, 1998; Pierson et al. 1999).

Mines may also offer prey such as moths and other insects and open water for drinking in chambers that intercept ground water. Such water resources are especially important in desert regions where surface water may be uncommon.

Because of the importance of historical and abandoned mines to Townsend's big-eared bats, several management issues related to mines and mining may pose a threat to the species. These include: closure of mines, renewed mining, environmental contamination, and human disturbance at mine roosts. The latter two topics are discussed elsewhere in the Threats section of this report.

Abandoned Mine Lands (AML) programs are tasked with the closure of open mines hazardous to human safety. To determine the appropriate closure method at a mine, it is necessary to determine through surveys what species may be using the mine. Permanent abandoned mine closure methods have resulted in the destruction of roosting habitat and have also caused direct mortality of bats by trapping them within the closed mine without prior exclusion at the appropriate season (Brown 1995b; Altenbach and Pierson 1995). Bat conservationists have advocated for assessment and planning for the appropriate mine closure method (fences, bat gates, cupolas, large grates) that allow bats to pass through openings too small for humans, while maintaining air flow patterns crucial for internal habitat conditions (Sherwin *et al.* 2009).

California's Department of Conservation has an AML unit that is actively engaged in reducing the hazards associated with open mines. It works with state and private mine owners to ensure that wildlife-compatible closure methods are implemented. It also coordinates with federal land management agencies for closures on BLM and other federal lands. See

http://www.conservation.ca.gov/omr/abandoned_mine_lands for more information on AML issues in California.

Modern methods of mineral extraction have allowed mining companies to renew mining in historical areas previously abandoned. For example, the use of chemical extraction methods for gold from open pit mines often occurs directly in areas with abandoned shaft mines. Renewed mining in historical mine districts has the potential to impact Townsend's big-eared bat and other bat species where the modern mine obliterates the previous underground mine (Pierson et al. 1991). In addition, renewed mining may impact native vegetation and water sources used for foraging around the mine, and may introduce chemical contaminants used for mineral extraction ~~to the environment~~. See the section on Environmental Contaminants for more information on this aspect of mining impacts to bats.

In summary, CDFW considers the impacts associated with mine closures and renewed mining to be important potential threats to Townsend's big-eared bats. Active AML programs at the state and federal level should minimize the threat of mine closures to sensitive species. Environmental review of proposed mining projects through CEQA and NEPA should ensure adequate assessment and disclosure of potential impacts to Townsend's big-eared bat of such projects. Provided such programs are adequately funded by state and federal agencies, it is likely that population-level impacts associated with legacy mines and renewed mining would not occur. However, there is less certainty that important roost sites and Townsend's big-eared bat populations would be adequately protected in the absence of a listing of the species as threatened or endangered.

Overexploitation (for Scientific Use)

As a nongame mammal (defined in Fish and Game Code section 4150), Townsend's big-eared bat is not harvested or collected for commercial or personal use. Collection of Townsend's big-eared bat does occur in California on a limited basis for bona fide scientific and educational purposes. Such collection is regulated according to Fish and Game Code (sections 1002 *et seq.*), which is administered by CDFW.

In the past, scientific collections were made on a much greater scale than occurs today. The mammal collections at the Museum of Vertebrate Zoology, Los Angeles County Museum of Natural History, and at many other museums and universities in the western U.S. were established through the lethal taking of representative specimens of California's mammalian fauna. Such collections remain an important resource for scientific investigations of the phylogeny, evolution, taxonomy, diet, morphology, physiology of California's fauna (Pyke and Ehrlich 2010).

For long-lived/low fecundity species such as Townsend's big-eared bat, it is possible that repeated scientific collection may have a population impact. As documented by Brown et al. (1994), the Townsend's big-eared bat maternity colony at Prisoners Harbor (Santa Cruz Island) was subjected to three collecting episodes over a period of 25 years in which a total of 246 individuals were taken. The Santa Cruz Island colony, which apparently numbered "more than" 300 individuals (which probably included both adult females and their young) in 1939, has never recovered to its historical size, though other impacts, including roost loss and disturbance have been contributing factors.

Non-collecting scientific study may also impact Townsend's big-eared bat populations through disturbance of roosts. Before Townsend's big-eared bat's susceptibility to roost site disturbance was well documented, Pearson et al. (1952) conducted investigations of the basic ecology and reproductive biology of Townsend's big-eared bat in California. These studies included occasional entry into maternity and hibernation roosts at multiple sites around California to collect information and to place wing-bands on bats. In one case, the authors banded 75 young Townsend's big-eared bats during the early night while the adult females were foraging. By the next morning, the young had been carried by their mothers to another roost site, presumably in response to the disturbance at the original roost site (Pearson et al. 1952). The authors did not document whether there was an impact in terms of growth or survival of the young from this disturbance event.

Placement of wing bands on bats is a long-standing method used to mark individual bats (Barclay and Bell 1988, Gannon et. al. 2007). Recapture of banded bats can provide information on movements, survival, and population size. Based on available information, it appears Townsend's big-eared bat does not handle wing-banding as well as other bat species. Ellison (2010) summarized results from her own and others' studies suggesting a relatively high proportion of banded Townsend's big-eared bat suffer from perforated wing membranes, scarring, tissue-swelling, infection, and irritation. Moreover, the banding activity may have disturbed some individuals sufficiently to cause them to move to different roost sites (Ellison 2010).

Because of the concerns related to over-collection, disturbance at roosts, and wing-banding, CDFW carefully controls the activities of scientific researchers working on Townsend's big-eared bat in California. All persons who may take[5] Townsend's big-eared bat for scientific or educational purposes are required to possess a current Scientific Collecting Permit and, while a candidate for listing, a CESA Memorandum of Understanding issued under the authority of Fish & G. Code § 2081(a). Among the standard conditions of research permits are: a prohibition on entry into known roost sites (unless specifically authorized for a particular study), immediate departure from sites discovered to be maternity roosts, and measures to minimize the risk of introducing the fungus that causes White Nose Syndrome to hibernacula. Wing-banding is not currently authorized for any researcher working on Townsend's big-eared bat. No collection of Townsend's big-eared bat specimens is currently authorized for any individual. Prior to Townsend's big-eared bat's designation as a Candidate for listing, Scientific Collecting Permits that authorized work with Townsend's big-eared bat had similar provisions for the protection of Townsend's big-eared bat individuals and populations.

Given the level of control exerted by CDFW on scientific researchers working with bats, overexploitation for scientific purposes is not considered to be a threat to the continued existence of Townsend's big-eared bat in California.

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[5] "Take" is defined in Fish and G. Code §86 as "to hunt, pursue, catch, capture, or kill" or to attempt to do so.

EXISTING MANAGEMENT, MONITORING, AND RESEARCH ACTIVITIES

CDFW

The California Department of Fish and Wildlife is the state trustee agency for fish, wildlife, and botanical resources. In addition to its current status as a Candidate for CESA listing, CDFW designates Townsend's big-eared bat as a Species of Special Concern (Williams 1986). The SSC designation does not confer any legal protection on the species, but rather is intended to ensure management, conservation, and research activities are implemented to prevent future declines and the need for listing under the California Endangered Species Act (Comrack et al. 2008). As an SSC, Townsend's big-eared bat is also designated as a Species of Greatest Conservation Need (SGCN) in California's State Wildlife Action Plan (SWAP, CDFG 2007). This designation provides additional focus on the species by CDFW, as well as funding opportunities for research and conservation actions from the State Wildlife Grant program of the U.S. Fish and Wildlife Service.

As part of CDFW's general mission to monitor wildlife resources, known Townsend's big-eared bat roosts on CDFW lands (Wildlife Areas and Ecological Reserves) are monitored. This includes the maternity colony that occurs on the Chorro Creek Ecological Reserve in CDFW's Central Region. Through on-going monitoring, CDFW has documented the impact of human disturbance at this site and has implemented measures to reduce the threat of disturbance to the colony (R. Stafford 2014, 2015 pers. comms.).

Townsend's big-eared bat is currently a Candidate for listing as threatened or endangered under the California Endangered Species Act. As such, the prohibition on "take" of listed and candidate species of CESA applies to Townsend's big-eared bat. Regulatory programs of CDFW now review proposed CEQA, timber harvesting plans, and scientific research applications to ensure that no take of the species would occur, unless authorized by one of the statutory exemptions allowing such take, such as the Incidental Take Permit and Safe Harbor mechanisms of CESA, or through a Memorandum of Understanding for take for scientific or educational purposes. All such take may only be authorized if it is fully mitigated and would not jeopardize the continued existence of the species in California. As mentioned above, should the species not be listed then it would revert to the Species of Special Concern designation. SSCs typically receive some attention during CEQA review, but protection from take and population-level impacts is less certain. This applies not only to projects for which CDFW is the lead or responsible agency, but for CEQA projects for which other state agencies (such as CDPR and CalFire, see below) or counties or cities are the lead agency.

CDFW is currently implementing three projects relevant to Townsend's big-eared bat that are funded by the State Wildlife Grant (SWG) program. The California Bat Conservation Plan (CBCP) was initially funded by SWG in the mid-2000s and, after several years of development is now nearing completion, thanks in part to a new SWG to complete final edits. The CBCP addresses the management and conservation of all bat species occurring in California, including Townsend's big-eared bat, and will provide specific recommendations for the management, policy development, and research for all species, all ecoregions, and all the major conservation issues affecting bats in the state. Included in the

CBCP is a relative ranking of the species for conservation concern – Townsend's big-eared bat consistently was rated by the authors as among the greatest concern bat species.

The second SWG-funded project directly addresses the current conservation status of Townsend's big-eared bat in California. Previously, the California Department of Fish and Game funded a statewide survey for Townsend's big-eared bat in the 1980s by Elizabeth Pierson and William Rainey (Pierson and Rainey 1998). The new statewide survey effort is being conducted over a two-year period and is targeting known and highly-suitable locations for maternity and hibernation roosts. This project is being contracted to researchers from Humboldt State University and Texas A&M University (Joe Szewczak and Michael Morrison) and should provide an updated snapshot of the species' status as of 2015-2017.

SWG funding was also provided to CDFW to implement a project to expand bat monitoring in California according to the North American Bat Monitoring Program (Loeb et al. 2015). This project is initially focused on acoustic monitoring of bat activity around the state, which probably will not provide a lot of data on Townsend's big-eared bat due to its quiet echolocation calls. However, CDFW plans to increase efforts to monitor important roosts for this and other species in the future as the NABat program continues to develop.

CDPR

The California Department of Parks and Recreation manages state parks throughout California. As with other land management agencies, CDPR manages sensitive biological resources, such as Townsend's big-eared bat, both through review of proposed project impacts under the environmental review process, as well as through focused monitoring efforts at known roosts (such as at Hearst San Simeon State Historical Monument).

CalFire

The California Department of Forestry and Fire Protection (CalFire) is the lead agency in California for timber harvest projects on private and state forest lands. Timber harvest review is a CEQA-equivalent environmental review process and, as such, requires proposed timber management projects to assess and disclose potential impacts on the environment, including to biological resources. Since the designation of Townsend's big-eared bat as a candidate for listing under CESA, CalFire has been proactive in working with timber companies and registered professional foresters to ensure significant impacts to the species, as well as "take," are avoided.

NPS

The National Park Service lands in California include several known Townsend's big-eared bat roost sites, including the large number of caves at Lava Beds National Monument, the Randall House maternity colony at Point Reyes National Seashore, the hibernacula and maternity roosts at Pinnacles National Park, and the Scorpion Ranch maternity roost on Santa Cruz Island. In general, the NPS approach to sensitive biological resources, such as Townsend's big-eared bat and its habitat, is to survey, monitor, manage, and to conduct research on the species.

USGS
The U.S. Geological Survey has played a major role in locating and monitoring Townsend's big-eared bats in central coastal California.

This is rarely, if ever, done -

are implemented to replace the lost structure or to improve the use of the structure by bats after project completion.

Most known Townsend's big-eared bat roost sites on Forest Service lands are not consistently monitored (though with some exceptions, such as the Kentucky Mine colony in the Sierra National Forest). The overall strategy implemented by the USFS has been to protect and avoid impacts (L. Angerer 2015 pers. comm.).

SUMMARY OF LISTING FACTORS (14 California Code of Regulations 670.1)

CESA directs CDFW to prepare this report regarding the status of Townsend's big-eared bat based upon the best scientific information available to CDFW. CESA's implementing regulations identify key factors that are relevant to the CDFW's analyses. Specifically, a "species shall be listed as endangered or threatened ... if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors: (1) present or threatened modification or destruction of its habitat; (2) overexploitation; (3) predation; (4) competition; (5) disease; or (6) other natural occurrences or human-related activities." (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A)).

The definitions of endangered and threatened species in the Fish and G. Code provide key guidance to CDFW's scientific determination. An endangered species under CESA is one "which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease" (Fish & G. Code, § 2062). A threatened species under CESA is one "that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by [CESA]" (*Id.*, § 2067).

The following summarizes CDFW's determination regarding the factors to be considered by the Commission in making its decision on whether to list Townsend's big-eared bat. This summary is based on the best available scientific information, as presented in the foregoing sections of the report.

Present or threatened modification or destruction of its habitat

Disturbance, degradation, and loss of suitable roost sites is a recognized threat to Townsend's big-eared bat populations, both in natural roost sites such as large, old trees and caves, as well as in artificial roosts such as old buildings and mines. Although recent examples of disturbance at roost sites are relatively rare compared to such events in the historical period, lacking the protections of CESA it is possible the species could be impacted at multiple roost sites in the future, which could lead to population-level impacts. However, there is no current indication disturbance of roost sites is a significant threat at this time. Additionally, although impacts to foraging habitat could also affect the species, there is no current indication that impacts to foraging habitat poses a significant threat at this time. Therefore, CDFW does not consider modification and destruction of habitat to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Overexploitation

CDFW does not consider overexploitation to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Predation

CDFW does not consider predation to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Competition

CDFW does not consider competition to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Disease

White Nose Syndrome is an important potential threat to Townsend's big-eared bat in California. Monitoring and research to determine the species' susceptibility to the disease as well as its occurrence in western North American are needed to assess the actual level of this threat. As discussed above, however, this disease is not currently impacting Townsend's big-eared bat in California. Therefore, CDFW does not consider disease to be a significant threat to the continued existence of the Townsend's big-eared bat in California.

Other Natural Events or Human-Related Activities

Mining (including renewed mining), agricultural development and pesticide use, restoration or demolition of old buildings and other anthropogenic structures used as roosts, forest management, and recreational caving and mine exploration all have the potential to impact Townsend's big-eared bat populations. State and federal environmental review programs typically include assessment and disclosure of potential impacts to the species in the CEQA/NEPA process. Adequate environmental review should prevent such activities from affecting Townsend's big-eared bat at the population or statewide level. at least on California lands.

Climate change, especially more frequent and severe drought, has the potential impact Townsend's big-eared bat in California. Continued and increased monitoring of the species' abundance and distribution should help determine the actual impact of these threats to the species.

MANAGEMENT RECOMMENDATIONS

These recommendations were developed by CDFW in accordance with the requirements of Fish & G. Code, § 2074.6. This list includes some recommendations developed by other authors, including Johnston (2004), Ellison et al. (2003), Tigner and Stukel (2003), Hinman and Snow (2003), and Bradley et al. (2006). CDFW recommends these actions be implemented regardless of the Commission's decision on listing Townsend's big-eared bat as threatened or endangered. This list includes recommendations for actions that could be undertaken by CDFW as well as by other public agencies, non-governmental organizations, and private land owners.

Research and Monitoring Needs

- Complete comprehensive statewide population assessment of Townsend's big-eared bat by 2017.
- Implement consistent long-term monitoring at representative Townsend's big-eared bat roost sites in California.
- Design and test artificial structures suitable for use by Townsend's big-eared bat during the maternity and hibernation seasons.
- Create standardized procedures for monitoring Townsend's big-eared bat populations. Ensure all such studies will not adversely impact the subject populations.
- Conduct additional analyses of the possible effects of climate change and drought on Townsend's big-eared bat and determine best approaches to address possible adverse effects.
- Conduct research on the role environmental contaminants play in the health of Townsend's big-eared bat populations. This should be done exceedingly carefully, if at all.
- Develop methods to create basal hollows in suitable large old trees.
- Conduct genetic studies to determine the population genetic structure of Townsend's big-eared bat in California, with special attention to the degree of divergence and isolation of populations on Santa Cruz Island relative to the mainland and between coastal and interior populations.

CDFW Administrative Actions

- If results of current statewide Townsend's big-eared bat survey indicate a decline in the population status is occurring that may lead to endangerment, prepare a staff recommendation to list the species as Threatened or Endangered for consideration by the Fish and Game Commission.
- Working with partners at state and federal agencies, as well as private landowners, ensure that management of Townsend's big-eared bat roost sites is consistent with continued site occupancy at or above existing population levels.
- Attempt to secure new funding and position resources as a priority to establish a full-time permanent bat specialist position within the Nongame Wildlife Program of CDFW to address data assimilation and conservation of bats in California, including Townsend's big-eared bat.
- Support research on the design and effectiveness of artificial structures suitable for use by Townsend's big-eared bat during the maternity and hibernation seasons.
- Create interagency and other stakeholder cooperation in, and public support for, conservation efforts for Townsend's big-eared bat. Partner with non-governmental organizations such as Bat Conservation International, The Nature Conservancy, and local NGOs in such efforts.
- Develop greater awareness of Townsend's big-eared bat and other bat conservation and management issues within CDFW.
- Direct fiscal and position resources to complete the draft California Bat Conservation Plan.

Management of Known Roost Sites

- Prior to changing management of caves, mines, or buildings that could be used by Townsend's big-eared bat or other bat species, such sites should be evaluated and/or surveyed during appropriate seasons for their use by Townsend's big-eared bat.
- Existing roosts should be left undisturbed and occupied roosts should only be entered for management or research purposes.
- Bat-friendly gates should be installed at Townsend's big-eared bat roosts where other methods of controlling human entrance are not effective. Special consideration should be given to gate design to minimize risk of injury or unsuitability for Townsend's big-eared bat.
- Abandoned mines suitable for use by Townsend's big-eared bat should not be collapsed or closed in a manner to prevent bat use.
- Effectiveness monitoring (use of data loggers to passively record bat use and human disturbance) should be implemented at gated roost sites and other roost sites actively managed for bat resources (as through signage, information for visitors, etc.).
- Ensure foraging habitat, including access to open water, within the vicinity of maternity roosts remains suitable for use by Townsend's big-eared bat. Analysis of habitat suitability should be made on a site-specific basis, but start with using the area within a 24-km radius of the roost site.
- Where a Townsend's big-eared bat or other bat roost site has a history of recreational use by humans, implement a management plan to ensure new impacts from human use do not occur. The Kentucky Mine Stamp Mill management plan (Tierney and Freeman 2007) is a good example of such a plan that appears to be successful.

Landscape Management Practices

- Developed springs and other water sources should be kept available for in-flight drinking as outlined in various "wildlife-friendly" water facility publications.
- If protracted drought poses a threat to Townsend's big-eared bat, develop additional water sources for drinking in areas where open water limits population size.
- Restore or enhance riparian habitat.
- Implement basal hollow creation projects to increase opportunities for Townsend's big-eared bat to use tree roosts in coastal redwood forests (and possibly in interior forests where large tree species, such as giant sequoia, have the potential to serve as roost sites)

CEQA Review of Proposed Projects

- Ensure direct and cumulative impacts from projects proposed under CEQA and CEQA-equivalent regulatory programs are not likely to result in a substantial reduction in population or range of Townsend's big-eared bat and other bat species.

Public Education and Outreach

- Conduct and cooperate with other agencies on public outreach events about Townsend's big-eared bat and other bat species.
- Disseminate the California Bat Conservation Plan to the public, when complete.

- Encourage citizen participation, as appropriate, in bat monitoring projects, but this is difficult while maintaining good data quality
- Promote bat-friendly exclusions where it is necessary to remove bats from buildings and other structures.

Health and Disease

- Continue and expand surveillance for WNS by state and federal agencies and researchers.
- Support research on the etiology and epidemiology of WNS on *Corynorhinus* species, including Townsend's big-eared bat.
- Continue and expand, if necessary, decontamination requirements for persons entering hibernacula for Townsend's big-eared bat and other hibernating bat species to minimize the risk of introducing the fungus that causes WNS.
- Work with other state and federal regulatory agencies to prevent the introduction of environmental contaminants that may affect the health of Townsend's big-eared bat and other bats. These may include aerial pesticide application and chemicals used in processing mined minerals.

LISTING RECOMMENDATION

CESA directs CDFW to prepare this report regarding the status of Townsend's big-eared bat in California based upon the best scientific information. CESA also directs CDFW based on its analysis to indicate in the status report whether the petitioned action is warranted. (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).) CDFW includes and makes its recommendation in its status report as submitted to the Commission in an advisory capacity based on the best available science. In consideration of the scientific information contained herein, CDFW has determined that the petitioned action is or is not warranted at this time.

PROTECTION AFFORDED BY LISTING

It is the policy of the State to conserve, protect, restore and enhance any endangered or any threatened species and its habitat (Fish & G. Code, § 2052.). If listed as an endangered or threatened species, unauthorized "take" of Townsend's big-eared bat will be prohibited, making the conservation, protection, and enhancement of the species and its habitat an issue of statewide concern. As noted earlier, CESA defines "take" as to hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill. (*Id.*, § 86.) Any person violating the take prohibition would be punishable under State law. As to authorized take, the Fish & G. Code provides CDFW with related authority under certain circumstances. (*Id.*, §§ 2081, 2081.1, 2086, 2087 and 2835.) In general and even as authorized, however, impacts of the taking on Townsend's big-eared bat caused by the activity must be minimized and fully mitigated according to State standards.

Additional protection of Townsend's big-eared bat following listing is also likely with required public agency environmental review under CEQA and its federal counterpart, the National Environmental Policy Act (NEPA). CEQA and NEPA both require affected public agencies to analyze and disclose project-related environmental effects, including potentially significant impacts on endangered, rare, and

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11. Current and future projected climatically-suitable areas for Townsend's big-eared bat in California (J.Stewart, unpublished data) under four projections of future climate. Climatically-suitable areas were modelled using MaxEnt and existing occurrence records. For the period 2070-2099, areas shown in dark blue remain suitable, areas shown in red are suitable under current climate conditions but are projected to become unsuitable, and areas in light blue are modelled as currently unsuitable but would become suitable in the future.

12. California abandoned mines. Add citation