PETITION

Before the California Fish and Game Commission

Family of burrowing owls in the Altamont Pass Wind Resource Area

To List California Populations of the Western Burrowing Owl (*Athene cunicularia hypugaea*) as Endangered or Threatened Under the California Endangered Species Act

Center for Biological Diversity
Defenders of Wildlife
Burrowing Owl Preservation Society
Santa Clara Valley Audubon Society
Urban Bird Foundation
Central Valley Bird Club
San Bernardino Valley Audubon Society

March 5, 2024

FGC – 670.1 (3/94)

NOTICE OF PETITION TO THE STATE OF CALIFORNIA
FISH AND GAME COMMISSION

For action pursuant to Section 670.1, Title 14, California Code of Regulations and sections 2072 and 2073 of the Fish and Game Code relating to listing and delisting endangered and threatened species of plants and animals.

I. SPECIES BEING PETITIONED:

Common name: Western burrowing owl
Scientific name: *Athene cunicularia hypugaea*

II. **RECOMMENDED ACTION:**

List as endangered: San Francisco Bay Area, Central-Western California, and Southwestern California populations;

List as threatened: Central Valley and Southern Desert Range populations

OR

List the burrowing owl throughout its entire range in California as threatened

The Center for Biological Diversity, Defenders of Wildlife, Burrowing Owl Preservation Society, Santa Clara Valley Audubon Society, Urban Bird Foundation, Central Valley Bird Club, and San Bernardino Valley Audubon Society submit this petition to list imperiled populations of the western burrowing owl in California as endangered or threatened, pursuant to the California Endangered Species Act (California Fish and Game Code §§ 2050 et seq.). This petition demonstrates that these California populations of the western burrowing owl clearly warrant listing, based on the factors specified in the statute. Alternatively, the petitioners request a threatened listing for the burrowing owl throughout its entire range in California.

III. AUTHOR OF PETITION:

Jeff Miller, Center for Biological Diversity
1212 Broadway, Suite 800
Oakland, CA 94612
(510) 499-9185
jmiller@biologicaldiversity.org

I hereby certify that, to the best of my knowledge, all statements made in this petition are true and complete.

Signature:  Date: March 5, 2024

Table of Contents

Executive Summary

The western burrowing owl was once a ubiquitous part of the California landscape, over which it was widely distributed in grasslands, shrub steppe, and deserts. Many historical sources reported this owl to be widespread, common or abundant in grassland habitat. Burrowing owl population declines began by at least the 1940s throughout most of the range of the species in California. Declines have been most precipitous in coastal grasslands extending from Sonoma to San Diego counties, where breeding burrowing owls were once abundant. The burrowing owl has been extirpated as a breeding species by human activities from at least 19 of 51 California counties where it formerly occurred; and is nearing extirpation in 10 other counties. The species now no longer breeds throughout roughly 16% of its former range in the state; and is nearing extirpation in an additional 13% of its California breeding range.

The most important threats facing burrowing owls in California are direct mortality and permanent habitat loss caused by urbanization, and reduction or elimination of their primary burrow excavators, ground squirrels, from grazing and agricultural lands. Because of their highly specialized, ground-dwelling lifestyle and dependence on underground tunnels, burrowing owls are extremely vulnerable to direct and indirect impacts of grading, disking, tilling, earthmoving, burrow blockage, and eradication of ground squirrels. Foraging habitat area requirements for the owl may be substantial and difficult to fulfill in urbanizing regions and even in more natural habitats, where prey is sparse or variable in space or time. Urbanization exposes burrowing owls to increased hazards of traffic, breeding and foraging habitat destruction, decreased foraging opportunities, and concentrated abundance of predators. Broadscale urban expansion has already caused extirpation or near extirpation of burrowing owls in most coastal areas, and human population growth there and throughout the Central Valley and Southern California is projected to continue at an increasing rate. Some of the state's largest remaining burrowing owl populations face significant mortality and habitat loss from industrial renewable energy development, with estimates that large solar and wind projects are taking up to thousands of burrowing owls in California each year. Regional extirpation of burrowing owls is being driven by eviction of owls, either through active or passive relocation, to accommodate urban and renewable energy development. Grassland conversion to non-compatible forms of agriculture, such as vineyards, orchards, or rice, also contributes to the population decline.

Two California statewide surveys have been conducted for burrowing owls. The Institute for Bird Populations surveyed statewide from 1991-1993, documenting that breeding owl populations in most areas of California, including the Central Valley, incurred significant declines between the 1980s and early 1990s. Nearly two-thirds (61%) of the state's burrowing owl colonies had been eliminated during that decade, and the number of owl pairs decreased by approximately 60% over more than half of the statewide range of the burrowing owl, corresponding to an average annual rate of decline of 4-7%. Consistent decreases of 2.5% per year are considered by the U.S. Fish and Wildlife Service to be biologically significant, even for species that are widely distributed and relatively abundant; such rates are indicative of chronic population declines. An annual rate of -2.5% amounts to a cumulative decline of about 50% over a span of 27 years. A resurvey of the entire breeding range in the state from 2006-2007 documented a further 11% decline of burrowing owls by 2007. Declines were apparent in numerous regions, including throughout the Central Valley and in Southwestern California, with precipitous declines in the San Francisco Bay Area and Bakersfield. A few subsequent regional focused surveys have documented further declines of breeding burrowing owl numbers in the middle and southern Central Valley, San Francisco Bay Area, Southwestern California, and the Imperial Valley.

In most of their desert range in northeastern California, breeding burrowing owls have apparently always been sparsely distributed and uncommon. Early estimates of 90-227 breeding pairs in this region proved to be optimistic; the only focused survey of the region in 2006-2007 found zero breeding pairs. Only a handful of breeding pairs have subsequently been reported. The petitioners are not requesting a separate listing for the Northern Desert Range population.

Breeding burrowing owls have declined significantly in the Northern Central Valley, where focused owl surveys estimated 231 pairs in the region from 1991-1993. Only 12 pairs remained during resurvey from 2006-2007. There have been only a few breeding season observations of burrowing owls from 2015-2023 in the Northern Central Valley, and only in Butte and Yuba counties. Northern Central Valley owls are threatened by ground squirrel control. The petitioners are requesting that the Northern Central Valley population be listed as threatened as part of a larger Central Valley or statewide population.

Breeding owls have declined in the Middle Central Valley, where focused owl surveys estimated 595-600 pairs in the region from 1991-1993, and 545 pairs during resurvey from 2006-2007, an 8% decline. Some breeding colonies remain in eastern Contra Costa and eastern Alameda counties (including at Altamont Pass Wind Resource Area, where there have been recent and significant declines), and San Joaquin County. More recent localized resurvey efforts have documented near extirpation from Yolo County and Sacramento County, and anecdotal information and reports indicate recent sharp declines in Solano, eastern Contra Costa, eastern Alameda, San Joaquin, and Merced counties. Middle Central Valley owls are threatened by urban development, changes in land use, poisoning of ground squirrels, direct persecution, drought, and mortality at wind turbines. The petitioners are requesting that the Middle Central Valley population be listed as threatened as part of a larger Central Valley or statewide population.

Breeding owls have declined in the Southern Central Valley, where focused owl surveys estimated 1,396 pairs in the region from 1991-1993, and 1,113 pairs during resurvey from 2006-2007, a 20% decline. Most breeding colonies remain in Tulare and Kern counties. Localized resurvey efforts in 2007 documented declines in the region. Anecdotal information and reports indicate recent declines in Kings and Kern counties. Southern Central Valley owls are threatened by urban development, utility-scale renewable energy development, and agricultural conversions. The petitioners are requesting that the Southern Central Valley population be listed as threatened as part of a larger Central Valley or statewide population.

Burrowing owls were formerly numerous throughout the San Francisco Bay Area region, particularly in the interior east of the Bay. Focused surveys from 1991-1993 documented a 60% decline in breeding locations and a 51% decline in colonies from the 1980s, with a regional estimate of only 165 pairs. Resurvey of the region from 2006-2007 estimated 119 pairs, all in the interior. Breeding burrowing owls have been extirpated from the entire coast (Sonoma, Marin, San Francisco, San Mateo and Santa Cruz counties) and portions of the interior (Napa and southwestern Solano counties); and they are near extirpation in western Contra Costa and western Alameda counties. Breeding owls continue to decline everywhere they remain in the Bay Area. Localized resurvey efforts document continuous and significant declines and near extirpation even in Santa Clara County, formerly the stronghold for the species in the region. As of 2023 there are fewer than 25 breeding pairs remaining in the region. San Francisco Bay Area owls are now near extirpation, and are threatened by urban development and habitat loss, eviction methods, pest management, and ground squirrel control. The petitioners are requesting that the San Francisco Bay Area population be listed as endangered.

Breeding owls have declined throughout most of Central Western California, particularly on the coast. Breeding burrowing owls have been extirpated from coastal San Luis Obispo County and are very near extirpation from coastal Monterey County and the western 75% of Santa Barbara County. Focused surveys from 1991-1993 estimated 46 pairs in the region (38 in the interior and 8 on the coast). Resurvey of the region from 2006-2007 covered a much greater number of upland blocks, and estimated 84 pairs in the region, all in the interior. Anecdotal information and reports indicate continuing declines, and there may be no large owl colonies remaining in the region. Owls seem to have declined on the Carrizo Plain. Central Western California burrowing owls are threatened by urban and solar development. The petitioners are requesting that the Central Western California population be listed as endangered.

Burrowing owls were historically abundant throughout Southwestern California. Focused surveys from 1991-1993 estimated 263 pairs in the region (227 in the interior and 36 on the coast), a 57-85% decline since the mid-1980s. Massive declines continued through the early 2000s, particularly on the coast. Resurvey efforts from 2006-2007 estimated 150 pairs in the interior, a further 34% decline. More thorough survey coverage and knowledge of all remaining breeding populations provided a 2006-2007 estimate of 42 pairs for the coast. Breeding burrowing owls have been extirpated from Ventura, western Los Angeles, and Orange counties and are near extirpation in San Diego County. Significant breeding populations remained in western Riverside and southwestern San Bernardino counties, where further recent declines have been documented and long term persistence is unlikely. Southwestern California owls are threatened by urban development, habitat loss, degradation and fragmentation, ground squirrel eradication, coastal predator management, and disturbance. The petitioners are requesting that the Southwestern California population be listed as endangered.

Historically, burrowing owls were present in low densities within the Imperial and Coachella valleys, similar to populations in surrounding undisturbed deserts. With the intensification of agriculture, the Imperial Valley owl population grew to the largest and most dense in California by the 1990s. Focused owls surveys from 1991-1993 detected 1,045 owl pairs and estimated an Imperial Valley population of 6,571 pairs. Resurvey from 2006-2007 estimated 6,408 pairs, 2.5% fewer than the previous decade. Subsequent focused surveys with more accurate survey methodology detected and estimated significantly fewer (35-41% fewer) breeding owls. Estimates of male owl territories were down to 3,776-4,133 in 2012. There have been no focused surveys since, but there is anecdotal information and reports of further recent declines. Imperial Valley owls are threatened by changes in agricultural practices and irrigation, lining of earthen canals with concrete, and conversion of farmland to massive utility-scale solar, wind, and geothermal projects. Focused owl surveys from 1991-1993 found zero owls in the Coachella Valley, where they were thought to be extirpated. Resurvey from 2006-2007 detected 49 pairs and estimated 53 pairs in the Coachella Valley region, an apparent new colonization by owls. Coachella Valley owls are threatened by development and significant habitat loss. The petitioners are not requesting a separate listing for the Imperial Valley or Coachella Valley populations.

Burrowing owls were historically uncommon in small, scattered populations in the southern desert range. Statewide surveys from 1991-1993 did not cover the southern deserts. The first systematic survey was from 2006-2007, with an estimate of up to 560 pairs in the southern deserts. There are now large populations nesting in agricultural areas in the Palo Verde Valley (179 pairs) and in the western Mojave Desert (560 pairs), with smaller numbers in the eastern Mojave Desert (32 pairs). Few to no breeding owls have been detected in the northern Mojave Desert, eastern Sierra Nevada, or the Sonoran Desert (excluding Palo Verde Valley). Southern

Desert owls are threatened primarily by urban development and massive utility-scale solar development. The petitioners are requesting a threatened listing for the Southern Desert Range population.

Exceptions to the widespread declines of burrowing owls in California have been few. The species appears to be abundant in only a few small areas of the state, such as Imperial Valley and Palo Verde Valley. Large owl populations have colonized specific habitats in these valleys in response to irrigated agriculture in those desert regions. Burrowing owls were known from the agricultural Imperial Valley in the 1960s and 1970s, and became quite numerous and concentrated there in the 1990s. By the early 1990s, burrowing owls in the Imperial Valley comprised more than 70% of the estimated statewide owl population, though they have declined significantly since then. Throughout the rest of the desert regions of the state that support breeding burrowing owls (Modoc Plateau and the majority of the southern deserts, which cover more than 40% of their state range), numbers are very low and owls are not concentrated.

Extensive data from banded burrowing owls shows very little evidence of movements of resident owls between regional populations in California. Burrowing owl populations in the Imperial and Palo Verde Valleys do not serve as a dispersal source and cannot be expected to augment geographically isolated or depleted populations elsewhere in the state.

In many areas, sustained eradication of ground squirrels has occurred during the same period as burrowing owl declines. Although agricultural practices in some areas appear to benefit burrowing owls, this is not the case in much of the Central Valley. High rates of burrowing owl occurrence in Imperial Valley and Palo Verde Valley agro-ecosystems have been attributed to a combination of factors: year-round abundance of invertebrate prey; open-water earthen canal delivery systems that provide an abundance of nesting opportunities; and tolerance of burrows by farmers. Factors that affect prey abundance and burrow availability have the potential to cause decreases in the burrowing owl populations in these areas, such as housing development, industrial scale energy development, and changes in agricultural practices.

Existing protection and management efforts have not collectively been able to slow or halt burrowing owl population declines that have continued throughout most of the burrowing owl range in California. Some federal Habitat Conservation Plans (HCPs) and state Natural Community Conservation Plans (NCCPs) in California employ burrowing owl protection and mitigation measures, augmented by some habitat acquisition. But these conservation lands typically comprise only small areas, that are not necessarily contiguous nor provide connectivity to existing populations. Only a handful of these HCPs and NCCPs can point to any success in preserving burrowing owls, and few have the ability to protect large areas of owl habitat with biologically meaningful numbers of remaining breeding burrowing owls. There are 14 federally approved mitigation banks and 21 state conservation banks and preserves for burrowing owls in California, where credits are purchased in exchange for permits allowing destruction of known owl breeding habitat, and usually passive eviction of owls from a project site. The conservation bank approach implicitly endorses extirpation of owls from areas of high development by not requiring on-site conservation measures, ensuring that owls will eventually be eradicated from urbanizing areas. Based on the minimal numbers of breeding owls documented in these mitigation banks, it is impossible to claim they are a net benefit for maintaining burrowing owls in California. The small number of conservation banks with owl habitat, their small size, and the rising cost of purchasing suitable land for habitat make this approach incapable of protecting significant populations of owls. Several conservation easements for burrowing owls are located within the footprint of the Altamont Pass Wind Resource Area, where its wind turbines present a clear mortality risk.

Several California Fish and Game Code sections provide legal protections from the take of birds of prey, eggs, and nests, but current implementation and practice has been inadequate to protect burrowing owls. The California Department of Fish and Wildlife has developed guidance for reviewing and commenting on environmental documents and making recommendations to avoid, minimize, and mitigate potential negative impacts on burrowing owls, but this depends mainly on the California Environmental Quality Act (CEQA) lead agencies agreeing to adopt their use. The frequent failure of the CEQA process to adequately disclose and mitigate for project impacts to burrowing owls, let alone provide substantive protections, has been well documented and is discussed in this petition. CEQA is not, and was never intended to be, a habitat protection mechanism. Burrowing owls in California require California Endangered Species Act protection to prevent the steady march toward statewide extirpation.

This petition presents information indicating that listing the San Francisco Bay Area, Central-Western California, and Southwestern California populations of the burrowing owl as endangered, and listing the Central Valley and Southern Desert Range populations of the burrowing owl as threatened is warranted. It also presents information that listing the entire statewide population as threatened is warranted.

Requested Action and Petitioners

Petitioners request that the California Fish and Game Commission list three California populations, or Evolutionarily Significant Units (ESUs), of the western burrowing owl (*Athene cunicularia hypugaea*) as endangered under CESA: the Southwestern California, Central-Western California, and San Francisco Bay Area ESUs; and list two California populations of the western burrowing owl as threatened under CESA: the Central Valley ESU and the Southern Desert Range ESU.

If the Commission determines that the entire Central Valley population does not warrant threatened status, Petitioners request that the Commission evaluate whether the Northern Central Valley, Middle Central Valley, and Southern Central Valley constitute distinct populations of burrowing owls, and whether any of these three populations separately warrants listing. These separate regions of the Central Valley have differing abundance and population trends of breeding burrowing owls. If the Commission determines that the entire Southern Desert Range population does not warrant threatened status, Petitioners request that the Commission evaluate whether the Western Mojave, Eastern Mojave, and Sonoran Desert constitute distinct populations of burrowing owls, and whether any of these three populations separately warrants listing. These separate regions of the southern deserts have differing abundance and population trends of breeding burrowing owls.

Alternatively to listing ESUs, Petitioners request that the Commission list the western burrowing owl in the entirety of California as a threatened species under CESA. All available data show sharp declines in breeding burrowing owls throughout the state in recent years, accelerating in many areas to near extirpation in the past decade or even half decade. With land use changes and uncertainty in the Imperial Valley, coupled with apparent, accelerating declines, statewide threatened status is warranted. The degree of loss of burrowing owl colonies in the past 20 years demonstrates that protections are urgently needed immediately and that the burrowing owl is a threatened species across the state.

The California Fish and Game Commission acknowledges ESUs of species that can be evaluated for listing separately where the information available warrants independent treatment. The use of ESUs by the California Department of Fish and Wildlife to evaluate the status of species pursuant to CESA is supported by the determination by California's Third District Court of Appeal that the term "species or subspecies" as used in CESA (Fish & G. Code, §§ 2062 and 2067) includes ESUs. To be considered an ESU, a population must meet two criteria: 1) it must be reproductively isolated from other conspecific (i.e., same species) population units, and 2) it must represent an important component of the evolutionary legacy of the species (Waples 1991). This petition provides information about the reproductive isolation of breeding burrowing owl populations in the Southwestern California, Central-Western California, San Francisco Bay Area, Central Valley, and West Mojave bioregions. Each of these declining populations of burrowing owls represents an important component of the evolutionary legacy of the species.

Petitioners:

The Center for Biological Diversity is a national, nonprofit conservation organization with more than 1.7 million members and online activists dedicated to the protection of endangered species and wild places. Defenders of Wildlife is dedicated to the protection of all native animals and plants in their natural communities, with a nationwide network of nearly 2.2 million members and activists. Santa Clara Valley Audubon Society promotes the enjoyment, understanding, and protection of birds and other wildlife by engaging people of all ages in birding, education, and conservation. Burrowing Owl Preservation Society works to increase California’s burrowing owl population through education and research and protection and enhancement of grassland habitat. Urban Bird Foundation works to protect, defend, rescue and conserve bird life. Central Valley Bird Club is dedicated to the study of the distribution, status, ecology, and conservation of birds in the Central Valley of California. San Bernardino Valley Audubon Society strives to connect people to the natural world, focusing on birds and other wildlife to conserve natural resources in Southern California's Inland Empire in San Bernardino, Riverside, and Imperial Counties.

Natural History

Description and Distinguishing Characteristics

The western burrowing owl is a small, cryptically-colored owl that is adapted for life in open, arid, relatively flat to rolling terrain covered by low-stature vegetation, such as grasslands, prairies, shrub steppes, and desert shrubs. The burrowing owl is a unique bird of prey, in that it nests and roosts in underground burrows usually excavated by other fossorial animals, including ground squirrels, coyotes, foxes, badgers, skunks, kangaroo rats, and tortoises (Zarn 1974). Burrowing owls in California rely primarily upon ground squirrel burrows: California ground squirrel (*Otospermophilus beecheyi*) throughout most of the state; and Mohave ground squirrel (*Xerospermophilus mohavensis*) in the Mojave Desert. Where host burrows are absent, burrowing owls may themselves excavate simple burrows where soil substrates are light and friable, but burrow excavation by burrowing owls rarely occurs in California. Burrowing owls have persisted in human-altered environments, such as in urban and agricultural landscapes, and including in some locations where natural grasslands have been nearly eliminated. Burrowing owls will sometimes use burrow surrogates, such as culverts, piles of concrete slab and rubble, and concrete pipes where natural burrows are limited.

Burrowing owls have a distinct appearance and are not easily confused with any other owl due to their ground-dwelling (fossorial) nature. Burrowing owls are small, with brown and white mottling, and have long, almost bare, stilt-like legs and a stubby tail. Long legs help them see over short-grass vegetation in a landscape with few elevated perches, and also aid in running down prey. Burrowing owls have a round head lacking ear tufts, white eyebrows, yellow eyes, and a distinct oval facial ruff. Adults are a rich sandy-brown color on the head, back, and upper parts of the wings, and are thickly spotted with whites and buffs on the underparts. This coloring provides camouflage in dry grassland habitats. Males and females are difficult to distinguish in the field, although females are usually darker during the breeding season (males may appear faded from spending more time exposed to the sun during the breeding season). Unlike many other raptors, the female is slightly smaller than the male, which may be an adaptation for squeezing into narrow burrows. Adult birds are about 19-25 cm (7-10 inches) tall and weigh an average of 150 grams (Zarn 1974). A brood pouch is often visible among adult females during the breeding season. Juveniles are distinguished from adults by their solid buffy breast and white collar.

Burrowing owls require open fields or grasslands to access abundant food supply. Low vegetative cover also allows burrowing owls to watch for predators, and proximity to ground squirrels increases security by means of mutual alarm-calling. Burrowing owls frequently nest in social aggregations, forming loose colonies. Colonies are tied to clustered spatial distributions of host burrowing mammals, such as ground squirrels and prairie dogs, but where squirrels are abundant and widespread, owls typically inhabit only about 25% of the squirrels' distribution, leaving large areas with squirrel burrows empty. Burrowing owl aggregations are principally self-organized, with the most successful breeders in the centers of aggregations. Nesting season in California is typically from February through August (though nestling emergence from nest burrows has been documented as late as early October in California). Pairs can fledge 4-5 young in good years, though the number fledged is usually smaller.

After the nesting season, most owls in California likely remain throughout the winter as year-round residents (but they may move away from their breeding areas during nonbreeding seasons), and owls from other areas augment resident California populations. Burrowing owls opportunistically forage, and in many areas, they may control levels of insects and rodents that are linked to human disease and crop damage. Burrowing owls appear to be adapted to sporadic prey abundance and harsh climatic conditions. In areas in which they do not migrate, owls often cache prey to consume later. Burrowing owls have evolved anti-predator defenses, such as co-habitation with squirrels and mutual alarm-calling, rattlesnake mimicry, scent-masking, and use of auxiliary burrows, in response to their vulnerability to both terrestrial and aerial predators. They also attack and kill rattlesnakes, and at night, they aggressively repel advances made by badgers, coyotes or striped skunks.

Taxonomy

The western burrowing owl belongs to the Class Aves, Order Strigiformes (Owls), Family Strigidae (Typical Owls), Genus Athene, Species cunicularia, and Subspecies hypugaea. Up to 18 subspecies of *Athene cunicularia* are recognized (Clark et al. 1978). Two of these occur in North America: the western burrowing owl (*A. c. hypugaea*), inhabiting North and Central America west of the eastern edge of the Great Plains south to Panama; and the Florida burrowing owl (*A. c. floridana*), found in Florida and on the Bahama Islands.

Molina initially classified the burrowing owl as *Strix cunicularia* in 1782. The species has since received several taxonomic changes and has been variously placed in the genus *Speotyto* or *Athene*. It was designated as *Athene* by the American Ornithologists' Union (AOU) in 1983, moved back to *Speotyto* in 1991 based on karyotypic evidence, and reverted to *Athene* in 1997 (AOU 1983, 1991, 1997).

As for the owl's etymology, Athena was the Greek goddess associated with the owl, and Speotyto was derived from the Greek "speos" meaning cave and "tyto" meaning owl. The Latin "cunicularus" means "little miner." The burrowing owl is commonly known as the ground owl, prairie dog owl, howdy owl, or Billy owl, and is referred to as "Lechuza Llanera" in Hispanic cultures.

Range

The western burrowing owl is distributed from the Mississippi River to the Pacific Ocean, north into the prairie provinces of Canada and south to Mexico and western Panama (Haug et al. 1993; Trulio 1998b). Grinnell and Miller (1944) characterized the historical range of the burrowing owl in California as follows:

> "Suitable areas (treeless and level) almost throughout the state, from the Oregon line east of the Siskiyou mountains south to the Mexican border, and from the Nevada border and Colorado River west to the ocean shore; includes practically all islands from the Farallones south. Mostly rare or wanting in coastal counties north of Marin and in all mountainous areas. Mainly Lower and Upper Sonoran life zones; but breeds locally in Transition zone, and vagrants go even higher. Altitudes of occurrence extend from 200' below sea level in Death Valley and around the Salton Sea up regularly to 5300 feet in Lassen County."

Historically, burrowing owls have been found to reach maximum abundances in wide, lowland, interior valley bottoms and in flat coastal lowlands (Grinnell and Miller 1944). Surveys by DeSante and Ruhlen (1995) found that 92% of the breeding owls located throughout California occurred in such lowland areas, generally below 60-300 meters in elevation. These types of habitat are under the most severe pressure from urban development.

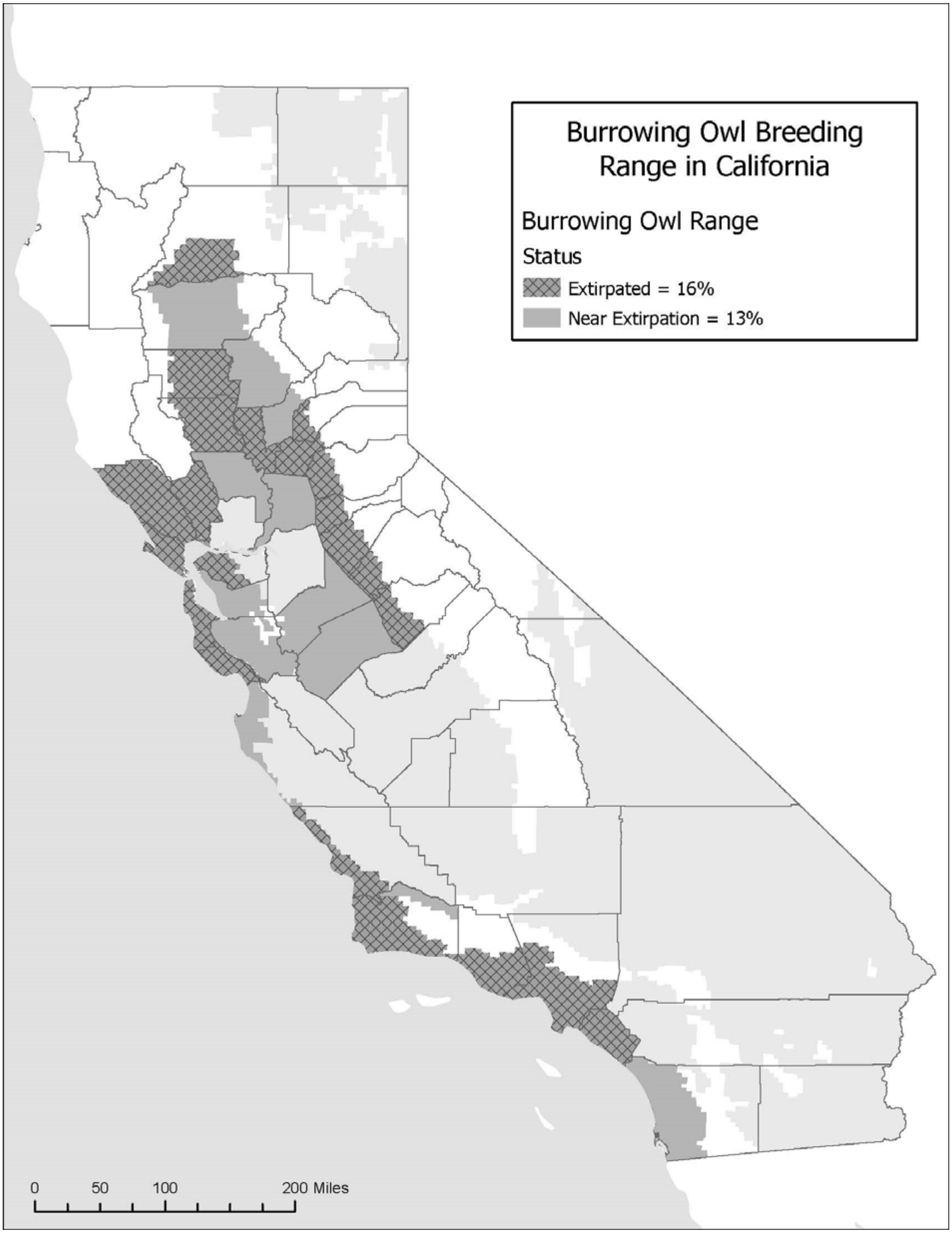

Figure 1 - Range of breeding burrowing owls in California, showing areas of extirpation and near-extirpation; map by CBD 2024

Burrowing owls have experienced a significant range reduction in California. See Figure 1. DeSante and Ruhlen (1995) determined that breeding burrowing owls had been extirpated since the early 1980s from Marin, Napa, San Francisco, Santa Cruz, coastal San Luis Obispo, and Ventura counties. By 2001, burrowing owls had been eliminated from an estimated 8% of their former breeding range in California (J. Barclay, using data from DeSante et al. 1996). By the time of the 2003 CESA listing petition, breeding burrowing owls had been further extirpated or were very near extirpation (only one or two breeding pairs still existing) in Sonoma, western Santa Barbara, Orange, coastal Monterey, and San Mateo counties. Excluding consideration of desert areas, by 2003 breeding burrowing owls had apparently been extirpated from at least 6,460 square miles, or 10% of their former range in California (CBD et al. 2003). This petition provides evidence that burrowing owls have now been extirpated or are very near extirpation as a breeding species from additional areas in the: northern Central Valley (Shasta, Tehama, Glenn, Butte, Nevada, Yuba, Colusa, Lake, Sutter and Placer counties); Middle Central Valley (Yolo, Sacramento, Stanislaus, and Merced counties); San Francisco Bay Area (Sonoma, southwestern Solano, western Contra Costa, western Alameda, Santa Clara, and San Mateo counties); Central-Western California (coastal Monterey and western Santa Barbara counties); and Southwestern California (western Los Angeles, Orange, and western San Diego counties). Breeding burrowing owls have now been extirpated from roughly 16% of their former range in California and are nearing extirpation as a breeding species from an additional 13% of their California range.

Reproduction and Growth

Western burrowing owls generally adopt burrows excavated by other animals, usually those of ground squirrels (*Otospermophilus beecheyi* and *Xerospermophilus mohavensis*), prairie dogs (*Cynomys* spp.), American badgers (*Taxidea taxus*), or other small burrowing animals. Although some burrowing owls may dig their own burrows if the soil is soft enough (burrowing owls in Florida do this on a regular basis), they generally prefer to enlarge and adapt existing mammal burrows. Burrowing owls in California live primarily in ground squirrel burrows, for the most part taking over ground squirrel burrows. Ground squirrels appear to welcome co-habitation by burrowing owls, which defend them against rattlesnakes and nocturnal predators. Where burrows are scarce, owls may attempt to nest in pipes, culverts, or artificial nest boxes.

Nest burrows are usually 1 to 3 meters long, with a downward slope of about 15 degrees, a J- or U-shaped bend, and an enlarged nest chamber at the end (Coulombe 1971). Burrowing owls exhibit strong site fidelity and adults often return to the same burrow or a nearby area each year. Adult males often use one or more “satellite” burrows near the nest burrow during the nesting period, as do juvenile owls for a few weeks after they emerge from the nest. Both adults in a pair prepare the burrow for nesting using their feet, beaks, and wings to scrape out dirt (Thomsen 1971; Martin 1973; Voous 1988). They often begin these renovations at several burrows, eventually selecting the best one as a nest site. The burrow is frequently lined with horse or cattle dung and other material such as grass, feathers, and other debris, but is sometimes left unlined (Thomsen 1971; Martin 1973; Evans 1982; Johnsgard 1988; Voous 1988). It has been speculated that the lining material acts as an absorbent, attracts dung beetles eaten by the owls, masks odors produced by the birds (making detection by predators more difficult), or produces heat by decomposition, controlling temperature and humidity within the nest cavity and aiding in the incubation of eggs (Martin 1973; Green and Anthony 1989). The habit of lining the burrow with manure is so strong that owls will promptly replace dung when it is removed (Martin 1973). Nest burrows are often also adorned by animal carcasses, toad skins, canid scat, clumps of grass, and shiny objects such as plastic trash (see Smallwood and Morrison 2018 for references).

Burrowing owls often nest in loose colonies, which may be a response to local abundance of burrows and food, or an adaptation for mutual defense. Colony members can alert each other to the approach of predators and join in the harassment of them. During the nesting season, adult males forage over home ranges 2-3 km^2 in size and the ranges of neighboring males may overlap considerably. A small territory around the nest burrow is aggressively defended against intrusions by other burrowing owls, ground squirrels, and predators.

Breeding season for the burrowing owl in California typically occurs between February 1 and August 31 (CDFG 1994, 2012), although breeding in December has been documented (Thompson 1971; Gervais et al. 2008). In the Imperial Valley, pair formation begins as early as mid-January (Coulombe 1971). Breeding behavior includes nest site selection by the male, pair formation, copulation, egg laying, hatching, fledging, and post-fledging care of young by the parents. The male owl conducts courtship displays in front of the burrow. Capable of producing more than 17 vocalizations, the “primary song” is given only by adult males when near the burrow to attract a female. A two-syllable “who-who” is given at the entrance of a promising burrow. This call is also associated with breeding and territory defense. Once a female is enticed to the site, courtship antics involving various postures, vocalizations, and displays undertaken by both sexes, usually within 15 meters of the burrow. Nest site selection begins after pair formation, with the males gathering and distributing most of the nesting material (Anderson et al. 2001).

By February owls are pairing up and can be observed standing together outside the nest burrow. Actual breeding occurs anywhere from March through August, with the peak of the breeding season occurring between 15 April and 15 July, the period when most burrowing owls have active nests (eggs or young) (CDFG 2012). Burrowing owls are primarily monogamous for the nesting season, and some pairs in the Imperial Valley may remain together throughout the year (Coulombe 1971). Barclay and Menzel (2011) reported on two-nest polygynous breeding at Camp Parks in Dublin, Alameda County, where one male burrowing owl paired with two females that each raised young, but this appears to be rare.

Females usually produce only one clutch per year, but may lay a second clutch if the first is lost. Pairs are capable of laying a second clutch after the first brood successfully fledges (Gervais and Rosenberg 1999). Burrowing owls will lay up to 12 eggs in a chamber of the nest burrow, one of the largest clutch sizes of any raptor species, although 7 eggs is the norm (Haug et al. 1993). Eggs are laid between March and May depending upon location. The incubation period lasts 29 days (Coulombe 1971). The female incubates the eggs while the male brings food to the female and stands guard near the burrow by day. After hatching, the nestlings remain in the nest chamber for approximately 2 to 3 weeks. By this time, the young are large and the burrow is very crowded, and young birds will often stand at the burrow entrance eagerly waiting for the parents to bring food.

Just before or just after they emerge (mid-May through early August), young lose their natal down and gain juvenal plumage. Juveniles emerge from the burrow weighing approximately half to two thirds of adult weight and they reach adult weight within a month of emergence (Landry 1979; Priest 1997; Lantz and Conway 2009). Young fledge (acquiring the feathers necessary for flight) after 44 days (Haug et al. 1993). Burrowing owl parents will feed young for another 6 to 8 weeks after emergence, with young remaining near the burrow with their parents until fall. By mid-September, the young molt into adult plumage and disperse to find their own burrows.

The timing of nesting activities may vary with latitude and climatic conditions. Burrowing owls may change burrows several times during the breeding season, starting when nestlings are about three weeks old (Haug et al. 1993).

Although published accounts for life expectancy of burrowing owls are lacking since returns of banded owls are sparse, an average longevity of 5 years is informally used (Kennard 1975). The record age for a banded owl in the wild is 9 years and 11 months (BBL 2023).

Reproductive success may be one of the most important factors in maintaining population viability for species with relatively low survivorship and a short life span (Emlen and Pilkitch 1989); and this is likely to be true for burrowing owls (Gervais and Rosenberg 1999). Burrowing owl adult and juvenile survivorship is highly variable among studies, with between-year return rates for adults from 30-83% (Thomsen 1971; Haug et al. 1993; Clayton and Schmutz 1997). Menzel (2018) found a 15% return rate of burrowing owls raised in artificial burrows and nesting at San Jose Airport during the subsequent breeding season was comparable to the 16% return rate observed for another nonmigratory population of burrowing owls in California's Imperial Valley (Rosenberg and Haley 2004), and higher than the 8% rate reported for a migratory population in Colorado (Lutz and Plumpton 1999). Although up to 10 young per nest can be fledged in good reproductive years (Gervais and Rosenberg 1999), the number of young successfully fledged from nests in central California varied from 3 to 6, with most nests fledging 4 or 5 young (DeSante et al. 1997). Average young fledged per nest was 2.5 in the Imperial Valley population (Rosenberg and Haley 2003). Early anecdotal accounts suggesting that 6 to 8 young were fledged (e.g. Dawson 1923) may have been biased by remarking on unusual aggregations. The number of owls fledged is primarily a function of population size, which is inter-annually cyclic. Nonetheless, an apparent reduction over time in fledging success corresponds with a documented decline of breeding populations of other avian predators in grassland habitats in central California in recent years, such as the loggerhead shrike (*Lanius ludovicianus*) and American kestrel (*Falco sparverius*) (DeSante et al. 1997). However, the longest-term study of a burrowing owl population ever published (Barclay et al. 2011), an 18-year study of the burrowing owl colony at San Jose International Airport, found that lower adult survival rather than reproductive success (which was highly variable) was the most important factor that contributed to a population decline. Barclay et al. (2011) counted the owl population each year and estimated annual reproduction and survival during periods of population increase and decline.

Seasonal Movements

In northern portions of the range of the burrowing owl in Canada and the United States, some populations are migratory, leaving their breeding areas in fall and returning to the same area in the spring. Most migrants from these areas are thought to winter in Mexico and in the southern portion of the western burrowing owl's range in the United States. In California, burrowing owls are predominately nonmigratory (Brenkle 1936; Ligon 1961; Thomsen 1971; Haug et al. 1993) or appear to wander within the region during the winter months (Coulombe 1971; Martin 1973; Botelho 1996), particularly in central and southern California. Burrowing owls in California will continue to use burrows during the winter or become strictly nocturnal (Thomsen 1971; Trulio et al. 2023; S. Smallwood pers. comm., 2023).

Winter migrants from outside of California may augment some California populations during winter months (Coulombe 1971; Kute et al. 2003). It is assumed that migrants may travel from northern areas that are covered in snow during the winter where their burrows and food may be inaccessible (as far away as Canada, Washington, Oregon, and Idaho). California has a large number of burrowing owls in the winter, relative to other portions of the species' North American breeding range. In fall and winter, individual owls can appear in unexpected places, such as on the smaller California islands, including South East Farallon Island (Lamb 1929; Unitt 1984; Chandler et al. 2016). The winter distribution of burrowing owls in California is suggested by data from the annual Audubon Christmas Bird Count. Unfortunately, detailed information on the magnitude and timing of winter movements of burrowing owls in California does not exist. Migratory owls in central coastal California will leave by the last week in March, and no breeding or pairing of migrants has been observed (Madden 2002).

U.S. Fish and Wildlife Service Bird Banding Laboratory (USFWS 1993) records contained 44 encounters of burrowing owls banded in California. Twenty-nine (66%) of these encounters occurred in the same 10-minute blocks where the owls were banded and 10 (23%) occurred in the 10-minute block adjacent to where they were banded. Of the remaining 5 recoveries, only 2 represented owls that had moved substantial distances. These were two owls banded in Orange County: a nestling banded in June that was recovered in Mexico (no specific location information) in October; and an owl banded in October that was recovered the following March in Nevada (J. Barclay, pers. comm. 2002).

The 2003 California Department of Fish and Game (CDFG; now CDFW) evaluation of the CESA listing petition erroneously implied that movements of burrowing owls from stable populations could augment declining populations elsewhere. In response to CDFG's report, wildlife biologist Jack Barclay referred to an analysis of all the records of burrowing owls banded in and recovered in California (Harman and Barclay 2003). These data included 4,553 owls banded in California and 90 records of banded owls encountered inside or outside California. These data showed no evidence of movements of resident owls between regional populations in California. Barclay personally banded 476 burrowing owls at an owl colony in San Jose and had only seven records of banded owls encountered outside this colony, with the farthest only eight miles away. Further analysis of significant California burrowing owl banding data showed no evidence of connectivity between regional populations (Harman and Barclay 2007). Harman and Barclay (2007) analyzed 20,597 records of all burrowing owls banded in the United States and Canada from 1955 through 2003, and reported to the U.S. Geological Survey (USGS) Patuxent Wildlife Research Center Bird Banding laboratory. Of the 4,708 burrowing owls banded in California, the encounter rate was 2.2% (102 encounters). Seventy-one percent (75/106) of encounters of burrowing owls banded in California occurred in the same 10-minute block of latitude and longitude, and only 4% (4/106) were encountered more than one 10-minute block from their banding location. Only two owls banded in California had been encountered outside the state. Four owls banded outside of California (in Idaho, Washington and British Columbia) were encountered in California, as winter migrants outside of the breeding season. There is no evidence that owls from abundant populations would serve as a dispersal source to augment geographically isolated or depleted populations (Harman and Barclay 2007).

Of 276 burrowing owls tracked during two consecutive South San Francisco Bay demography studies from 1998 through 2002, the average distance owls moved between breeding seasons was just from 0.5 to 0.9 miles (D. Chromczak, unpublished data, 2002). Of the owls monitored, 27% stayed at the same nesting location, 14% moved less than 0.05 miles (~265 feet), 34% moved 0.05 to 0.5 miles, 8% moved 0.5 to 1.0 miles, 14% moved 1.0 to 5.0 miles, and only 2% moved 5.0 to 10.0 miles (D. Chromczak, unpublished data, 2002). Pairs of owls that failed in a breeding attempt have been noted to move up to tens of kilometers before breeding again, even within the same season (J. Gervais, pers. comm., 2003).

Within the breeding season, burrowing owls tend to spend most of their time in the vicinity of the nest burrow, but will go further afield to hunt (Coulombe 1971). Male owls generally forage over home ranges from 2 to 3 square kilometers in size (Haug and Oliphant 1987), concentrating foraging efforts within 600 meters of the nest burrow (Gervais et al. 2003; Rosenberg and Haley 2003; Swaisgood et al. 2014; Hennessy et al. 2015). Manning (2009) found that diurnal home ranges of owls in the Imperial Valley averaged 0.8 acres, with males restricting 97% of diurnal movements to less than 110 meters from their burrow site.

Rosier et al. (2006) radio-tracked 15 adult burrowing owls from 13 nests within non-fragmented grassland at Carrizo Plain National Monument, to document post-breeding movements and dispersal. Of nests that failed, 8 radio-tagged individuals from 7 nests dispersed, whereas none of the owls from successful nests dispersed. Dispersal distances ranged from 0.2 km to 53 km (median 3.1 km). A few large dispersal distances observed within the breeding season were greater than previously published estimates of between-year breeding dispersal based on mark-recapture methods (e.g., Catlin 2004; Catlin and Rosenberg 2006, 2014; Manning 2009, who recorded small dispersal distances within the breeding season at intensively agricultural sites). Other studies with greater dispersal distances (e.g., Wellicome et al. (1997), who reported 49 km as the maximum dispersal distance detected between breeding seasons for adult burrowing owls in Saskatchewan, Canada) were thought to be due to fragmentation of habitat. The Rosier et al. (2006) large dispersal distances correlated with high nest failure, suggesting that breeding dispersal may be a mechanism for avoiding future nest predation, or a factor of high density of owls.

Seasonal movements other than migration may occur. After the young learn to fly, family groups will often move from burrow to burrow, and in the fall young owls will appropriate their own burrow nearby. In the winter, pairs will investigate new burrows and territorial boundaries will be in flux as forming pairs choose their burrows (Thomsen 1971).

As far as daily movements, owls will generally spend most of the day near their burrows, coming out in the late afternoon to perch and beginning to forage at dusk. Adults with young to feed return to the burrow at night (Thomsen 1971).

Feeding

Burrowing owls are most active at night (S. Smallwood, pers. comm., 2023), and secondarily crepuscular (active at dusk and dawn) in their foraging, but hunting activity has been observed over 24 hours (Grant 1965; Coulombe 1971; Marti 1974). They will forage in natural, ruderal (areas such as roadsides where vegetation has been disturbed), or manicured grasslands. Burrowing owls predate primarily on large insects and small rodents but will take a wide variety of prey and are known to be opportunistic in their feeding habits (Thomsen 1971; Zarn 1974a). Burrowing owls may hunt from a perch, capturing prey after short flights or glides, or hovering while hunting and returning to the perch after catching their prey. Burrowing owls will also walk, run, or hop after prey on the ground. Hunting style varies with type and activity of prey pursued, time of day, and vegetative substrate (Thompson and Anderson 1988; Haug et al. 1993). Burrowing owls probably also take insects that live in their burrows (Coulombe 1971).

Studies of nesting adults in San Diego (Wisinski et al. 2013; Swaisgood et al. 2014; Hennessy et al. 2015; Wisinski et al. 2016) found that prey deliveries to young appear to be a significant factor influencing both how many young the parents support to emergence and nest success (whether at least one chick fledges). The number of prey deliveries further interacts with the proportion of the total comprised of invertebrates; the number of chicks fledged and the number of successful nests drops as the proportion of invertebrate prey deliveries increases (year doesn't appear to be strongly predictive, when all sites are grouped together). Reproductive success appears related to the frequency of prey deliveries and potentially the type of prey. Importantly, there is substantial variation among burrows in the proportion of invertebrate vs. vertebrate prey, indicating that some owl home ranges may be of higher quality than others. However, owls living at these burrows do not appear to increase their foraging range to access higher quality prey and this appears to have impacts on reproductive success. Burrowing owls may not show adaptive behavior to poor foraging conditions by expanding their home range, and thus managers will need to take special consideration when siting artificial burrows or encouraging burrowing owl colonization. If burrows are sited in poor foraging habitat, they may become an ecological trap, drawing owls to areas of low productivity.

Important food items for burrowing owls include small rodents such as voles (*Microtus* spp.), mice (*Peromyscus* spp., *Mus* spp., *Reithrodontomys* spp., *Zapus* spp.), pocket mice (*Perognathus* spp.), pocket gophers (*Thomomys* spp.), kangaroo rats (*Dipodomys* spp.), and young ground squirrels (*Otospermophilus beecheyi*) (York et al. 2002; Trulio and Higgins 2012). It is interesting to note that burrowing owls generally do not hunt the ground squirrels upon which they depend for burrows – although squirrel colonies have many defenses against predators, they do not employ them against burrowing owls (which weigh only one fifth of a full-grown ground squirrel). Burrowing owls also eat a wide array of arthropods (such as beetles, grasshoppers, crickets, dragonflies, and crustaceans), reptiles, amphibians, small birds, fish, and even carrion (Bent 1938; Glover 1953; Earhart and Johnson 1970; Thomsen 1971; Zarn 1974a; Gleason and Craig 1979; Conroy and Chesemore 1987; Haug and Oliphant 1990).

Birds documented as prey items of burrowing owls include killdeer (*Charadrius vociferus*), horned lark (*Eremophila alpestris*), western meadowlark (*Sturnella neglecta*), Wilson's warbler (*Cardellina pusilla*), American avocet (*Recurvirostra americana*), red-winged blackbird (*Agelaius phoeniceus*), Brewer's blackbird (*Euphagus cyanocephalus*), black-headed grosbeak (*Pheucticus melanocephalus*), black tern (*Chlidonias niger*), California least tern (*Sterna antillarum browni*), mourning dove (*Zenaida macroura*), and various shorebirds (Stoner 1933a; Errington and Bennett 1935; Bent 1938; Neff 1941; Thomsen 1971; Gleason and Craig 1979; Warrick 1982; P. Bloom, pers. comm., 2002; Rosenberg and Haley 2003). Adult owls have also been documented preying on burrowing owl young (Botelho 1996; Rosenberg et al. 1998a).

Remains of spadefoot toads (*Scaphiopus* spp.) were found in burrowing owl pellets or burrows in Nevada (Bond 1942) and Kansas (Sperry 1941). Crayfish were the most common food item in a study in Colorado (Hamilton 1941) and attacks on large snakes have been documented (Fisher 1893). California newts (*Taricha torosa*) missing their heads were found in an owl burrow in Solano County (Stoner 1932a), and remains of snakes, scorpions, and centipedes have been found in burrows in Solano and Colusa counties (Stoner 1933a; Neff 1941). Burrowing owls in California have also been known to feed on bats. Thomsen (1971) discovered the remains of a hoary bat (*Lasiurus cinereus*) in pellets collected in Oakland; Hoetker and Gobalet (1999) found the Mexican free-tailed bat (*Tadarida brasiliensis*) to be the dominant vertebrate prey item in 18 owl pellets collected in Bakersfield; and J. Barclay (pers comm., 2002) observed free-tailed bat remains in owl burrows in San Jose.

<u>Natural Mortality</u>

Predators of burrowing owls are of two general types: predators that enter or dig up burrows to eat eggs, nestlings, and/or adult females; or predators that prey on older nestlings and adults when they are above ground. Because burrowing owls are ground nesters, their eggs and young are quite susceptible to predation. Mammals that can access nest chambers and are known predators of the burrowing owl include striped skunk (*Mephitis mephitis*), badger (*Taxidea taxus*), foxes (*Vulpes, V. macrotis mutica*, and *Urocyon cinereoargenteus*), raccoon (*Procyon lotor*), and various snakes, including rattlesnakes (*Crotalus* spp.) (Coulombe 1971; Kemper 1996). Predators that mainly catch owls above ground include peregrine falcon (*Falco peregrinus*), prairie falcon *(Falco mexicanus*), red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk (*Buteo swainsoni*), ferruginous hawk (*Buteo regalis*), northern harrier (*Circus hudsonius*), golden eagle (*Aquila chrysaetos*), great horned owl (*Bubo virginianus*), common raven (*Corvus corax*), American crow (*Corvus brachyrhynchos*), coyote (*Canis latrans*), and possibly short-eared owl (*Asio flammeus*) (Fowler 1931; Haug et al. 1993).

Burrowing owls will often line their burrow entrances or their burrow with dung, presumably to mask the burrow scent from predators (Martin 1973). In one study of burrowing owl nests in Oregon, only 2 of 15 nests (13%) lost to predation were lined with dung, while 23 of 32 successful nests (72%) were dung-lined (Green and Anthony 1989). Burrowing owls once used bison dung in natural habitats in other states, but now cattle dung is often used. If young owls are alarmed in the nest, they will make a rattlesnake-like buzz to deter predators (Voous 1988). Adults will give a short, low-level "chuck" call to warn of approaching predators, usually accompanied by bobbing the head up and down (Voous 1988).

Habitat Requirements

The burrowing owl occurs in prairies, grasslands, shrub steppe, deserts, and some agricultural areas in western North America (Haug et al. 1993). Burrowing owls use a variety of arid and semi-arid environments, with well-drained, level to gently sloping topography, characterized by sparse vegetation, low-stature vegetation, and bare ground (Haug et al. 1993, Dechant et al. 1999). Burrowing owls also nest in rolling hills, and even on steep slopes or cliffs, typically on the slopes facing the prevailing wind direction. In addition to natural environments, burrowing owls are sometimes found nesting in ruderal grassy fields, roadsides, airport infields, rural parks, college campuses, golf courses, athletic fields, and railroad beds. In California, owls will also nest in burrows in fallow agricultural fields, in margins of cultivated fields (for example, along roads or agricultural water conveyance canals; see Rosenberg and Haley 2001), and in pastures grazed by livestock. Primary habitat requisites are presence of burrows for roosting and nesting and vegetation structure that is relatively short and sparse. Perches may be important in areas where vertical vegetation structure limits visibility.

Burrows used by burrowing owls in California are usually excavated by ground squirrels (California ground squirrel and round-tailed ground squirrel), but in southern desert areas owls use ground squirrel, desert tortoise (*Gopherus agassizii*), or American badger burrows (Weathers 1983; Conway 2018). Burrows are reshaped underground and at the entrance by the owls to fit their needs. Burrow availability to owls is often limited in areas lacking ground squirrel colonies. Burrowing owls and ground squirrels occupy the same burrow system, undoubtedly encountering each other underground. This commensal relationship extends above ground, where burrowing owls cue in to ground squirrel alarm calls, responding to the squirrels early warning of danger. Ground squirrels also respond to the owls' alarm calls of approaching danger. Burrowing owls have also been observed to use the following structures for nesting or roosting: badger holes, coyote dens, sand dune cavities under ice plant, driftwood piles, culverts, concrete rubble piles, rock outcrops, and stand-pipes. They may sometimes excavate their own burrows in soft soils adjacent to agricultural irrigation canals and airport runways (Gervais, pers. com.; Barclay, pers. com.). Artificial structures can occasionally be suitable burrow sites (Collins and Landry 1977). Artificial burrows require permanent maintenance to provide long-term nesting opportunities (Belthoff and Smith 2003; Barclay et al. 2011; Menzel 2018).

The burrow protects against predators (Butts 1973; Green and Anthony 1989) and adverse weather conditions (Coulombe 1971), and it creates a microhabitat for arthropods such as earwigs and crickets, which are part of the primary food source (Coulombe 1971). In the Columbia Basin, Oregon, Green and Anthony (1989) studied nest site characteristics in association with nesting failure. They concluded that soil texture was important to long-term suitability of a nest site. They also analyzed the presence, abundance, and height of perches and found particular habitats were used only if elevated perches were present.

Vegetation cover and height are significant habitat factors due to the ground-dwelling nature and small size of the burrowing owl (Coulombe 1971; Zarn 1974a; Green and Anthony 1989; Trulio 1994). Vegetation cover that prevents the owl from observing approaching predators places the burrowing owl at a severe disadvantage. Vegetation cover between 44-57% was observed at occupied burrowing owl habitat in Santa Clara County, California (Trulio 1994) and in the Columbia Basin 28% cover was optimal (Green and Anthony 1989). Green and Anthony (1989) also found that owls selected areas with a greater percentage of bare ground. High vegetation presents similar disadvantages to owls in observing potential predators. In Oklahoma, burrowing owls occupied areas where the vegetation height was 4 inches or less (Butts 1973). In Santa Clara County, occupied burrows were found in areas with an average vegetation height of approximately 6 inches (Trulio 1994). Human-altered habitats that allow an owl to stand near the burrow entrance and effectively watch for approaching predators include grazed areas and areas where vegetation is removed without harm to the burrow (Coulombe 1971; Green and Anthony 1989; Trulio 1994).

Density of nesting burrowing owls was measured in six study areas, representing the primary habitats in which most of California's burrowing owl populations occur. The study areas included South San Francisco Bay (urban environment), Altamont Pass, Dixon National Radio Transmission Facility, Naval Air Station Lemoore (small grassland patches surrounded by agriculture), Carrizo Plain National Monument (large natural grassland), and the Imperial Valley (intensive agriculture). Preliminary results indicated 1.1 pairs per km^2 in the urban Bay Area; 0.9 pairs per km^2 in Lemoore grassland patches; 1.0 pairs per km^2 in Carrizo extensive grassland; and 8.3 pairs per km^2 along agricultural canals in the Imperial Valley (Rosenberg et al. 1997), but it is unclear whether study designs and study area sizes allow direct comparisons. In a previous study in the Imperial Valley, Coulombe (1971) estimated an average of 8.5 owls per km^2.

Western burrowing owls in California were reported historically (Grinnell and Miller 1944) to reach highest densities in interior valleys and coastal lowlands. Surveys conducted by DeSante and Ruhlen (1995) further confirmed burrowing owl preference for lowland areas with over 90% of the breeding owls located between 60-300 meters in elevation within their survey area in California.

Historically, western burrowing owls were found in natural areas of open prairies or open shrub-steppe habitat (Coulombe 1971; Butts 1973). The species is characteristic of flat arid areas that have rodent burrows and rare floods. In California, almost none of the owls' original prairie habitat remains. Human population growth and continuous land use changes have forced the species to use human-altered habitats ranging from agricultural irrigation ditches (Coulombe 1971) to urban habitats (Thomsen 1971; Collins and Landry 1977; Trulio 1995). Burrowing owls can tolerate a certain amount of non-threatening human activity, noise, and disturbance as long as other habitat requirements are met. Essential habitat requirements include suitable nesting and foraging opportunities and available roosting sites (Coulombe 1971; Voous 1988; Johnsgard 1998).

Typical burrowing owl habitat is open, dry, sparsely vegetated land with available burrows (Zarn 1974a). The California Department of Fish and Game's Wildlife Habitat Relationships System (CDFG 1990) database listed 18 major habitat types that support burrowing owls. In most of these habitats, burrowing owls are generally found in open country, where tree or shrub canopies cover less than 30% of the habitat (DeSante et al. 1996). Typical habitats include annual and perennial grasslands, open agricultural areas, deserts, and vacant lots. Other habitats include oak savannah; grass, forb, and open shrub stages of pinyon-juniper and ponderosa pine habitat; sandy beaches; and river bottom lands. Burrowing owls inhabiting urban landscaped areas may live in vacant fields, airports, athletic fields, golf courses, city parks, drainage sumps, railroad beds, and road cuts. Other more subtle characteristics affect burrow suitability. These characteristics include percent vegetative cover, height of vegetation surrounding the burrow, presence of colonial fossorial mammals, soil texture, and presence of perches for horizontal visibility (Green 1983; Hennessy et al. 2018).

Foraging opportunities are essential to burrowing owls, as discussed by Gervais et al. (2008):

> Useful as a rough guide to evaluating project impacts and appropriate mitigation for burrowing owls, adult male burrowing owls home ranges have been documented (calculated by minimum convex polygon) to comprise anywhere from 280 acres in intensively irrigated agroecosystems in Imperial Valley (Rosenberg and Haley 2004) to 450 acres in mixed agricultural lands at Lemoore Naval Air Station, CA (Gervais et al. 2003), to 600 acres in pasture in Saskatchewan, Canada (Haug and Oliphant 1990). But owl home ranges may be much larger, perhaps by an order of magnitude, in non-irrigated grasslands such as at Carrizo Plain, California (Gervais et al. 2008), based on telemetry studies and distribution of nests. Foraging occurs primarily within 600 m of their nests (within approximately 300 acres, based on a circle with a 600 m radius) during the breeding season.

Burrow availability is a major factor in defining burrowing owl habitat (Coulombe 1971; Green and Anthony 1989). DeSante et al. (1996) evaluated habitat-related factors associated with the probability of re-occupancy of breeding sites by owls. The presence of ground squirrels was the single highest predictor for re-occupancy (Belthoff and King 2002; Smallwood and Morrison 2018). Higher re-occupancy rates were also observed for sites near irrigation canals, sites with more than one pair of owls, and areas with high densities of owls. Burrows and the associated surrounding habitat are essential ecological requisites for burrowing owls throughout the year and especially during the breeding season. During the non-breeding season, burrowing owls remain closely associated with burrows, as they continue to use them as refuge from predators, shelter from weather and roost sites. Resident populations will remain near the previous season's nest burrow at least some of the time (Coulombe 1971, Thomsen 1971, Botelho 1996, LaFever et al. 2008). In a study by Lutz and Plumpton (1999) adult males and females nested in formerly used sites at similar rates (75% and 63%, respectively) (Lutz and Plumpton 1999). Burrow fidelity has been reported in some areas (Lutz and Plumpton 1999; Ronan 2002); however, more frequently, burrowing owls reuse historical nesting areas without necessarily using the same burrow (Haug et al. 1993, Dechant et al. 1999). Of higher fidelity than a nest burrow is the nest site, which might include the same or neighboring burrowing systems of ground squirrels (S. Smallwood, unpublished data). Burrow and nest sites are re-used at a higher rate if the burrowing owl has reproduced successfully during the previous year (Haug et al. 1993), the ground squirrels remain (Smallwood and Bell 2022; S. Smallwood, unpublished data), and if the number of burrows is not a limiting factor.

Burrowing owls may use “satellite” or non-nesting burrows, moving young at 10-14 days, presumably to reduce risk of predation (Desmond and Savidge 1998) and possibly to avoid nest parasites (Dechant et al. 1999). Successful nests in Nebraska had more active satellite burrows within 75 m of the nest burrow than unsuccessful nests (Desmond and Savidge 1999). Several studies have documented the number of satellite burrows used by young and adult burrowing owls during the breeding season as between one and 11 burrows with an average use of approximately five burrows (Thompsen 1984, Haug 1985, Haug and Oliphant 1990). Supporting the notion of selecting for nest sites near potential satellite burrows, Ronan (2002) found burrowing owl families would move away from a nest site if their satellite burrows were experimentally removed through blocking their entrance. Habitat adjacent to burrows has been documented to be important to burrowing owls. Gervais et al. (2003) found that home range sizes of male burrowing owls during the nesting season were highly variable within but not between years. Their results also suggested that owls concentrate foraging efforts within 600 meters of the nest burrow, as was observed in Canada (Haug and Oliphant 1990) and southern California (Rosenberg and Haley 2004). James et al. (1997), reported habitat modification factors causing local burrowing owl declines included habitat fragmentation and loss of connectivity.

Studied on a suitably-sized landscape (Smallwood et al. 2013) and throughout the year, (S. Smallwood, unpublished data), burrowing owls were found to shift their activity areas away from areas used for breeding. The exodus from breeding areas was inversely density-dependent, so the largest relocations out of breeding areas were from the densest breeding areas. Hypotheses for this behavior include the need to rest forage during the non-breeding season and the need to escape parasite and predator loads at nest sites. An implication of this behavior pattern is the inherent need for greater habitat space than observed during the breeding season.

In conclusion, the best available science indicates that habitat for the burrowing owl in California must include year-round opportunities for breeding, foraging, wintering and dispersal to landscapes covered by short or sparse vegetation (at least at some time of year), presence of burrows, burrow surrogates or presence of fossorial mammal dens, well-drained soils, and abundant and available prey within close proximity to the burrow (Haug et al. 1993; CDFG 2012). Proximity to ground squirrels is of critical importance to benefit from mutual alarm-calling to minimize predation risk.

Demography (Reproduction, Survival and Dispersal)

Like other owls, burrowing owls breed once per year during an extended reproductive period, during which most adults bond monogamously. However, occasional polygyny and extra-pair fertilizations make it difficult to accurately assign parentage from field observations (Barclay 1993; Johnson 1997a, c; Barclay and Menzel 2011). High local burrowing owl densities and mobile young have been shown to result in extra-pair copulations, brood amalgamation and mixing, joint-nesting, and possibly "egg-dumping", making the burrowing owl apparently unique among birds of prey in exhibiting a complex suite of social behaviors (Johnson 1992). In the same study of California owls in Yolo County, at least 37% of adults alloparented, caring for juveniles that were not their own young (Johnson 1997c). These behaviors make it difficult to estimate demographic parameters without genetic confirmation. Using genetic information, Hennessy et al. (2015) found that all observed burrowing owl parents were genetic parents, however, also observed “adoptions” of neighboring owlets.

The lifespan of burrowing owls in the wild is at most 5-8 years (Johnson 1997b). In the Bay Area, Thomsen (1971) documented average annual survival rates of 30% for juveniles and 79% for adults, based on banded birds. For burrowing owls in Yolo County, depending on assumptions about emigration and immigration, estimates of the probability of juvenile burrowing owl survivorship, which is equal to the chance of surviving to age at first breeding (1 year), ranged from 0.23-0.93, and annual adult survivorship ranged from 0.42-0.93 (Johnson 1997b). Johnson’s study population was subsequently extirpated.

In San Diego, Wisinski et al. (2022) produced survival estimates of adults and juveniles from 2013-2022 in Otay Mesa, and found that survival of both adults and juveniles is highly variable between years and sometimes much lower than reported by Johnson. Wisinski et al. (2022) recorded an apparent survival rate in 2022 for adults of 0.46 (95% CI: 0.36–0.56); and an apparent survival rate for juveniles of 0.10 (95% CI: 0.06–0.17). These rates measured the percentage of juveniles banded in one year that survived and were observed as part of the adult population in the following year. Wisinski et al. (2022) observed high variability in juvenile return rates (0.09-0.51) and survival rates (0.10-0.55) since 2013. Their results indicate high variation in annual juvenile survival, decreasing adult survival, and potentially increasing variation in adult survival (0.35-0.83).

In burrowing owls, reproduction begins at one year of age. Clutch size is difficult to determine, but this species is thought to lay an indeterminate number of eggs in response to prey abundance. Clutches in museum collections in the western United States contained 1-11 eggs (Murray 1976). Average clutch size over the North American range of the owl was 6.5 eggs, with a range of 4-12 (Haug et al. 1993). In California, Landry (1979) reported a range of 1-11 with an average of 7 eggs. Studies have documented nesting success in a population to range from 100% in New Mexico (Martin 1973), to 33% in California (Thomsen 1971). In California, Gervais and Rosenberg (1999) and Smallwood (unpublished data) documented up to 10 fledglings per nest in high reproductive years. The number of young successfully fledged from nests in the Central Valley ranged from 3-6 (DeSante et al. 1997).

Research on burrowing owl demography in five different California owl populations (south San Francisco Bay area, Altamont Pass, NAS Lemoore, Carrizo Plain National Monument, and the Imperial Valley) indicated that survival rates and reproductive rates were relatively high in agricultural areas (Lemoore and Imperial) and the grasslands of the Altamont Pass, and lower in the urban area of south San Francisco Bay and the grasslands of Carrizo (Rosenberg et al. 2000; Gervais 2002; Ronan 2002; Rosenberg and Haley 2001).

In California, breeding burrowing owls are predominantly nonmigratory, with some winter immigration occurring from northern portions of the range in Canada and the United States. Burrowing owls are highly philopatric (meaning they show strong fidelity to their nest site and territory from year to year), especially where resident, with breeding adults often returning to the same or nearby burrows each year (Botelho and Arrowood 1998; CDFW 2012). Second-year birds will often attempt to nest near (< 0.2 mile) their natal sites (Rosenberg et al. 1998). Burrowing owls in migratory populations often renest in or near the same burrow, particularly if breeding was successful there the previous year (Belthoff and King 1997). Adult males exhibit the greatest fidelity to nest burrows and locales (Wellicome et al. 1997). Postnatal dispersal probably has a density-dependent component. Juveniles may disperse in the fall, but long-distance dispersal is rare. In a study of burrowing owls in Yolo County, only 2 of 87 color-banded juvenile owls dispersed, moving 1 and 8 miles (1.5 and 12 km), respectively, from their natal sites (Johnson 1997c). Root mean square dispersal distances were 0.2 km for all adults and 0.5 km for other juvenile owls in the above study. Research from four other studies (Rosenberg et al. 2003; Gervais 2002; Ronan 2002; Rosenberg and Haley 2001; Rosenberg et al. unpublished data) provided evidence of some limited dispersal between the Carrizo Plain, the south Bay Area, and NAS Lemoore burrowing owl populations, based on limited band returns.

The degree of demographic and genetic connectivity among populations of California burrowing owls remains unknown. There appeared to be a possible meta-population dynamic linking at least populations among the Carrizo Plain, the San Jose area, and the Central Valley around Lemoore, since owls banded at Naval Air Station Lemoore had been recovered as breeders at the Carrizo Plain and the San Jose area. In addition, the number of breeding pairs in the Central Valley (Naval Air Station Lemoore) and the Imperial Valley study sites remained nearly constant between 1997 and 2000, despite dramatic fluctuations in productivity and survival (Gervais 2002, Rosenberg and Haley 2003). Genetic analyses of burrowing owls from 3 demographic study sites (Lemoore NAS, Carrizo Plains, and the Imperial Valley) failed to identify population differentiation or evidence for genetic inbreeding or population isolation (Korfanta 2001; Korfanta et al. 2005). Korfanta et al. (2005) suggested that gene flow observed between populations could be attributed to long-distance dispersal, but also noted that as few as one dispersing individual owl per generation is enough to account for the lack of genetic differentiation they observed. Klute et al. (2003) attributed this lack of genetic differentiation to continuous habitat relative to long-distance dispersal of juvenile and some adult owls. A study by Rosier et al. (2006) of post-breeding dispersal of adult burrowing owls in an extensive California grassland suggested that long-distance dispersal (up to 53 km during breeding season) may occur more frequently than has been observed or previously expected. However, the extent of long-distance dispersal in California burrowing owls is still largely unknown. A female burrowing owl successfully bred first in Arizona and then dispersed 1,860 km to Saskatchewan, where she successfully raised seven young during the same breeding season (Holroyd et al. 2011).

Analysis of extensive California burrowing owl banding data showed no evidence of connectivity between regional populations (Harman and Barclay 2007). Harman and Barclay (2007) analyzed 20,597 USGS Patuxent Wildlife Research Center Bird Banding Laboratory records of all burrowing owls banded in the United States and Canada from 1955 through 2003. Of the 4,708 burrowing owls banded in California, the encounter rate was 2.2% (102 encounters). Seventy-one percent (75/106) of encounters of burrowing owls banded in California occurred in the same 10-minute block of latitude and longitude, and only 4% (4/106) were encountered more than one 10-minute block from their banding location. Only two owls banded in California had been encountered outside the state. Four owls banded outside of California (in Idaho, Washington and British Columbia) were encountered in California as winter migrants outside of the breeding season. There is little evidence that owls from abundant populations would serve as a dispersal source to augment geographically isolated or depleted population (Harman and Barclay 2007). Because the extent of demographic and genetic connections between the large southeastern owl populations and others in California is not known, neither declining populations in other areas of the state, nor large populations in the Imperial and Palo Verde Valleys, can be assumed to be source populations that could contribute to population viability elsewhere (CDFG 2003).

Previously some limited genetic studies have failed to identify any significant barriers to gene flow among resident or migratory breeding groups in western burrowing owls (Desmond et al.

2001; Korfanta et al. 2005; Macías-Duarte et al. 2020), but Barr (2023) and Barr et al. (2023) detected clear population structure patterns associated with resident migratory phenotypes. Barr found distinct genetic clustering of residents by population and no limitations to gene flow among the migratory breeding groups. Barr (2023) and Barr et al. (2023) analyzed population structure and genetic diversity in western burrowing owls using low coverage, whole genome data, and found significant genetic differences between resident and migrant owls. Barr found genetic structure was linked to the migratory phenotype, with resident owls being highly structured and migrant owls having no structure.[1] Among resident populations, Barr observed significantly higher genetic differentiation, significant isolation-by-distance, and significantly elevated inbreeding.

A study by Trulio et al. (2023) from 2014-2018 in Santa Clara County and southern Alameda County used new genomic methods for assigning individuals to hybrid classes in order to characterize the migratory status of burrowing owls and determine the extent of gene flow between wintering and resident individuals. Trulio et al. (2023) used a combination of surveys, genomic sequencing of feathers (83), and bird banding (85 owls) to assess migratory status and interactions between winter and summer owls. The data showed a pattern of migration in which long-distance migratory birds were found in areas outside the breeding sites and joined resident owls at the breeding sites in the winter, but disappeared from these areas by the next breeding season. These results fit a pattern of partial migration in which long-distance migrants join resident birds in the winter. Although during breeding seasons they never observed any migrants that were banded in winter either within or outside the breeding sites, genomic analysis showed that some migrants stayed into the summer and bred with resident owls to produce hybrid offspring. Two owls sampled during the breeding season were classified as migrants, and 22 had genomic signatures intermediate between resident and migrant genomes suggesting some migrant individuals did not migrate in spring, but instead stayed to potentially breed with resident owls.

The findings of Trulio et al. (2023) included: (1) owls banded during winter that were resighted were seen only during subsequent winters and often were found in close proximity to where they were banded; (2) genomic data showed that all the owls captured in winter outside the breeding sites exhibited genetic variation consistent with migratory burrowing owls, as did 17 out of 20 unbanded birds found at the breeding sites in winter; capture of a bird banded in British Columbia supported the genomic data; (3) no owls banded in summer were found outside their breeding sites in winter; and (4) the numbers of owls on the breeding sites increased each winter from summer numbers and then decreased the following summer, as expected for this form of partial migration. These findings were not consistent with the type of partial migration researchers have previously described in burrowing owl populations, in which some breeding birds migrated in winter while others remained resident. Trulio et al. (2023) confirmed partial migration for these burrowing owl populations, which separates

[1] Two sample sites, the Imperial Valley of CA and Phoenix, AZ, were exceptional in being resident breeding sites that could not be distinguished from the migrants. Arid regions subject to intense irrigation particularly for agriculture are known to support thriving populations of western burrowing owls. The Imperial Valley, for instance, experienced a 2.5X fold increase in burrowing owl population density areas heavily impacted by agriculture (Macías-Duarte et al. 2020). Increased gene flow resulting from this change may explain the lack of differentiation in between both Imperial Valley and Phoenix populations and the migratory group. The recency of this phenomenon might be indicated by the fact that these two sites exhibit the same pattern of isolation by distance as other resident breeding sites, as it is possible that the sites have yet to reach equilibrium. Also, the Phoenix population has long been subject to an on-going, intense translocation project without any guidance on population structure, genetic relatedness, or verification of migratory phenotypes (Doublet 2020) from 1980 to 2000 as agricultural operations escalated in the area. Recent work suggests non-breeding partial migratory populations may be experiencing a switch to breeding partial migratory populations in desert areas with extensive agriculture.

breeding populations and allows for genetic divergence of the populations. However, bringing individuals together from these different breeding populations may result in interbreeding if migrants switch to becoming residents. In their study, some migratory owls and first-generation hybrid owls stayed and bred with the local population, a finding that had proven difficult to confirm in burrowing owls (Holroyd et al. 2011; Macías-Duarte and Conway 2021). Despite the introduction of long-distance migrants, this Santa Clara County and southern Alameda County population studied by Trulio et al. (2023) has experienced significant population declines in recent decades.

California's Burrowing Owl Populations Comprise Different ESUs

CESA defines an "endangered species" as a species or subspecies of animal or plant that is in serious danger of becoming extinct through either all or "a significant portion" of its range. (Cal. Fish & Game Code § 2062.) A "threatened species" is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts. (Cal. Fish & Game Code § 2067.) CDFW has concluded—and appellate courts have upheld—that the term "range" is construed to refer to the range of a species or subspecies within California, not the worldwide range of the species or subspecies. (California Forestry Assn. v. California Fish & Game Com. (2007) 156 Cal.App.4th 1535, 1550-551.) This means that a species or subspecies that may not be endangered in other states or countries may still be endangered within California.

Courts also have confirmed that the phrase "significant portion" of a range authorizes CDFW to designate certain populations of a species or subspecies as "evolutionarily significant units" or "ESUs" and list such populations as endangered under CESA. (Id. at 1549; Central Coast Forest Assn. v. Fish & Game Com. (2018) 18 Cal.App.5th 1191, 1236-37 ["CCFA II"].) In other words, ESUs are a population of a species or subspecies "that is considered distinct for purposes of conservation." (Central Coast Forest Assn. v. Fish & Game Com. (2012) 211 Cal.App.4th 1433, 1439 fn 5 [depublished] ["CCFA I"].) CDFW has confirmed that the use of ESUs to evaluate the status of species pursuant to CESA is appropriate. In the Status Review of Fisher, CDFW designated fishers in northern California and the southern Sierra Nevada as two separate ESUs based upon the reproductive isolation of these fisher populations and the degree of genetic differentiation between them. In designating these ESUs, CDFW highlighted the need to maintain "geographically widespread and genetically diverse" populations of the species.

Researchers determined that breeding burrowing owls in California occupy seven distinct biogeographic regions (DeSante et al. 1996; DeSante et al. 2007; Wilkerson and Siegel 2010). See Figure 2. These generally correspond with recognized distinct ecological bioregions of California as defined by Miles and Goudey (1997), the USGS, Western Geographic Science Center; and California Inter-agency Natural Areas Coordinating Committee.

- **San Francisco Bay Area**. The Bay Area coast region extends from Sonoma County south to Santa Cruz County, inclusive, from the crest of the outermost Coast Range west to the Pacific Ocean, coinciding with areas most heavily affected by extensive summer fog. The Bay Area interior portion extends from Sonoma and Napa counties south through Santa Clara County, inclusive, east to the crest of the innermost coast range, up to 610 m, encompassing most of the greater San Francisco Bay Area and associated interior valleys. The region is delineated by the coast ranges to the east, and the northern limits of the burrowing owl range on the coast to the north.

- **Central Valley**. The Central Valley bioregion is a wide, flat, low-elevation trough of sediments bounded by the Coast Ranges to the west and Sierra Nevada to the east. The Northern Central Valley portion extends from Colusa, Sutter, and Placer counties, inclusive, north to the head of the Sacramento Valley, from the 610 m contour line in the innermost Coast Ranges east to 610 m in the western Sierra Nevada Mountains; and encompasses the northern part of the Sacramento Valley. The Middle Central Valley portion extends from Yolo, Sacramento, and El Dorado counties, inclusive, south through eastern Contra Costa, eastern Alameda, and south to Merced and Mariposa counties, inclusive, east to 610 m in the western Sierra Nevada Mountains; and encompasses the southern part of the Sacramento Valley, the northern part of the San Joaquin Valley, and all of the Sacramento-San Joaquin Delta. The Southern Central Valley portion extends from San Benito, Fresno, and Madera counties, inclusive, south to the head of the greater San Joaquin Valley, and from the crest of the innermost Coast Range east to 610 m in the western Sierra Nevada Mountains; and encompasses the southern part of the San Joaquin Valley and low-lying valleys and basins to the south.

- **Central-Western California**. The Central California Coast bioregion is bounded by the Coast Ranges to the east and the Pacific Ocean to the west. The Central-Western Coast portion extends from Monterey County south to western Santa Barbara County, inclusive, and from the crest of the westernmost Coast Range west to the Pacific Ocean. The Central-Western Interior portion extends from Monterey and San Benito counties south through San Luis Obispo County into northern Santa Barbara County; and encompasses the valleys and plains (such as Carrizo Plain) of central-western interior California, exclusive of the Central Valley.

- **Southwestern California**. The Southwestern Coast portion extends from southern and southeastern Santa Barbara County southeast through western San Diego County to the Mexico border, from the 610 m elevation contour in the Transverse Range and the crest of the outermost Coast Range west to the Pacific Ocean; and encompasses the coastal plain of Southern California. The Southwestern Interior portion extends east to the 915 m contour line on the west slope of the westernmost desert range or the passes separating the coastal from desert watershed; and from southeastern Los Angeles County and extreme southwestern San Bernardino County south into northern San Diego County; and encompasses the interior valleys and plateaus of Southern California west of the desert regions.

- **Coachella and Imperial Valleys**. These valleys are in the Colorado Desert bioregion. The Coachella Valley portion extends from San Gorgonio Pass in the northwest, southeast through the Coachella Valley and Salton Sink, bounded on the east and west by the 610 m elevation contour in the mountains surrounding the Coachella Valley and Salton Sink. The Imperial Valley portion extends from the major irrigated regions near the south end of the Salton Sea south through Imperial County to the Mexico border, bounded on the east and west by the 61 m elevation contour that separates the floor of the Salton Sink and Imperial Valley from surrounding desert areas.

- **Northern Desert**. The northern desert range in northeastern California encompasses portions of eastern Siskiyou, Modoc, Lassen, eastern Plumas, and eastern Sierra counties, primarily in the Modoc Plateau and into the Northwestern Basin and Range bioregion.

- **Southern Desert**. The southern desert range, in southeastern California east of the Peninsular Range, includes: Western Mojave Desert; Eastern Mojave Desert; Northern Mojave/Eastern Sierra; and Sonoran Desert (including the lower Colorado River Valley and Palo Verde Valley) bioregions. The Mojave Desert is bordered to the north by the Garlock fault, to the west by the Sierra Nevada mountain range and the California montane chaparral and woodlands, to the south and east by the Sonoran Desert, and to the southwest by the San Andreas Fault. The West Mojave Desert area is located in the northwestern third of the California Desert Conservation Area and encompasses 9.3 million acres in portions of Inyo, Kern, Los Angeles, and San Bernardino counties.

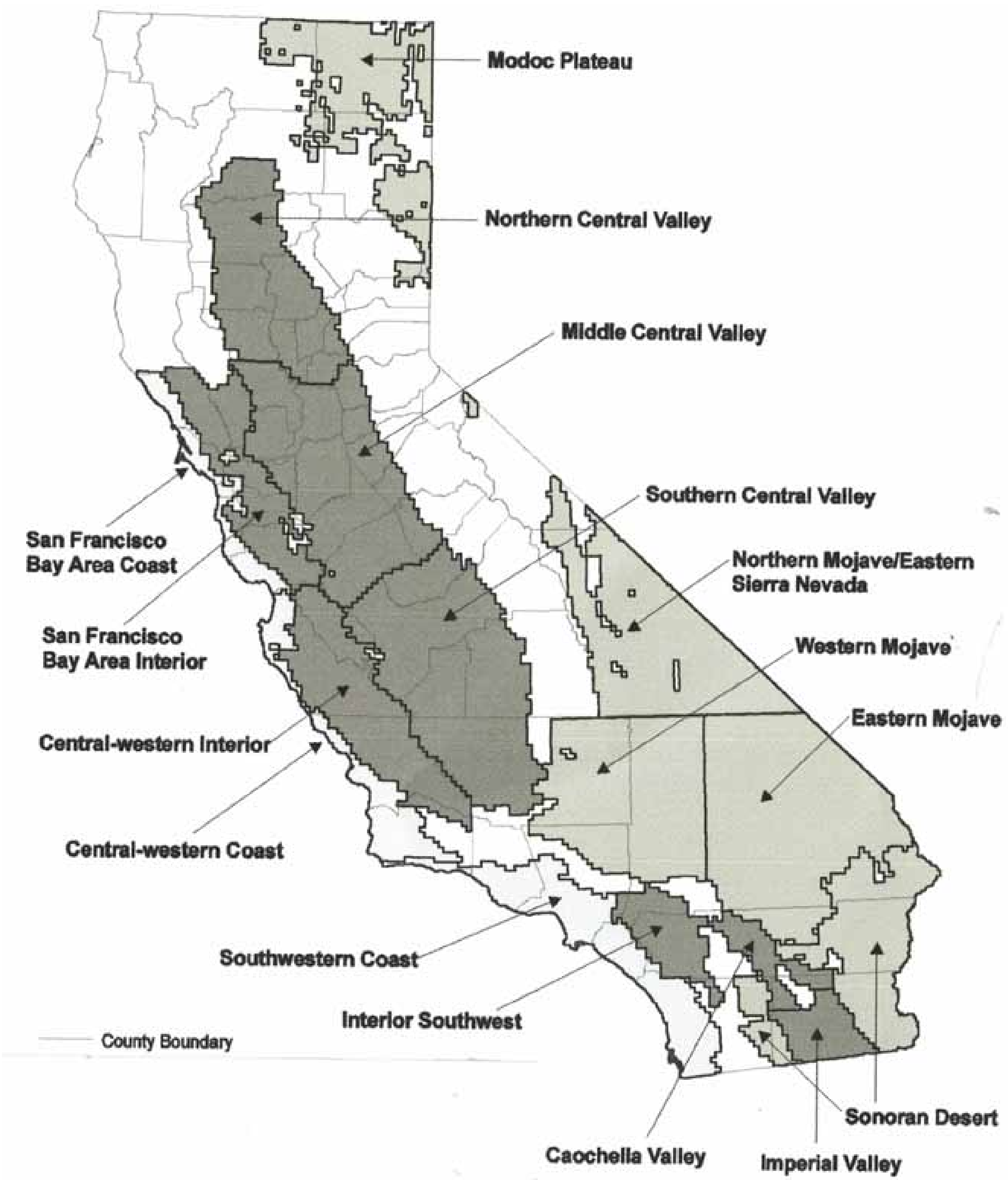

Figure 2 – Burrowing owl regions in California, as delineated by Wilkerson and Seigel (2010)

Breeding burrowing owl populations can be delineated by these regions, which are separated by geography and elevation (and in some cases by international or state borders). As discussed in the section on demography above, there is no evidence of regular connectivity between regional breeding populations, and it cannot be assumed that owls from abundant populations disperse to augment geographically isolated or depleted populations. Though a handful of migratory owls are occasionally recruited (staying year-round) into resident breeding populations, there is no evidence of resident owls becoming migratory. Although some limited genetic studies have failed to identify any significant barriers to gene flow among resident or migratory breeding groups, Barr (2023) and Barr et al. (2023) found significant genetic differences between resident and migrant owls, with significantly higher genetic differentiation, significant isolation-by-distance, and significantly elevated inbreeding for resident populations. In other words, regional resident burrowing owl populations inhabiting distinct bioregions are effectively reproductively isolated. The loss of breeding owls from any region in California is particularly significant because there are no known locations in the state where a breeding population of burrowing owls has been eliminated and subsequently been reestablished. Breeding burrowing owl populations in the Southwestern California, Central-Western California, San Francisco Bay Area, Central Valley, and Southern Desert Range bioregions appear to be significantly reproductively isolated, with very little supplementation of breeding members from other regions.

Each of these regional populations of burrowing owls represent an important component of the evolutionary legacy of the species. For example, the southern Central Valley has a substantial number of burrowing owls that breed in uplands habitats where grasslands remain, while in most areas of the state burrowing owls breed primarily in lowlands (DeSante and Ruhlen 1995). While throughout most of the state burrowing owls have an association with California ground squirrels, owls in the southern desert region rely on Mohave ground squirrels and desert tortoises for burrows. While burrowing owls in many desert areas—like the Imperial Valley—rely on manmade water-conveyance structures, those in the western Mojave Desert are instead concentrated in or along edges of scrublands, on the periphery of urban areas, and in active or fallow agricultural fields (Wilkerson and Siegel 2011). Maintenance of regional burrowing owl populations that are geographically widespread is important because they may consist of individuals capable of exploiting a broader range of habitats and resources than less spatially diverse populations. They also may contain genotypes that are more able to adapt to long-term environmental change and are more resilient to detrimental stochastic events, an important consideration given the rapid climatic shifts occurring in California.

Distribution, Abundance, and Population Trends

This section covers the distribution, abundance, and population trends of resident, breeding populations of burrowing owls. In California, breeding burrowing owls are predominantly nonmigratory, and remain year-round. Winter immigration of burrowing owls into California occurs from northern portions of the range in Canada and the United States, but these owls generally depart before the breeding season (Trulio et al. 2023).

Historical and Recent Distribution and Abundance

In the 2003 CESA listing petition (CBD et al. 2003), petitioners extensively researched the historical distribution and abundance of breeding burrowing owls throughout California, through 2003. Historical literature sources, as well as a number of California and other western museum collections were searched for historical documentation of breeding burrowing owls. The California Department of Fish and Game's Natural Diversity Database (CNDD) was also searched, as was Cornell University's eBird project database (Sullivan et al. 2009).

Literature searched included: American Birds, the Auk, the Condor, North American Bird Bander, Ornithologist and Oologist, Pacific Coast Avifauna, and the Proceedings of the California Academy of Sciences. Museum collections reviewed for egg set data and breeding season collection records included: the American Museum of Natural History, California Academy of Sciences, Chicago Academy of Sciences, Cleveland Museum of Natural History, California State University Chico, California State University Long Beach, California State University Northridge, Delaware Museum of Natural History, Field Museum of Natural History, Los Angeles County Museum, Museum of Southwest Biology, National Museum of Natural History, Occidental College, Oakland Museum, Pacific Grove Museum of Natural History, Santa Barbara Museum of Natural History, Smithsonian Museum, Slater Museum of Natural History, University of California Berkeley Museum of Vertebrate Zoology, University of California Los Angeles Fritz Hertzel Museum, University of California Santa Barbara Museum of Vertebrate Zoology, University of California Santa Cruz, University of Nevada Las Vegas, U.S. Geologic Survey Biological Survey, University of Washington Burke Museum, Western Foundation of Vertebrate Zoology, and Yale Peabody Museum.

From these sources, a site was considered confirmed as a breeding location if: 1) eggs were collected; 2) a bird was collected during breeding season that had mature reproductive parts; or 3) juvenile owls were seen during or immediately after what the California Department of Fish and Game considered to be nesting season for burrowing owls, February 1 through the end of August (CDFG 1994). A site was considered a probable breeding location if: there was evidence of owl occupation of burrows; single or multiple birds were collected or observed during the nesting season; pairs were observed outside of the nesting season; or multiple birds were observed year-round.

Although numerical data on the statewide historical abundance of burrowing owls do not exist, many early naturalists commented on the widespread abundance of the burrowing owl prior to widespread human population growth and development in California. As early as 1869, burrowing owls were observed in abundance in California, with Canfield (1869) reporting "I have seen them every day for years, hundreds and perhaps thousands of them in all." Baird (1870) considered the species to be "probably one of the most common birds in California." Keeler (1891) described the owl as "an abundant resident of the open valleys and foothills of the State." Grinnell (1915) and Dawson (1923) both noted it was a "common resident" within its range. Dawson (1923) observed that the species enjoyed "an almost unbroken distribution throughout the treeless or lightly timbered sections of the State, from the base of the Sierras down to the ocean's edge." Grinnell and Wythe (1927) listed the owl as a "fairly common resident" of the dry interior of the San Francisco Bay Area.

Burrowing owl populations experienced dramatic non-cyclical declines in a large portion of the state, from at least the 1940s through 2003 (CDFG 2003). Historical accounts provide high-quality descriptive records of past distribution and trends in abundance of burrowing owls in California. At least six descriptions in the historical ornithological literature between 1869 and 1927 (Canfield 1869; Baird 1870; Keeler 1891; Grinnell 1915; Dawson 1923; Grinnell and Wythe 1927) indicated the bird was a fairly common resident throughout grassland habitat in the state. However, by the 1940s, widespread declines in burrowing owl abundance were recognized by Grinnell and Miller (1944). Even by 1944, when a widespread decline in abundance was noticeable, Grinnell and Miller (1944) observed that "numbers in favorable localities are large," although "latterly becoming scarce in settled parts of the state." By 1978, the CDFG Bird Species of Special Concern in California report (Remsen 1978) commented that the "decline noticeable by the 1940s (Grinnell and Miller 1944) has continued through to the present time…the decline has been almost universal throughout California."

During three years of a comprehensive survey of burrowing owls throughout much of the state, DeSante and Ruhlen (1995) and DeSante et al. (1997) detected that burrowing owl declines had occurred in the first half of the 1980s. Their evidence also suggested that large declines in owl numbers and distribution occurred into the early 1990s. Although no similar systematic surveys were conducted between the early 1990s and 2003, regional information provided by CDFG regional staff, as well as anecdotal reports from local experts, suggested that declines continued in many areas, especially those regions subject to urban expansion (CDFG 2003). When combined with the number of counties in which owls had already been extirpated or nearly extirpated, burrowing owls appeared to be at risk in at least 45 out of 51 counties within the species' distribution, in at least 56% of potential habitat statewide (CDFG 2003).

North American Breeding Bird Survey (BBS) data from linear roadside surveys in California (Sauer et al. 2002) had been cited by some as demonstrating an increasing trend in the statewide burrowing owl population between 1966 and 2001. DeSante et al. (2007b) examined BBS data in California and found that the 6% per year population increase suggested by these data was essentially driven by three routes in the Imperial Valley with large and increasing populations.[2] Sheffield (2021) examined burrowing owl population dynamics using BBS and Christmas Bird Count data to assess changes occurring over 20 years this time. BBS data for the entire U.S. and Canada revealed that the 1966-2017 trend was slightly more than a 1% loss per year, and California demonstrated long-term (20-year) declining BBS population trends from

[2] Analysis of the route-specific counts (each survey route is a 24.5 mile stretch of secondary road) showed that the "increasing trend" reflected increases on only three survey routes (Niland, Brawley, and Alamo River), all within the Imperial Valley (CDFG 2003). Surveys there were initiated in the early 1970s, and burrowing owl counts on the Alamo River and Niland routes appear to have peaked at 50 and 95 observations, respectively, and then declined. In contrast, burrowing owl numbers on the Brawley route appeared to have generally increased, with a maximum of 57 burrowing owl observations made in 2000. Estimation of burrowing owl population trends on these three routes is subject to the general limitations of the BBS, which was designed to sample roadside habitat for multiple species concurrently, at a continental scale (O'Connor et al. 2000). In addition, all three Imperial Valley samples show much year-to-year variability, further confounding trend estimation. Elsewhere in California, on at least 39 other BBS routes where burrowing owls have been recorded, counts had consistently been very low, ranging from 0-15 owls per survey from the early 1970s to 2003 (CDFG 2003). Declining trends during at least one time-interval were detectable for three of those routes (Atwater, Oilfields, Tranquility), but for most of the survey routes, burrowing owl numbers were too small to calculate a trend, routes were sampled intermittently, or routes were simply discontinued (CDFG 2003).

+5% in 1997 to -2% in 2017 (Sheffield 1997; Sauer et al. 2007; Sauer et al. 2011; Sauer et al. 2017; Sheffield 2021).

The best quantitative estimates of burrowing owl population change in California were produced by DeSante and others (DeSante and Ruhlen 1995; DeSante et al. 1996; and DeSante et al. 1997) during research they conducted in 1991-93. In contrast to the Breeding Bird Survey, these researchers focused on only one species, searching as thoroughly as possible for burrowing owls, not along roads, but throughout 25 km^2 sampling blocks. The scientists compared regional distribution and abundance data between two time-intervals, the 1980s (1981-1990) and the early 1990s (1991-1993). Information for the 1980s included anecdotal, but often very thorough, data on traditional breeding locations and numbers of owls reported by local birders and other experts. Data for the 1990s were obtained from a sample of survey plots conducted throughout the California habitat range of the burrowing owl, exclusive of the Great Basin and southeastern deserts (areas where owls were thought to be sparse and not numerous).

Between the two time periods, the number of burrowing owl breeding groups (a surrogate for number of "colonies"), in most of the surveyed area, decreased on the order of 38% to 61%, depending on assumptions about whether or not groups of owls that were not detected prior to the 1990s had actually been present. DeSante and Ruhlen (1995) concluded that the larger percentage decrease (61%) was probably the more accurate value. The largest declines in number of breeding groups (70-75%) occurred in the Southwestern and Central-Western regions, declines generally confirmed by CDFG regional staff (CDFG 2003). Somewhat smaller decreases (50%) in the number of groups between the two time-intervals appeared to occur in the Central Valley. Anecdotal information from the 1980s was not available for the Imperial and Coachella Valleys, so a comparison of the number of owl breeding groups between the two decades was not possible for those locations. However, other data sources suggested that the burrowing owl population in the Imperial Valley agro-ecosystem was increasing by the early 1990s (Rosenberg and Haley 2001).

DeSante et al. (1996) reported 1,995 breeding pairs of burrowing owls in California. Based on assumptions of sampling design and the actual area surveyed, DeSante et al. (1996) estimated that 9,266 breeding pairs of burrowing owls existed during 1991-1993 in their statewide survey area,[3] which excluded the Great Basin, northern and southern desert areas, and the Channel Islands. DeSante et al. (1996) estimated that 71% (6,571 pairs) of the state's breeding population of burrowing owls occurred in the Imperial Valley, where they existed at very high densities (up to about 2.37 pairs/km^2). As the Imperial Valley comprises only 2.5% of the state's land base, this was a hugely disproportionate distribution of the species, and a circumstance dependent upon maintenance of accidentally favorable agricultural practices, as will be discussed below. DeSante et al. (1996) estimated 24% of breeding owls (2,221 pairs) occurred in the Central Valley, with over half of those owls (1,396 pairs) in the southern Central Valley, only 594 pairs in the middle Central Valley, and 231 pairs in the northern Central Valley. Only 474 pairs of owls were estimated to be present in the entire area of central western and southwestern California. Of these owls, it was estimated that 227 pairs were in the southern interior region, 165 pairs in the Bay Area interior region, and the remaining 82 pairs were scattered throughout the central coast (8 pairs), central interior (38 pairs), and southern coast (36 pairs) regions. No breeding pairs of owls were thought to remain in the coastal Bay Area and Coachella Valley regions. The findings of DeSante et al. (1996) are more fully discussed below by region, and in the section on population trends.

[3] The 95% confidence limits on this estimate extended from 7,884 to 10,370 pairs.

Decreases in the number of pairs of owls were also detected during the same studies by DeSante and others. The overall decrease in the number of breeding pairs in the entire survey area, derived from numerical data from the decade of the 1980's (again, not including the Imperial and Coachella Valleys) was most likely between 50% and 60% over a nine or ten-year period, and may have been closer to 60%. This corresponds to an average annual rate of decline of between 4% and 7%. These rates of decline were similar to those detected during a handful of long-term intensive studies of color-marked burrowing owls during that same time period in the San Francisco Bay Area (Trulio 1997) and in the middle Central Valley near Davis (Johnson 1992, 1997c).

See Table 1 for the best estimate of breeding pairs of western burrowing owls as of 1993 by region. This information was from the DeSante and Ruhlen (1995) and DeSante et al. (1996) surveys.

Wintering populations of burrowing owls also appear to have declined through the late 1980s, based on data from the Audubon Christmas Bird Count (Sauer et al. 1996). Data are collected in the winter instead of during the breeding season and they indicate a declining trend in wintering owls over the period 1959-1988 in California. It is unknown whether this suggested declines in numbers of owls breeding in more northern populations that would normally winter here, or if it reflected decreasing suitability of California habitat for the species during winter.

In response to the 2003 petition, CDFG also reviewed the status of burrowing owls and located additional information on historical distribution and abundance up to 2003 (CDFG 2003). The 2003 petition and subsequent information submitted to the California Fish and game Commission demonstrated that burrowing owls had been historically widespread and common in many areas of California where they had been extirpated by 2003 (8% of their former range) or near extirpation (22% of their former range) in the state.

See Table 1 for the best estimate of the number of breeding pairs of western burrowing owls as of 2003 by region. This information was provided by CDFG (2003), based on the DeSante and Ruhlen (1995) and DeSante et al. (1996) surveys, information in the 2003 listing petition (CBD et al. 2003), and CDFG review of known information at that time.

In 2006-2007 Wilkerson and Siegel (2010) re-surveyed the entire breeding range of the species in California (except the Channel Islands) using similar methodology.[4] Wilkerson and Siegel (2010) covered 11 regions previously surveyed by DeSante et al. (2007), and also included new regions that weren't surveyed by the 1991-1993 study (DeSante et al. 2007), including 5 eastern desert areas such as the Modoc Plateau and the Mojave and Sonoran deserts. For areas that were surveyed in both studies, Wilkerson and Siegel (2010) assessed changes in distribution and abundance from 1993. Wilkerson and Siegel (2010) located 1,758 breeding pairs of burrowing owls in California. Using data from randomly-selected blocks, they extrapolated a statewide, breeding season population of 9,187 +/- 2,346 pairs during 2006-2007.

Wilkerson and Siegel (2010) estimated that 69% (6,408 pairs +/- 2,384) of the state's breeding population of burrowing owls occurred in the Imperial Valley, where they existed at very high densities, but down 3% from the 1991-1993 surveys. Wilkerson and Siegel estimated 12% of

[4] The Wilkerson and Siegel (2010) surveys did not capture the hundreds of pairs of burrowing owls in the Altamont Pass in eastern Contra Costa and Alameda counties, likely due to insufficient access to privately held property and the inability to detect owls by surveying from public roads in this area.

breeding owls (1,113 pairs) occurred in the Southern Central Valley, down 20% from 1991-1993 surveys. An additional 545 pairs were estimated in the Middle Central Valley, down 16% from 1991-1993 surveys. No pairs were detected (only 12 pairs were estimated) for the Northern Central Valley, down 100% from 1991-1993 surveys. The burrowing owl population for the entire Central Valley was down 27% from 1991-1993 surveys. Only 448 burrowing owls were estimated to be present in the entire area of central western and southwestern California. Of these owls, it was estimated that 150 pairs were in the southwestern interior region, 119 pairs in the Bay Area interior region, 53 pairs in the Coachella Valley region, and the remaining 126 pairs were scattered throughout the central interior (84 pairs) and southern coast (42 pairs) regions. Breeding owls were shown to be extirpated from the coastal Bay Area and the central-western coast regions, and near extirpation in the southwestern coast region.

Wilkerson and Siegel (2010) were the first to extensively survey previously uncovered eastern desert portions of the burrowing owl California range. They confirmed presumed low densities and surveys yielded few or no owls in the Modoc Plateau/Great Basin (0 pairs), Northern Mojave/eastern Sierra Nevada (1 pair), eastern Mojave (32 pairs), and Sonoran Desert region excluding Palo Verde Valley (0 pairs). Wilkerson and Siegel (2010) detected large previously un-surveyed aggregations in the Palo Verde Valley (179 pairs) and the western Mojave Desert region (560 pairs).

See Table 1 for the Wilkerson and Siegel (2010) best estimate of the number of breeding pairs of western burrowing owls as of 2007 by region.

There has been no comprehensive statewide survey of burrowing owls since 2007; however a number of regional surveys have been conducted since 2007, providing more recent and more accurate estimates of breeding numbers in many regions, including in the middle Central Valley (Widdicombe 2007; BOPS 2015; Conrad 2023; Smallwood 2023a; Menzel et al. 2024), Bay Area (Townsend and Lenihan 2007; SCCHCP 2015; SCVHA 2016; Talon Ecological Research Group 2023), central and southwestern California (Kidd et al. 2007; Lincer and Bloom 2007; SDZWA 2022; Bloom 2023), and Imperial Valley (Manning 2009; IID 2012). The more recent 2007-2012 surveys in the Imperial Valley are worth noting due to the fact that they demonstrated that substantially lower owl populations existed in the Imperial Valley (21% to 43% lower) than had previously been estimated, using presumably much more accurate survey methodology. Manning (2009) also documented a 27% population decrease between the years 2007-2008 in the Imperial Valley, and the Imperial Irrigation District resurveyed in 2011 and 2012, and estimated a population of only 3,776 to 4,133 male territories (IID 2012).

For more recent information on breeding burrowing owls, the CDFW Natural Diversity Database was searched from 2015-2023 (though CNDDB records are supposedly years behind with data entry). Cornell University's eBird project database was searched from 2015-2023, for reports of more than one owl during breeding season, though most eBird reports do not note breeding status. See Table 1 for an estimate of breeding pairs of western burrowing owl as of 2023 by region, based on more recent regional surveys, CNDDB and eBird data, and additional information in this petition.

Region	1991-1993	2003	2006-2007	2023
Northern Desert	**?**	**90-149**	**0-5**	**1-10**
Central Valley	**2,221**	**2,221-2,227**	**1,670**	**<1,465**
Northern Central Valley	(231)	(231)	(12)	(1-2)
Middle Central Valley	(594)	(594-600)	(545)	(<350)
Southern Central Valley	(1,396)	(1,396)	(1,113)	(<1,113)
San Francisco Bay Area	**165**	**165**	**119**	**<25**
Bay Area Coast	(0)	(0)	(0)	(0)
Bay Area Interior	(165)	(165)	(119)	(<25)
Central-Western	**46**	**92**	**84**	**<84**
Central-Western Coast	(8)	(8)	(0)	(0)
Central Western Interior	(38)	(38)	(84)	(<84)
(Carrizo Plain)	-	(46)	(?)	(?)
Southwestern	**263**	**263**	**192**	**<140**
Southwestern Coast	(36)	(36)	(42)	(<40)
Southwestern Interior	(227)	(227)	(150)	(100?)
Coachella Valley	**0**	**10-20**	**53**	**<53**
Imperial Valley	**6,571**	**5,600-6,571**	**6,408**	**<4,000**
Southern Deserts	**?**	**500-1,000**	**772**	**<772**
Palo Verde Valley	-	(500-1,000)	(179)	(<50?)
Statewide	**9,266**	**8,941-10,477**	**9,298-9,303**	**<6,549**

Table 1. Best estimates of breeding pairs of burrowing owls in California by region. 1991-1993 estimates by DeSante and Ruhlen (1995), DeSante et al. (1996, 2007); 2003 estimates by CDFG (2003); 2006-2007 estimates by Wilkerson and Siegel (2010); 2023 estimates by Petitioners, based on regional surveys and information in this petition.

Northern Coastal California

The humid coastal belt of northwestern California has generally been considered outside of the range of the burrowing owl. Baird (1870) noted that "from Monterey north this species becomes very rare, or entirely absent on the west side of the Coast Range" and Grinnell (1915) knew of no records of the species north of Marin County in the humid coast strip proper. But Wilder (1916) reported on possible breeding of burrowing owls in Humboldt County, near Carlotta and in the Mattole and Eel River Valleys in the early 1900s; however, burrowing owls in the Wilder Collection were poorly catalogued and may not have been resident owls (CDFG 2003). There is a known historical breeding record from the Middle Fork Eel River drainage in Mendocino County (USDA and USDI 1996). No recent observations of breeding owls in Humboldt or Mendocino County could be located and burrowing owls are not known to breed in either county (CDFG 2003).

Northern Desert Range

The northern desert range of the burrowing owl encompasses portions of eastern Siskiyou, Modoc, Lassen, eastern Plumas, and eastern Sierra Counties (DeSante et al. 1996).

The burrowing owl was apparently never common in most of its northern desert range, except north of Mt. Shasta, where the species was reportedly common in the late 1800s (Townsend 1887; Merriam 1899). Subsequent accounts of burrowing owl distribution in the northeast part of the state (Dawson 1923; Grinnell and Miller 1944; Small 1974; Zeiner et al. 1990) did not describe local distribution or estimate the number of burrowing owls in the region. The statewide burrowing owl survey by DeSante et al. (1996) did not include the northern desert range, where owls were presumed to be sparse. Barclay and Cull (1999) produced a very rough population estimate of 90 to 149 pairs for the northern desert range, quantifying owl habitat in northeastern California (presumed to be 2,647 square miles or 6,855 km^2 of portions of Lassen, Modoc, Plumas, Sierra, and Siskiyou Counties), based on population densities described elsewhere. The lower limit of this population estimate used the mean population density of 0.53 owls/25 km^2 for the northern Central Valley from DeSante and Ruhlen (1995); the upper limit used the average owl density of 1 adult/5,683 acres outside prairie dog towns in Oklahoma reported by Butts (1973). In a subsequent estimate using plant community and elevation data, Cull and Hall (2007) presumed 4,044 square miles or 10,476 km^2 of potential burrowing owl habitat in the northern desert region, which could potentially support between 103 and 227 burrowing owl pairs, based on density figures reported elsewhere. These estimates were likely unrealistic.

The 2006-2007 breeding survey by Wilkerson and Siegel (2010) was the first to provide a focused burrowing owl survey of northeastern California. Wilkerson and Siegel (2010) detected no burrowing owls on random blocks or historic known breeding blocks in the northern desert region, so the "best estimate" produced by their study was zero pairs. Subsequent to this survey, a very small breeding colony was observed in Sierra Valley at late as 2009 (Wilkerson and Siegel 2010), with eBird reports of 1-2 pairs through 2019.

Siskiyou County

Burrowing owls were reportedly common in the 1880s "on the sage-covered districts north of Mount Shasta," about 15 miles from the mountain (Townsend 1887; Merriam 1899). Historical records confirmed breeding at Gazelle in 1918; and indicated probable breeding at Yreka in 1883 and 1922, at Bray in 1922, near Lava Beds National Monument in 1936 and 1937, and near the northwest corner of Lower Klamath Lake in 1940 (Bond 1939; South 1940; NMNH 2001; CAS 2002a). As of 2003, breeding season observations were reported in Shasta Valley, Butte Valley, and in grasslands of the upper Klamath River (CDFG 2003).

The only recent (2015-2023) breeding season observations in Siskiyou County were two locations reported on eBird: 1-2 birds at Lower Klamath National Wildlife Refuge in May and June of 2016; and 1-2 birds along Kuck Road N of Montague, from April-July 2015. There are no recent CNDDB occurrences.

Modoc and Lassen Counties

Historical records indicated probable breeding at Alturas in 1910 (MVZ 2001). Burrowing owls apparently regularly occurred at elevations as high as 5,300 feet in Lassen County (Grinnell and Miller 1944). Historical records indicated probable breeding in Petes Valley in 1929, near Herlong in 1963, and at Milford in 1975 (CSULB 2001; MVZ 2001). Three pairs of owls were observed in the spring and summer of 1975 and 1976 east of Schaeffer Mountain (P. Bloom, pers. comm., 2002). There were nesting burrowing owls and other observations in the Honey Lake Basin in eastern Lassen County from 1992 to 1998 (SAD 1992; Holmes and Novick 1993; BioSystems Analysis, Inc. 1993a, 1993b, 1994, 1995; KEA Environmental 1997, 1998; CNDDB 2001). CDFG (2003) obtained several additional historical records from regional staff in the U.S. Bureau of Land Management Alturas Field Office; Honey Lake Valley had several records in the 1950s and 1960s, and burrowing owls were likely in the Alturas area and Madeline Plains to the south. The burrowing owl was considered to be a sparse but presumably stable nesting species in shrub/steppe habitats in Lassen and Modoc Counties (CDFG 2003).

Recent (2015-2023) breeding season observations on eBird include: 1-4 owls at Modoc National Wildlife Refuge in 2019 and 2020; 2-4 owls near Upper Alkali Lake from 2015-2022; a dozen observations of 1-3 owls from 2015-2020 along Hwy 395 north of Honey Lake; and 1-6 owls from 2017-2023 along Smoke Creek Ranch Road, likely representing one family group. There are no recent CNDDB occurrences.

Plumas and Sierra Counties

Historical breeding season observations in Plumas and Sierra Counties could not be located. In the early 1990s, D. DeSante (pers. comm., 2003) located a small colony of about 5 pairs of breeding burrowing owls in the Sierra Valley along the Plumas-Sierra County line. This colony was well known to regular Sierra Valley birders for many years.

From 2009-2019 there were regular summer reports on eBird of up to a few breeding pairs in Sierra Valley, with about two dozen reports of 1-4 owls in the valley from 2015-2023. In Sierra County, there were eBird reports of 1-2 owls from 2016-2018 at the Loyalton Water Treatment Plant and near Bassetts. There are no recent CNDDB occurrences in Plumas or Sierra counties.

Northern Central Valley

The range of the burrowing owl in the northern Central Valley encompasses the southwestern 20% of Shasta County; most of Tehama County; the western 70% of Butte County; the eastern 80% of Glenn County; the western 85% of Yuba County; the western 20% of Nevada County; all but the northwestern 5% of Colusa County; portions of Lake County; all of Sutter County; and the western 40% of Placer County (DeSante et al. 1996).

Despite the presence of large areas of annual grasslands and historical references implying that burrowing owls were common or abundant from the foothills of the Sierras to the ocean, distribution and abundance information for the north Central Valley is sparse (CDFG 2003). There are historical records of confirmed burrowing owl breeding in almost every county in the northern Central Valley.

DeSante et al. (1996) only detected 18 pairs of owls but estimated that 231 pairs of owls remained in the northern Central Valley in the mid-1990s, about 3% of the state breeding population. These pairs were associated to a large degree with agricultural lands, although substantial numbers occurred in more urban settings and at airports.

Wilkerson and Siegel (2010) surveyed 33 randomly-selected and 15 historic known breeding blocks in the northern Central Valley region. They found 0 burrowing owls in the random blocks and only 10 pairs in the historic breeding blocks; and 2 pairs were incidentally detected outside the targeted blocks. All pairs were detected on lowland blocks in Tehama and Yuba Counties. The 2010 study established a "best estimate" of 12 pairs for the lowland subregion and 0 for the upland subregion. This was only a difference of 6 pairs from the DeSante et al. (1996) surveys from 1991-1993; but because DeSante et al. found 11 pairs on randomly-selected plots, their overall estimate was 231 pairs (assuming an even distribution), compared to the more recent estimate of only 12 pairs.

Southwestern Shasta County

Historical or recent breeding season observations in southwestern Shasta County could not be located on eBird or the CNDDB.

Tehama County

Historical records indicated probable breeding near Red Bluff in 1874, 1884, and 1924 (MVZ 2001; NMNH 2001). England et al. (1988) failed to find any records or observe any burrowing owls during surveys of the Mill and Deer Creek drainages and higher elevation meadows in Tehama County, during 1980-1987 surveys. Observations confirmed breeding near Gerber in 1993 and 1994, and indicated probable breeding near Gerber in 1993 and near Red Bluff in 1994 (CNDDB 2001).

Wilkerson and Siegel (2010) detected 4 breeding pairs of owls from 2006-2007 in lowland survey blocks in Tehama County.

There are no recent (2015-2023) eBird records during breeding season; the last report was a single pair with young in Corning Grasslands in 2009; single or small numbers of owls annually winter (sometimes through early February) along Lassen Road east of Vina, but do not breed. There are no recent CNDDB breeding occurrences.

Butte County

Historical records confirmed breeding at Biggs in 1906, and indicated probable breeding at Chico in 1975 (CSUC 2001; NMNH 2001). Observations indicated possible breeding southwest of the Chico Airport in 1998 (CNDDB 2001), at a site threatened by commercial development. During the 1970s at least 2-3 pairs of burrowing owls were observed in and around Gray Lodge Wildlife Area in Butte County, and breeding birds were known on Sutter Buttes grazing land and pastures, but none were observed since the conversion of grazing or idle lands to more intensive farming (CDFG 2003). Burrowing owl densities may never have been numerous in Butte County, but a decline from the 1980s to 2003 was thought to have occurred, due primarily to habitat loss, ground squirrel control, and nest vandalism (CDFG 2003).

There has been only one recent (2015-2023) breeding season observation location on eBird and in the CNDDB in Butte County, at the 56-acre Tuscan Preserve (under conservation easement) and nearby Nord-Cana Highway.[5]

Glenn County

Historical records confirmed breeding at Willows in 1928; and indicated probable breeding at Saint John in 1906, and near Norman in 1934 (DMNH 2001; MVZ 2001; NMNH 2001). Observations indicated probable breeding southwest of Orland and possible breeding at two other sites in the vicinity of Orland in 1992 (CNDDB 2001).

There are no recent (2015-2023) observations of breeding owl pairs in Glenn County in the CNDDB or on eBird.

Yuba County

Historical records confirmed breeding at Sheep Dip in 1906 (MVZ 2001).

Wilkerson and Siegel (2010) detected 8 breeding pairs of owls from 2006-2007 in lowland survey blocks in Yuba County. The only recent (2015-2023) breeding season report of owls in Yuba County on eBird has been of 1-2 birds in the vicinity of Beale Air Force Base. There are no recent CNDDB breeding occurrences.

Nevada County

Historical records indicated probable breeding near Truckee in 1935 (MVZ 2001).

There are no recent (2015-2023) observations of burrowing owls in Nevada County in the CNDDB or on eBird.

Colusa County

Historical records confirmed breeding near Maxwell in 1932 (Neff 1941). Observations confirmed a “good” breeding colony west of Antelope Valley in 1992 and 1993 (breeding in artificial burrows after 22 natural burrows were destroyed in 1992); and indicated probable or possible breeding at 8 additional sites west of Arbuckle, Williams, and Maxwell in 1992 (CNDDB 2001).

There are no recent (2015-2023) observations of burrowing owls in Colusa County in the CNDDB or on eBird; a search of eBird records for the last decade shows a small number of wintering birds, mostly single birds, with no evidence of summering or breeding owls.

---

[5] Burrowing owls were reportedly common on this property in the 1950s. Historically, owls occupied natural caves and burrows in earthen banks; 24 artificial burrows were installed from 2010-2018. One owl pair was detected in the vicinity in 1992; 1 pair fledged 6 young from an artificial burrow in 2015; breeding owls were observed in 2016; 1 pair fledged 4 young in 2017; and 3 adults were observed in October 2018.

Lake County

Burrowing owl eggs were collected historically from Lake County, but no specific locality or date was given (NMNH 2001). Historical records also indicated probable breeding at Upper Lake throughout the 1890s (Stephens 1895; McGregor 1898; NMNH 2001). In the 1970s, the burrowing owl was still distributed in the Cache Creek and Stanton Creek watersheds (West 1973).

There are no recent (2015-2023) observations of breeding owl pairs in Lake County in the CNDDB or on eBird.

Sutter County

The only historical breeding season observation located in Sutter County was a probable breeding colony near Pleasant Grove in 1993 (CNDDB 2001).

There are no recent (2015-2023) observations of breeding owl pairs in Sutter County in the CNDDB or on eBird; but single burrowing owls are occasionally found wintering in the Sutter Buttes.

Placer County

The historical status of the species in Placer County is uncertain. Western Placer County was historically dominated by grasslands with most of the lower elevation areas composed of vernal pool grasslands, and it is unlikely that Placer County ever supported large populations of the species. Most of the vernal pool grasslands were converted to rice production of other forms of agriculture in the past 50 years. Most of the grasslands at, or just above, the valley floor have been either eliminated by development or significantly degraded by fragmentation. The only historical breeding season observation located in Placer County was probable breeding northwest of Roseville in 1998 (CNDDB 2001).

By the mid-late 1990s there were no more than a handful of known, active burrowing owl breeding sites in the county, northwest of Roseville west of Highway 65, and almost exclusively in the fringes of agricultural areas and often in the berms of irrigation canals or along roadways (E. Pandolfino, pers. comm. 2024). None of those locations have hosted confirmed breeding burrowing owls in the past several years, and the only currently known breeding location is just north of Lincoln in a Placer Land Trust vernal pool reserve, where one to a few pairs of owls breed most years (some in natural burrows in dry years but mostly in above ground artificial burrows; there are very few breeding season reports elsewhere in Placer County and none with confirmed breeding (E. Pandolfino, pers. comm. 2024).

A search of eBird and CNDDB records in Placer County for the last decade shows a small number of wintering birds, mostly single birds, with no evidence of summering or breeding owls; with the exception of 1-2 owls seen lingering through April or May from 2018-2020 in agricultural lands west of West Park, but with no evidence of breeding.

Middle Central Valley

The range of the burrowing owl in the middle Central Valley encompasses all of Yolo and Sacramento Counties; all but the southwestern 5% of Solano County; the eastern 50% of

Contra Costa County; the eastern 20% of Alameda County; all of San Joaquin, Stanislaus, and Merced Counties; the western 30% of El Dorado County; the western 55% of Amador County; the western 70% of Calaveras County; the western 25% of Tuolumne County; and the western 60% of Mariposa County (DeSante et al. 1996).

Although there are historical records of confirmed breeding in almost every county in the middle Central Valley, there are little data on overall historical distribution and abundance of the burrowing owl, despite the presence of relatively large areas of annual grasslands. Historic references imply that burrowing owls were common or abundant from the foothills of the Sierras to the ocean. Burrowing owls were documented to have been locally abundant in Solano County (at Fairfield) and Merced County (at Los Banos) in the 1930s (WFVZ 2001); and in Yolo County (at U.C. Davis) and San Joaquin County (at Stockton) in the 1960s (Remsen 1978; Kemper 1996).

DeSante and Ruhlen (1995) located 405 pairs and estimated that 594 breeding pairs of owls remained in the middle Central Valley in the mid-1990s, about 6% of the state breeding population. Unbeknownst to DeSante and Ruhlen (1995), at the time there were likely more than 500 pairs of burrowing owls in the Altamont Pass, located mostly within the footprint of the wind farms (Smallwood et al. 2013). The pairs in the Valley portion of the Middle Central Valley were thinly distributed in a crescent around the Delta region (in Yolo, Solano, Sacramento, eastern Contra Costa, San Joaquin, Stanislaus, and Merced Counties), and were associated to a large degree with agricultural lands, although substantial numbers occurred in more urban settings and at airports. (Kemper 1996) also estimated 595-600 breeding pairs in the middle Central Valley.

In the 2006-2007 Wilkerson and Siegel (2010) statewide survey, substantial concentrations of owls were located in lowland areas of Yolo, Solano, Sacramento, eastern Contra Costa, and San Joaquin counties. Only 2 pairs were found in Stanislaus County and only 1 pair was detected in Merced County. No burrowing owls were found in the upland blocks of western El Dorado, Amador, Calaveras, Tuolumne or Merced Counties. The study estimated 545 breeding pairs for the middle Central Valley region (Wilkerson and Siegel 2010).

Development continued to be a major factor causing a general decline in burrowing owls from 2000-2023 in the middle Central Valley region (S. Smallwood, pers. comm., 2023). Over the past two decades, owls in the middle Central Valley have continued to decline in both area occupied and total number of individuals detected, with substantial declines since 2018 and known breeding pairs dwindling to just a few sites in the Sacramento area as of 2023 (Conrad 2023).

Yolo County

Historical records confirmed breeding at Woodland in 1886 and indicated probable breeding there in 1922 (MVZ 2001; NMNH 2001).

Kemper (1996) reported a “dependable” owl colony on the U.C. Davis campus in 1962, noting that owls could be seen any time then. B. Johnson monitored this colony from 1981, when the colony had 22 pairs, to 1991, when the population plummeted to only 1 adult; this colony increased to several pairs by the late 1990s, but was threatened by development (CNDDB 2001; PHBA 2002). The overall burrowing owl population at Davis likely declined 50% - from 40 pairs in the mid-1980s to 20 pairs in the mid-1990s (PHBA 2002). Other owl colonies north of Davis also severely declined or were extirpated in the 1980s: such as a burrowing owl colony adjacent to the Yolo County Airport that had 10 pairs of birds in 1976, that was extirpated by 1983 when the site was flooded to create a pond; and a colony of 3 to 5 pairs observed from 1978 to 1983 near road 102, 2 miles north of Davis, that had only one pair left by 1986 (CNDDB 2001). In 1985, B. Johnson estimated Yolo County's burrowing owl population on the order of 70 to 80 pairs, after which the species went into "serious decline" of about 50% in Yolo County to 30 or 40 pairs in 2000 (PHBA 2002). Remaining breeding colonies by 1996 included pasturelands bordering the Yolo Bypass, south of El Macero, and a few pairs residing near Davis (Kemper 1996; CNDDB 2001). As of 2001, owls were known to occupy sites at U.C. Davis, the Yolo Airport, and Mace Ranch Park (CDFG 2002a).

Widdicombe (2007) surveyed Yolo and Solano counties for nesting pairs of burrowing owls each year from 2000-2005. In Yolo County, the main nesting areas were in north Davis and in the Dunnigan Hills. Although no significant change in abundance was recorded over the survey period, Widdicombe (2007) estimated that assuming equivalent coverage in 2000 and 2005, the numbers of breeding pairs detected would have declined from 58 to 46, or by approximately 20%. Widdicombe estimated between 40 and 60 nesting pairs remained over the whole of Yolo and Solano Counties in any given year during the survey period. Widdicombe also summarized adverse effects on burrowing owls within the study sites, noting that 11 out of the 30 sites were threatened by urban development and other changes in land use, poisoning of ground squirrels, livestock grazing, and direct persecution.

CDFG (2008) biologists monitored burrowing owl populations at Yolo Bypass Wildlife Area (YBWA) and Wildhorse Golfcourse (WG) from 2006-2008. A total of 31 occupied nest burrows were located (YBWA = 23 nests, WG = 8), with only 12 successfully producing young (YBWA = 7, WG = 5). Productivity dramatically dropped at each site from 2007-2008, with 3.8 young/nest at YBWA and 2 young/nest at WG, a 73% decrease in the number of juveniles produced at both sites (122 juveniles in 2007 vs. 331 in 2008). No owls nested in the artificial nest burrows at the Yolo Bypass in 2008.

Focused breeding season surveys by Wilkerson and Siegel (2010) found relatively large concentrations of owls from 2006-2007 in lowland areas of Yolo County, locating 63 pairs in the county.

Localized extirpations and declines in burrowing owls continued in Yolo County from 2000-2017 (S. Smallwood, C. Portman, pers. comm. 2023). Within the proposed Mace Ranch housing development site in Davis, 13-15 acres of occupied burrowing owl habitat was disked at the end of April 2000 before the juveniles could fly. An October 1999 survey by Jones and Stokes found 14 owls and 11 active sites over the proposed Mace Ranch project site; a February 2000 survey by EDAW Inc found 7 owls and 20 active burrows on 8 of the Mace Ranch development acres. Within the proposed Mace Ranch project, the Davis City Council secured 3.5 acres (of the proposed 8-acre park) as designated burrowing owl habitat near the occupied (but disked) acres. Burrowing owls successfully bred there for six years with a breeding season population of 8 owls in 2005; and 3 breeding pairs and as many as 8 owls on the 3.5 acres as of 2006. As mitigation for the loss of owl habitat, the city of Davis secured 33 acres within a 63-acre Burrowing Owl Reserve at Yolo County Grasslands Park. While there is historic documentation of nesting burrowing owls on other areas of Grassland Park (Institute for Bird Populations 1980), there is no documentation that the 63-acre reserve ever hosted nesting owls. This "mitigation" resulted in loss of 13-15 acres of occupied nesting habitat in exchange for 33 acres of unoccupied habitat. The City of Davis failed to comply with the Mace Ranch Habitat Management Plan (J. Barclay 2004), with the vegetation not kept to the effective height standard of 4-5 inches and burrowing owls were extirpated from Mace Ranch by 2008. Owl surveys since 2007 have found zero nesting owls at the Reserve (Sustain Environmental Inc. 2007, 2008, 2009; S. Smallwood, pers. comm. 2010; C. Portman and P. Nieberg, pers. comm., 2012).

The Institute for Bird Populations (IBP) 2006-2007 statewide census documented that the largest population of breeding burrowing owls in Yolo County was in and around the City of Davis. IBP survey blocks 4265-610, 4270-610 and 4265-605 comprised the City of Davis, 170-acre Wildhorse Golf Course, and an agriculture buffer. Wildhorse Golf Course was built in 1998 using topsoil scraped from adjacent city property, and portions were designated as an agricultural buffer. A 2001 revegetation and restoration plan (Chan 2001) noted “25 to 30 owls” on the 38-acre agricultural buffer. The revegetation plan was designed to replicate foothill woodlands (Chan 2001), so that trees and tall-stature shrubs were planted which inhibited burrowing owl success. Wildhorse Golf Course hosted 17-19 burrowing owl pairs in 2006 (McNerney 2005-2014). The 2006-2007 IBP survey detected 32 pairs burrowing owl on the golf course and 6 pairs on the ag buffer. The 2014 IBP-BOPS survey (BOPS 2015) detected zero pairs on the golf course and only 3 pairs on the ag buffer; and in 2015 local birders detected only 1 pair in the ag buffer. A 2024 golf course management report (C. Klein. pers. comm., 2024) reported there have been no owls at Wildhorse Golf Course or the ag buffer since 2021.

Just north of the Wild Horse Golf Course site, a pair of burrowing owls nested in a ground squirrel burrow under the concrete lining of an irrigation ditch. In the mid- to late-1990s, grain bait treated with anti-coagulants was distributed on the ground for ground squirrels, subsequently killing all the ground squirrels in the area. S. Smallwood (pers. comm., 2023) found the adult and fledging burrowing owl nestlings dead among the squirrels; at least one or two of the owls had blood running out of their bills. The nest site was never used again.

A population on the southeast perimeter of Davis where 4-5 pairs were housed in a canal bank was extirpated when the surrounding fields were developed (S. Smallwood pers. comm., 2010). Owls nested along North Davis Canal in the 1990s, but Yolo County staff buried the nest burrows. Also in the 1990s, burrowing owls nested along fence lines on the east side of the railroad tracks between the south and main channels of Willow Slough, but these nest sites were destroyed by a tractor blade while the ground squirrels were also poisoned with anti-coagulant baits. Two pairs of owls nested along a fence line between F Street and the old Davis Landfill on Road 102, but again a tractor blade was used to damage burrows while anti-coagulant baits were deployed. The owls persisted until 2019, although no nestlings emerged that last year; the owls never returned after 2019.

In 2006 the City of Winters approved the Winters Highlands Subdivision, a housing development on 103 acres of open grassland, hosting between 5 confirmed and 12 estimated nesting burrowing owl pairs on and near the project site (Smallwood 2004). Observed ground disturbances during development included disking and burning the site and erecting a fence without avoidance measures (S. Smallwood, C. Portman, pers. comm., 2010). A focused survey in 2017 found no remaining owls (ECORP Consulting 2017). The final conditions of approval for the project included burrowing owl habitat compensation: “The applicant shall either acquire and protected, or mitigation credits purchased at an approved mitigation bank 19.5 acres of burrowing owl habitat. If the applicant chooses to acquire and protect land for the burrowing owl, the protected lands shall be adjacent to occupied burrowing owl habitat.” (Winters 2006). The applicant purchased 19.5 acres of mitigation credits at Elsie Gridley Mitigation Bank; but a review of Elsie Gridley annual reports revealed that there were never any nesting burrowing owls at Elsie Gridley (LSA 2007-2017), so the mitigation measure to protect burrowing owl habitat adjacent to occupied burrowing owl habitat was not met.

A substantial number of owls were threatened by development at Conaway Ranch and on land slated for development by U.C. Davis (S. Smallwood pers. comm., 2010). The land at Russell Ranch proposed as mitigation for the U.C. Davis West Campus Neighborhood is too small to support the necessary number of owls to mitigate the effects of the project (S. Smallwood pers. comm., 2010). The City of Davis still had 21 known breeding pairs of owls as of 2007 (YHC 2017). Smallwood (2013b) documented the destruction and extirpation of most of the significant burrowing owl populations around Winters and Davis (including Mace Ranch Park, U.C. Davis, and Wild Horse) by urban development, ground squirrel poisoning, and disking of known breeding burrows during nesting season.

The Burrowing Owl Preservation Society, in consultation with IBP, conducted a burrowing owl survey in 2014 following the IBP's survey protocol, covering 45 survey blocks (5 km x 5 km), covering 3,250 square kilometers throughout Yolo County, representing the most significant known breeding areas for burrowing owl. They detected 15 nesting pairs (Menzel et al. 2024), down from 63 pairs detected in 2007 (Wilkerson and Siegel 2010). The 2014 surveys documented a precipitous 76% decline in the county's burrowing owl population as compared to the previous survey in 2006–2007.[6] Since 2007, land-use changed from suitable breeding habitat (natural grassland, pasture, or fallow field) to unsuitable habitat (agricultural crops) at 4 of the 51 locations (8%) where burrowing owls were detected in 2007, but remained the same at the remaining historical breeding locations (Menzel et al. 2024). In survey blocks in the southern part of Yolo County, where land-use has remained the same over the decades, burrowing owls were found in relatively similar locations and densities as during prior surveys. The majority (71%) of owls occurred in areas where surveyors also observed California ground squirrels, the prime provider of burrows in this county. Private land supported two-thirds (67%) of the nesting burrowing owls, demonstrating their continued vulnerability in the face of potential land conversions.

Breeding burrowing owls now appear to be nearing extirpation in Yolo County. Breeding burrowing owls were completely extirpated from Davis by 2021 (S. Smallwood, pers. comm., 2023). In 2023, the Burrowing Owl Preservation Society resurveyed the six Yolo County blocks with detections in 2014, following the same survey protocols (Menzel et al. 2024). While in 2014, 22 adults and 18 juveniles were detected in those six blocks, only 5 adults owls and zero juveniles were detected in one block in 2023 (Menzel et al. 2024), despite repeated surveying throughout the breeding season and repeat visits attempting to detect juveniles among the 5 adults. In 2023, the Burrowing Owl Preservation Society resurveyed the six blocks with detections in 2014, following the same survey protocols (Menzel et al. 2024). BOPS also queried people who routinely survey historic nesting sites which were not within the six 2014 detection blocks, including Yolo Habitat Conservancy consultants and the manager of the Yolo

[6] During the 2014 breeding season, volunteers assessed 45 5 km x 5 km survey blocks out of a total of 135 blocks covering the county. Of the 45 blocks, 38 were randomly selected; the remaining seven blocks were specifically surveyed because they contained historical nest locations. For comparability with data IBP surveyors collected during the 2006–2007 statewide survey, this survey followed methods described in Wilkerson and Siegel (2010) with a few exceptions. In fact, this survey effort was more extensive, with 45 blocks surveyed throughout the county compared to only 20 blocks surveyed during IBP's 2006–2007 statewide survey. Many of the citizen science surveyors were professional biologists and most were local, hence familiar with their assigned survey blocks and some of the historical nest locations. Moreover, using volunteers had the advantage of allowing for greater geographical and temporal survey coverage than could have been managed with fewer paid professionals limited by a modest budget. Methods were consistent with IBP's two previous statewide surveys, allowing for a direct comparison of trends. Any biases in data, such as inaccessible blocks, were comparable between surveys. Also consistent was the notion that a single bird observed during the breeding season was to be counted as a pair; however, at such low densities this may actually have over-estimated burrowing owl numbers slightly.

Bypass Wildlife Area, as well as local biologists familiar with Yolo County burrowing owl habitat and historic nesting sites and local birders. Menzel et al. (2024) also report that in 2023, breeding burrowing owls were not observed in any of the following protected public grasslands that were independently surveyed in Yolo County: the 60-acre Burrowing Owl Reserve at Yolo County Regional Grasslands Park (J. McNerney, pers. comm. 2023); Yolo Habitat Conservancy easements (C. Alford and J. Estep, pers. comm. 2023); and the Yolo Bypass Wildlife Area (J. Aucelluzzo, pers. comm. 2023). A review of eBird (2023) data for Yolo County by Menzel et al. (2024) contained an estimated 49 burrowing owl pairs total during the 2015−2023 breeding seasons (15 May−15 July). During each breeding season from 2015−2020, owl sightings were reported at 1−9 distinct locations, whereas since 2021, sightings were reported at 0−3 locations throughout Yolo County. Showing a similar trend, iNaturalist contained an estimated 32 burrowing owl pairs for the 2015−2023 breeding seasons (15 May−15 July). During each breeding season from 2015−2020, 1−4 distinct locations were reported, whereas since 2021, no observations were submitted for Yolo County. There are no CNDDB records of burrowing owls since 2016. In summary, during resurvey of 2014 locations and reports from burrowing owl preserves, only five adult burrowing owls were detected in Yolo County during the 2023 breeding season, but no reproductive success was recorded in Yolo County (Menzel et al. 2024).

Sacramento County

Beginning with the rapid settlement of Sacramento County in the mid-1800s, habitat for wildlife has changed tremendously, and it is difficult to compare the distribution of Sacramento burrowing owls at that time with those in the area today (CDFG 2003). Historical records confirmed breeding near Freeport in 1899 and near Sacramento in 1901 and 1907; and indicated probable breeding in Sacramento in 1867, 1912, 1926, and 1951 (Storer 1926; Kirsher 1951; MVZ 2001; NMNH 2001; CAS 2002a). Since the 1950's, sizable colonies of burrowing owls were recorded at the California State University campus, Executive Airport, Sacramento Army Depot, Cosumnes River College, and Mather Air Force Base (Anderson 1979; Schulz 1997, CDFG 2003). There were nesting colonies of owls in downtown Sacramento as of 1974 (CNDDB 2001). Observations confirmed nesting in the vicinity of Rio Linda from 1987-1993, at Mather Air Force Base in 1989, at the Sacramento Army Depot in 1990, and at a number of locations in southern Sacramento from 1991-2001 (CNDDB 2001). Large populations remained in 2001-2002 at the Sacramento Army Depot, southeast of Sacramento Metro Airport, Cosumnes River College, and the Sacramento Regional Wastewater Treatment Plant (CNDDB 2001; SRCSD 2002).

As Sacramento development has filled in grasslands, increasingly isolated remnant tracts of urban open space south of the American River and in the North Natomas area continued to provide habitat for burrowing owls (CDFG 2003). Although declines and disappearances of owls had been detected at most of the historic sites, outlying areas still provided some habitat for the species (CDFG 2003). Some burrowing owls occupied the north Natomas area and patches of habitat that extended from the Sacramento Regional County Sanitation District (SRCSD) "Bufferlands" to The Nature Conservancy's Cosumnes River Preserve, as well as the rolling grasslands in eastern Sacramento County (CDFG 2003). No clear data existed on the distribution or abundance of these owls, or on their demographic relationship to the burrowing owls within the City of Sacramento limits (CDFG 2003).

A draft HCP was prepared for South Sacramento in 2004 (HEP 2004), which discussed the status of burrowing owls. Within the HCP study area, the largest burrowing owl populations were thought to remain at the Sacramento Army Depot, Cosumnes River College, southeast of

Executive Airport, and the SRCSD Bufferlands (HEP 2004; SRCSD 2004). There was a dramatic decline in owl numbers at the SRCSD Bufferlands, from 10 breeding pairs in 1996 and 1997 to only one pair in 2001, 2003, 2005 and 2006 (SCRSD 2006). One to two pairs were recorded at the Bufferlands through 2013, with absence during the breeding season thereafter, with the exception of 2017, 2018, and 2023. Only in 2017 were any young fledged (Conard 2024). The draft HCP documented 40 pre-2004 observations in the South Sacramento HCP study area, including at Cosumnes College, Mather AFB, Executive Airport, Florin Creek, and Kiefer landfill. The South Sacramento HCP was adopted in 2018. The burrowing owl decline in South Sacramento occurred despite ongoing active and consistent management over several years that significantly enhanced the population there in previous years. Due to severe losses of habitat for burrowing owls in the HCP study as a result of development and agricultural conversions to vineyards or orchards that are unsuitable as owl habitat, it was assumed that burrowing owl populations in the study area had declined substantially in the decades before 2004 (HEP 2004). Breeding burrowing owls have apparently been extirpated from the Natomas Basin, and there has been no nesting on HCP reserve lands documented since at least 2014 (Natomas Basin Conservancy 2021).

There are no breeding season observations of burrowing owls in Sacramento County in the CNDDB from 2017-2023. There were two observations in 2016: two owls observed on February 12, 2016 near Cosumnes River Preserve, with no evidence of breeding; and a family group of two adults and three juveniles observed in August of 2016 at Cosumnes River College (owls at this site were subject to disturbance from pets and development, and trees planted on the berms where they nest may eventually render the site unusable by owls). There was only one documented burrowing owl in Sacramento County during the 2021 breeding season (S. Smallwood, pers. comm. 2023). A search of eBird records reveals only two reported pairs in the entirety of Sacramento County during the 2021-2023 burrowing owl breeding seasons (one pair at Sacramento Regional Wastewater Treatment Plant from 2021-2023; and one pair at Rancho Seco Reservoir Park in March of 2022). Natural Resource Specialist with the Bufferlands, Chris Conard, who has tracked burrowing owl populations in the middle Central Valley for 25 years, reports that burrowing owls in Sacramento County and the wider region have undergone substantial declines in both area occupied, and the total number of individuals detected (Conard 2023, 2024).

The decline in breeding burrowing owl distribution and abundance within the county is best illustrated by comparing the first statewide survey, 1991-1993, the second statewide survey, 2006-2007 (Wilkerson and Siegel 2010), and the Sacramento County Breeding Bird Atlas (BBA), 2015-2020 (Pandolfino et al. 2021), with the current known breeding season distribution. Using focused searches of the same 5 km x 5 km blocks for each survey period, the survey in 1991-1993 recorded 14 occupied blocks and a total of 67 pairs, with a maximum of 19 pairs in a single block. In 2006-2007, 15 occupied blocks accounted for 50 pairs, with a maximum of 11 pairs in one block (Wilkerson and Siegel 2010). During the survey period of 2015-2020 for the Sacramento County BBA, there were 16 occupied blocks totaling 20 pairs, with a maximum of two pairs per block, and all of the occurrences had been tallied by 2018 (Pandolfino et al. 2021; Conard 2023, 2024). From 2019-2023, there was a combined total of only three occupied blocks during the breeding season, and a maximum of one pair per block (Conard 2023, 2024). While the spatial distribution of burrowing owls within Sacramento County in 2015 was similar to that recorded in 2006-2007, the decrease in density from a maximum of 11 pairs in a block to a maximum of two pairs was a strong sign of trouble (Conard 2023, 2024). After the 2018 breeding season, the burrowing owl population in Sacramento County had all but vanished; in the breeding season of 2023, there was only one known pair, and they failed to fledge young (Conard 2023, 2024).

There is an influx of wintering owls from unknown summering locations, but the species is less numerous and widespread even in winter than it was 25 years ago (Conard 2023, 2024). Survey information is incomplete, yet the signal of decline is strong and undeniable (Conard 2023, 2024). Some population decline has been caused by development and increased levee maintenance (surveys in 2006-2007 detected 40% of occupied sites on levees, and all of these sites were subsequently eliminated by increased levee maintenance), while other areas that appear intact have also seen sharp declines (Conard 2023, 2024). For years it seemed like habitat loss and disturbance were the main problems, but now it seems like a more fundamental ecosystem productivity problem is driving some of the decline; perhaps a combination of earlier losses compounded by drought and other factors, and possibly neonicotinoids causing insect prey declines (S. Smallwood, pers. comm. 2023; Conard 2023, 2024).

Solano County

Historical records confirmed breeding near Dixon in 1932 and near Fairfield in 1936; and indicated probable breeding near Vacaville in 1894, and on eastern Grizzly Island in 1927 (Stoner 1933b; MVZ 2001; NMNH 2001; WFVZ 2001). A. Anderson noted “lots of owls near Fairfield” in 1936 (WFVZ 2001).

There were numerous observations indicating an abundance of breeding owls between the Yolo Bypass and Dixon before 2003 (CNDDB 2001), with numerous colonies observed in the vicinity of Vacaville (north of Vacaville and west of Hwy. 505, near the Vaca Dixon Airport, and near Travis Air Force Base) (CNDDB 2001). Breeding owls were documented in the vicinity of Fairfield, and observations along Suisun Bay and the Delta confirmed breeding at Montezuma Slough, and indicated probable breeding in the Montezuma Hills and the vicinity of Rio Vista (USACE 1998; CNDDB 2001).

Wilkerson and Siegel (2010) located substantial concentrations of owls (>80 pairs) during 2006-2007 breeding season surveys in lowland areas of Solano County. However, most of these owls are on private lands that are under considerable risk of urban development.

The Solano County Breeding Bird Atlas (Berner 2015) reported that very little available habitat for burrowing owls in Solano County was native, undisturbed or secure. By 2015, small breeding concentrations were found at Travis Air Force Base, Jepson Prairie, and the peripheries of Leisure Town area golf courses, with patches of occupied habitat scattered throughout the diverse mosaic of irrigated pastures and crop land south and east of Dixon (Berner 2015).

Smallwood and Morrison (2018) studied a high-density population of burrowing owl nests at the National Radio Transmission Facility in Dixon from 2006-2011, where breeding pairs numbered 24–44 per year, averaging 34 pairs annually on 83 ha.

By 2023, Vacaville was down to one breeding pair of owls, which fledged no nestlings (S. Smallwood, pers. comm., 2023).

The CNDDB has only two documented locations of burrowing owls during breeding season since 2015: 2 adults and 3 juveniles observed at burrow on 17 June and 2 adults observed on 12 July, 2016 in Vacaville; and 2 adults observed resting and foraging near a burrow east of Vacaville during protocol surveys conducted February-July, 2017 (in a location proposed for residential development). A search of recent (2015-2023) eBird records in Solano County during the breeding season indicates breeding owl colonies remain at the former Greentree Golf

Course in Vacaville, at the NRTF radio station in Dixon, along rural farm roads to the east of NRTF, and along rural farm roads south of Yolano. February and March records in southern Solano County likely represent late lingering wintering birds.

Eastern Contra Costa County

Historical records confirmed breeding at Brentwood in 1915; and indicated probable breeding at Antioch in 1879 (MVZ 2001; NMNH 2001). Owls were frequently observed in the vicinity of Byron in the 1980s (Richmond 1985; CNDDB 2001). There were remaining owl populations in Concord, Pittsburgh, Antioch, Brentwood, Oakley, Byron, the Los Vaqueros watershed, and Vasco Caves Regional Preserve in the early 2000s (L. Trulio, pers. comm., 2001; CDFG 2002a; M. Ricketts, pers. comm., 2002; J. DiDonato, pers. comm., 2003). CNDDB records confirmed breeding at the Byron Airport in 1993 and 1994, and southeast of Antioch in 2001; and indicated probable breeding near Clifton Court Forebay in 1992, at Byron in 1999, and in the vicinity of Brentwood in 1999 (CNDDB 2001).

Townsend and Lenihan (2007) presumed that there were an unknown number, but many pairs of breeding owls in Byron, more than 8 pairs in South Antioch, and unknown numbers in Concord and Pittsburgh. A few other sites in eastern Contra Costa had at least several pairs: Brentwood, West Brentwood and Vasco Caves (now extirpated) (Townsend and Lenihan 2007). Wilkerson and Siegel (2010) located substantial concentrations of owls (~100 pairs) during 2006-2007 breeding season surveys in lowland areas of eastern Contra Costa County.

The Contra Costa Breeding Bird Atlas (Glover 2009) reported that the burrowing owl was still fairly common in eastern Contra Costa County where grasslands had been allowed to persist, most numerous in the vicinity of the Byron Airport and Clifton Court Forebay. By 2009 colonies still in existence around Knighton were precarious; Jersey and Bethel islands were unoccupied; there was a small population around Dougherty Valley east of San Ramon jeopardized by massive housing development; 10 pairs or less were present on the Los Vaqueros watershed; and 1-2 pairs persisted on private property on the western flank of Mount Diablo (Glover 2009). Breeding burrowing owls were confirmed in 6 blocks in eastern Contra Costa County and 2 blocks in southern Contra Costa County (Glover 2009).

The 24-acre Prewett Family Park Burrowing Owl Habitat Preserve was set up in 2009 by the City of Antioch to compensate for development project impacts to burrowing owl habitat. The preserve has a management and monitoring plan, with vegetation management using mowing; owls nest on the preserve in natural ground squirrel burrows. The maximum number of owls supported at the preserve was in 2013, when 5 breeding pairs/nest burrows were documented, with a maximum of 27 juveniles seen in July (LSA 2014). A search of eBird records from 2013-2023 seems to indicate this population has declined: the maximum number of owls recorded at the preserve was 13 in 2013; since 2016 the only records have been of single owls seen during the 2021 breeding season.

The CNDDB only has a handful of recent (2015-2018) reports of small numbers of burrowing owls during breeding season in Eastern Contra Costa County: 5 different adults at nest sites near Byron in April 2015 (all threatened by flooding from proposed expansion of Los Vaqueros Reservoir); 1 owl seen 17 February 2016 in Port Chicago (at a site that was subsequently graded and the burrows destroyed); 2 adults and a fledgling in Antioch September 2016; 1 adult at a burrow near Byron Hot Springs on 29 August 2016; 1 adult in Oakley May 2017; and single adults north of Livermore in March 2016 and March 2018. A search of recent (2015-2023) eBird records in eastern Contra Costa County during the breeding season indicates breeding owl colonies remain at: the former Concord Naval Weapons Station; Prewitt Park Burrowing Owl Preserve; a few scattered urban locations from Brentwood to Oakley; south of Byron near the airport, Byron Hot Springs Road and Clifton Court Forebay: and the Contra Costa portion of Altamont Pass.

Smallwood and Bell (2022) reported on the extirpation of breeding burrowing owls from Vasco Caves Regional Preserve, coinciding with substantial reduction in ground squirrel abundance; the number of burrowing owl nest attempts in Vasco Caves declined to 0 over the decade between 2006 and 2016. Over Smallwood's last 10 years of research in the Altamont Pass, burrowing owls declined 45% across eastern Alameda and Contra Costa counties, coinciding with a 63% retraction of the geographic extent of ground squirrel colonies (Smallwood 2023a).

Eastern Alameda County

(Stallcup and Greenberg 1974) observed that burrowing owl numbers continued to decline in eastern Alameda County through the 1970s. Numerous observations confirming breeding in the vicinity of Altamont Pass and Bethany Reservoir from 1973-2001 (CNDDB 2001). There was an owl colony at Lawrence Livermore Laboratory (L. Trulio, pers. comm., 2001), and a small number of burrowing owls observed breeding on the Laboratory's Site 300, on the north side of Corral Hollow Road (LLNL 1998; Jones & Stokes 2000). No burrowing owls were observed during field studies at the Carnegie State Vehicle Recreation Area (Jones & Stokes 2000).

Townsend and Lenihan (2007) presumed that there were an unknown number, but many pairs of breeding owls at Altamont Pass and in the Altamont Hills, plus relatively large populations at Camp Parks (11 pairs) and Mountain House Golf Course (at least 9 pairs), where development was occurring. A handful of other sites in eastern Alameda County had 2-3 pairs: San Antonio Reservoir, Dublin, North Livermore Avenue, Brushy Peak, and Bethany Reservoir (Townsend and Lenihan(2007).

The Camp Parks Reserve Forces Training Area (PRFTA) in Dublin had nearly 2,000 acres of grasslands and a historical population of 15-25 pairs of nesting burrowing owls[7] (Albion Environmental 2008). Most of the burrowing owls at Camp Parks occurred in mowed grass areas of the cantonment. Burrowing owls were impacted by military activities and infrastructure development, along with ground squirrel control on the installation, but had a relatively large, stable population. Camp Parks approved a Burrowing Owl Management Plan in 2008 (Albion Environmental 2008) to address planned urban development, infrastructure projects and some training activities on the base that would impact owls. The management plan prescribed annual focused owl surveys, avoidance and mitigation for development and training impacts, passively relocating non-nesting burrowing owls away from training and redevelopment project areas, and mitigating effects to burrowing owl habitat by maintaining appropriate habitat conditions in designated burrowing owl management areas, and regular monitoring of the nesting population. Albion Environmental biologists conducted focused year-round owl surveys on all of Camp Parks from 2008-2011 (Albion Environmental 2008, 2010, 2011, 2012), documenting 9, 12, 14, and 17 breeding pairs respectively.[8] More than half of the owls and nests documented were in

[7] Although there was no information about the exact numbers and distribution of nesting pairs, in 2003, 40 burrowing owls including 10 fledglings, were observed during a single survey in the cantonment and southern portion of the training area, and in July two owl colonies in the cantonment and training area A of approximately 11 breeding pairs were reported; these results suggested approximately 15 nesting pairs (Albion Environmental 2008).
[8] In 2008 they located 78 adult owls and 36 burrow locations, with 9 successful nests and a minimum of 20 juveniles. In 2009 they counted 23 adults at 12 nests, with 75% nesting success, a minimum of 45 juveniles, and productivity of 3.75 juveniles/nest or 1.96 juveniles/adult. In 2010 they estimated that 28 adult owls nested at 14 locations, with a

the cantonment area. They also annually observed military activities that displaced owls from nest burrows, and construction activities and extensive grading and ground disturbance in areas with owl nesting locations with no owl surveys, and without prior notification of the Environmental Division or following the management plan. In 2009 the military prepared an EIR (US Army 2009) for proposed development and military activities on portions of Camp Parks. The military conducted a land exchange with the City of Dublin to allow residential and commercial development on 189 acres of mostly open grassland at Camp Parks, an area with a significant number of annual burrowing owl nests. SunCal planned six major development projects at Camp Parks including the nearly 2,000-home "Dublin Crossing" development. The EIR acknowledged that significant nesting and foraging habitat for burrowing owls would be lost in the cantonment (the area with more than half of the annual owl nesting) but did not disclose the regional significance of the burrowing owl colony that would be displaced by development. The proposed mitigation was preconstruction surveys, with passive relocation of owls from development areas using burrow exclusion by installing using one-way doors. Because the EIR was approved without adequate mitigation measures for impacts to burrowing owls, a local conservation group filed suit in 2014. A settlement resulted in a conservation agreement that allowed the development to go forward with mitigation in the form of purchase of 313 acres of habitat for burrowing owls on or as close as practical to the Dublin Crossing Project site. This resulted in purchase of 184 acres and a conservation easement of 129 acres of grasslands in Livermore, protecting lands that supported two known breeding pairs of owls.[9] There has been further development at Camp Parks, including modernization of a firing range in 2017, bringing significant noise and disturbance to an area of the base that formerly had 30% of known owl nesting burrows. The project was done with an EA and Finding of No Significant Impact. Breeding owls are being systematically extirpated from Camp Parks, and the breeding population is greatly diminished. In 2017, burrowing owls were documented at 27 locations but only 4 breeding pairs were detected during focused surveys, 2 at PRFTA and 2 immediately outside the perimeter fence at the adjacent Federal Correctional Institution (CEMML 2018). The 2 pairs on PRFTA and 1 of the FCI pairs reproduced successfully, with a minimum 12 young between them; the fourth breeding pair on the FCI property was unsuccessful.

Installation development at PRFTA since 2011 has resulted in the loss of valuable and preferred breeding habitat in the cantonment area, with not a single pair of burrowing owls attempting to breed in the cantonment area for the first time since owls have been recorded at PRFTA (CEMML 2018). Construction and training activities have now also occurred within 250 feet of the only 2 successful breeding burrows recorded in 2016 and 2017, threatening the future viability of these locations (CEMML 2018).

The Altamont Pass Wind Resource Area (APWRA) in eastern Alameda County emerged as the site of a key population of burrowing owls in California. Numbers of burrowing owls in the APWRA are substantial, and productivity is high. There is likely also considerable movement of burrowing owls through the APWRA between the Bay Area and the Central Valley. Smallwood et al. (2013) estimated 537 breeding pairs of burrowing owls in the APWRA in 2011. Smallwood

minimum of 40 nestlings, minimum reproduction of 2.86 young/pair or 1.43 young/adult. In 2011 they estimated that 34 adult owls nested at 17 locations, with a minimum of 80 nestlings, and minimum reproduction of 4.71 young/pair or 2.29 young/adult. In all years they observed numerous owls during the non-breeding season at some of the same locations as during the breeding season, as well as at non-nesting locations.

[9] Two mitigation parcels were acquired using these funds, one a 129 acre conservation easement on the Two Sisters Ranch in Patterson Pass that was known to have one owl pair; owl boxes were supposed to be installed, and an owl management plan implemented by Wildlife Heritage Foundation, but the security for the endowment was in question. At the second site, 184 acres was purchased by at Doolan Canyon by City of Livermore, with one known owl pair, and the possibility of enhancing owl habitat.

detected evidence of a population cycle, but also a recent overall 45% decline in abundance. Colonies of California ground squirrels, which construct burrows in which most burrowing owl nests were attempted in the APWRA, declined in spatial extent from 821.9 ha to 294.4 ha (64%) between 2011 and 2019 among 43 sampling plots where Smallwood was able to map squirrel distribution. Among the 43 plots that were comparable between 2011 and 2019, ground squirrels in 2011 covered 35% of the land area, mostly over the lower 50% of slopes; but by 2019, ground squirrels only covered 12% of the land area. Smallwood (2023a) mapped 800 burrowing owl nest sites from 2011-2019 and estimated 537 nest attempts through May of 2011, or 3.201 nest attempts/km^2. During more recent surveys, compared to the peak years of 2011 and 2012, the peak years of 2018 and 2019 averaged a 29% decline in successful burrowing owl nests and a 49% decline in nest attempts (Smallwood 2023a). Across much of the APWRA, the use of anti-coagulant poisons has substantially reduced ground squirrel populations and hence burrowing owls, and ongoing and significant wind turbine collisions with owls have exacerbated the problem. Over Smallwood's last 10 years of research in the Altamont Pass, burrowing owls declined 45% across eastern Alameda and Contra Costa counties, coinciding with a 63% retraction of the geographic extent of ground squirrel colonies (Smallwood 2023a).

The CNDDB only has a handful of recent (2015-2020) reports of small numbers of burrowing owls during breeding season in Eastern Alameda County: 2 adults near Altamont Landfill March 2015; 1 breeding pair April 2015 at an abandoned golf course in Altamont Pass (purchased as mitigation for Los Vaqueros Reservoir); 3 pairs plus a single adult July 2016 at Cottonwood Canyon NW of Livermore; 1 adult at Las Positas College in Livermore March 2017; 5 adults at Las Positas College August 2018; 1 adult with a nestling May 2017 near Bethany Reservoir; 2 adults with 2 juveniles July 2017 near Bethany Reservoir; 1 pair with 3 young of year July 2016 near Bethany Reservoir (1 of these adults later found dead near wind turbines in 2018); 1 pair Jan-April 2016 4 miles ENE of Livermore; 1 adult March 2018 at Eagle Ridge Preserve; and several February sightings of individual owls near Calaveras Reservoir and Ohlone Wilderness, with no evidence of breeding. A search of recent (2015-2023) eBird records in eastern Alameda County during the breeding season indicates breeding owl colonies remain at: a few locations in rapidly urbanizing portions of Dublin; a few locations in North Livermore near Springtown Preserve; Altamont Pass; and Patterson Pass.

San Joaquin County

Historical records confirmed breeding at Waterloo and near Stockton in 1882, near Lathrop in 1896; and indicated probable breeding in the San Joaquin Valley in 1905, at Tracy in 1911, and at Holt in 1930 (Ray 1906; MVZ 2001; WFVZ 2002; CAS 2002a). In the Stockton area, known populations consisting of at least 17 pairs had dwindled to no more than 3 pairs from 1968-1978 (Remsen 1978). Burrowing owl colonies were reported in the 1980s at the Stockton Oxidation Ponds near Thornton, near the California Youth Authority facility southeast of Stockton, along Duck Creek northeast of Farmington, and just south-southeast of Mountain House (Richmond 1985; CNDDB 2001). As of 2001 a large breeding population remained in the vicinity of Tracy; 41 adults were seen at a colony in southwest Tracy in August 1998 (CNDDB 2001). Relatively large breeding colonies were found throughout southern Stockton, at the San Joaquin County Fairgrounds (15+ pairs in 1993), Moss Tract (7 adults in 1998), Walker Slough-French Camp Slough (6 adults and 6 juveniles in 1998), Stockton Metro Airport (4 adults and 6 juveniles in 1999), Stockton Railroad Yard, and Sharpe Depot (4 pairs in 1993, 8 pairs in 1997, 4 pairs in 1998, 7 pairs in 1999, and 13 pairs with 55 young in 2001) (CNDDB 2001). Observations indicated probable breeding in southwestern San Joaquin County south of I-580 (CNDDB 2001).

Wilkerson and Siegel (2010) located substantial concentrations of owls (>70 pairs) during 2006-2007 breeding season surveys in lowland areas of San Joaquin County.

The CNDDB has only two reports since 2015 of burrowing owls during breeding season in San Joaquin County: one adult April 2017 at Weston Ranch; and a small population at Sharpe Depot in Lathrop. The Sharpe Depot owl population has been monitored annually since 1997, when there were 8 pairs with 14 fledglings. Artificial burrows were installed in 1999 to mitigate for habitat loss from construction. The adult burrowing owl population at Sharpe Army Depot has shown considerable annual variation. The population has ranged from lows of 16 adults in 1997–1999 to a high of 43 adults in 2004, followed by a decline to between 30 and 34 adults since 2007 (Albion Environmental 2022). The Sharpe Depot colony suffered a sharp decline after 2013, and only 4 pairs with 12 young were observed in 2016; the last few years the population has shown a dramatic drop in numbers with no successful breeding owls on site from 2018-2022 (Albion Environmental 2022).

A search of recent (2015-2023) eBird records in San Joaquin County during the breeding season indicates breeding owl colonies remain at: one location in southwestern Lathrop; a handful of locations in urban Tracy; and areas outside of Tracy such as the Tracy Water Treatment Plant and agricultural fields east of Tracy.

Stanislaus County

Historical records confirmed breeding in 1928 in the Del Puerto Canyon area, on the San Joaquin side of the Mount Hamilton Range, and indicated probable breeding there in 1957 (Fowler 1931; MVZ 2001). Beedy and Granholm (1985) reported that burrowing owls could be found in the foothills west of Yosemite National Park, for example, northeast of Waterford in Stanislaus County. Records indicated probable breeding east of Oakdale, along Highway 120, in 1990 (SBMNH 2001).

Wilkerson and Siegel (2010) located only 2 pairs of owls during 2006-2007 breeding season surveys in Stanislaus County.

There are no recent (2015-2023) observations of breeding owl pairs in Stanislaus County in the CNDDB. There are only a few recent (2015-2023) observations in eBird that indicate remaining breeding owls in Stanislaus County, all in the eastern portion of the county, between Roberts Ferry, Cooperstown, and Knights Ferry (up to 13 owls on Crabtree Road, 1-3 birds along Willms Road, and 1-3 birds along Rock River Road). All other breeding season sightings have been of single owls, including in the vicinity of Woodward Reservoir Park, and in western Stanislaus County in Del Puerto Canyon and at Vivian Road/Fulkerth Road wetlands (some of which may have been lingering wintering birds).

Merced County

Historical records confirmed breeding near Dos Palos in 1923, at Los Banos in 1898, 1932, and 1933; and indicated probable breeding at Los Banos in 1903, at Snelling in 1925, and at Merced in 1908 and 1941 (Dawson 1923; AMNH 2001; MVZ 2001; UCLA 2001; WFVZ 2001). Egg collector D. De Groot noted “many burrowing owls” in the vicinity of a nest he raided at Los Banos in 1932 (WFVZ 2001). There was a large resident burrowing owl population at the San Luis National Wildlife Refuge, near Los Banos, in the 1970s and 1980s (Stebbins and Taylor 1973; Richmond 1985); the 1978 population at the refuge was estimated at 25 pairs (Remsen 1978). Although no systematic surveys were done, there was apparently still a “healthy” owl population at this refuge in the early 2000s, with observations of up to 26 owls in one hour (D. Warren, pers. comm., 2002). Observations confirmed breeding colonies in the vicinity of Los Banos Reservoir (many of these sites were threatened by the proposed Los Banos Grandes Reservoir), and indicated probable breeding along the Hwy. I-5 corridor around San Luis Reservoir, the vicinity of Merced (now eliminated by the U.C. Merced campus), and in northeastern Merced County near Kelsey Reservoir (CNDDB 2001).

Wilkerson and Siegel (2010) located only 1 pair of owls in lowland survey blocks and 0 owls in upland blocks during 2006-2007 breeding season surveys in Merced County.

There are only two recent (2015-2023) observations of owls during breeding season in Merced County in the CNDDB, both in 2016 at two locations off Highway 99 near Sandy Mush Road: 1 adult NW February 2016 of Chowchilla; and 2 adults and 2 active burrows Feb-March 2016. A search of eBird records in Merced County for the last decade shows no observations of burrowing owls at or near Los Banos Reservoir, San Luis Reservoir, or Kelsey Reservoir. Small numbers of owls have been reported 2015-2023 on eBird in areas of western Merced County (such as Los Banos Wildlife Area, San Luis NWR, Merced NWR, and Kesterson Unit), but they have been primarily single birds in February or early March, and may represent lingering wintering birds. There is no recent evidence of summering or breeding owls at U.C. Merced from 2013-2023. The Merced Vernal Pools and Grassland Reserve northeast of the campus seems to be the only confirmed remaining breeding colony in Stanislaus County, with 1-5 owls reported during breeding seasons from 2015-2018.

El Dorado County

Burrowing owls had been recorded historically from near Latrobe (Barlow 1901).

Wilkerson and Siegel (2010) located 0 owls during 2006-2007 breeding season surveys in upland blocks of western El Dorado County.

There are only a handful of recent (2015-2023) breeding season reports of burrowing owls in El Dorado County, in the vicinity of Folsom Lake and White Rock in the western portion of the county. All reports are of single birds in February or early March, likely representing lingering wintering birds. There are no recent (2015-2023) observations of breeding owl pairs in El Dorado County in the CNDDB.

Amador County

Historical records indicated probable breeding in Amador County in 1896 (CAS 2002a).

Wilkerson and Siegel (2010) located 0 owls during 2006-2007 breeding season surveys in upland blocks of Amador County.

There has only been one recent (2015-2023) eBird report of burrowing owl in Amador County during breeding season, a March 6, 2016 observation of a single owl at Papoose Pond near Camanche Village, likely representing a lingering wintering bird. There are no recent (2015-2023) observations of breeding owl pairs in Amador County in the CNDDB.

Calaveras County

Historical breeding season observations in Calaveras County could not be located. Burrowing owls were observed along the lower Mokelumne River in Calaveras/San Joaquin Counties (EBMUD 2001), but it is unclear whether these were during breeding season.

Wilkerson and Siegel (2010) located 0 owls during 2006-2007 breeding season surveys in upland blocks of Calaveras County.

There have been only a handful of recent (2015-2023) eBird observations during breeding season in Calaveras County, in the western portion of the county near Salt Springs Valley Reservoir and New Melones Lake. These were of 1-2 owls during February or early March, with no evidence of breeding and likely representing lingering wintering birds. There are no recent (2015-2023) observations of breeding owl pairs in Calaveras County in the CNDDB.

Tuolumne County

Historical breeding season observations in Tuolumne County could not be located, other than a report by Beedy and Granholm (1985) that burrowing owls could be found in the foothills along Hwy. 120, west of Chinese Camp.

Wilkerson and Siegel (2010) located 0 owls during 2006-2007 breeding season surveys in upland blocks of Tuolumne County.

There have been only a handful of recent (2015-2023) eBird observations during breeding season in Tuolumne County, in the western portion of the county near Tuttleton Recreation Area and west of Red Hills Recreation Area. These were of 1-2 owls during February or early March, with no evidence of breeding and likely representing lingering wintering birds. There are no recent (2015-2023) observations of breeding owl pairs in Tuolumne County in the CNDDB.

Mariposa County

Historical records indicated probable breeding owls east of Merced in 1941 (MVZ 2001).

There have been only a handful of recent (2015-2023) eBird observations during breeding season in Mariposa County, NW of Eastman Lake Recreation Area. These were of 1-2 owls during February or early March, with no evidence of breeding and likely representing lingering wintering birds. There are no recent (2015-2023) observations of breeding owl pairs in Mariposa County in the CNDDB.

Southern Central Valley

The range of the burrowing owl in the southern Central Valley encompasses the western 70% of Madera County; the southeastern 25% of San Benito County; the western 80% of Fresno County; all of Kings County; the western 50% of Tulare County; and the northwestern 55% of Kern County (DeSante et al. 1996).

Although there are historical records of confirmed breeding in almost every county in the southern Central Valley, there are little data on overall historical abundance of the burrowing owl in this area. However, the species was documented to have been locally abundant at a number of locations such as at Fresno in the early 1900s (Miller 1903; Tyler 1913a), in the Kettleman Hills in the 1940s (Wilson 1945), and at Tulare Lake in the early 1900s (Goldman 1908).

DeSante and Ruhlen (1995) found 278 pairs and estimated that 1,396 breeding pairs of owls remained in the southern Central Valley in the mid-1990s, about 15.1% of the state breeding population. In contrast to most regions, a substantial number of these pairs (396 pairs) were estimated to live in uplands, although owls were primarily concentrated in low-lying agricultural areas surrounding the mostly dry lake basins, such as the Tulare Lake Basin in Tulare and Kern Counties. Some numbers still existed in remaining grasslands, which are in uplands. Only 14% of the remaining breeding sites were found within 15 meters of irrigation canals (DeSante et al. 1996).

Conservation lands acquired for San Joaquin Valley threatened and endangered species such as the San Joaquin kit fox may provide habitat for burrowing owls in the southern Central Valley (CDFG 2003).

In 2003, Roberts and Garber (2007) revisited 35 of the sites in the southern Central Valley where DeSante and Ruhlen (1995) documented breeding burrowing owl occurrence and that also had burrowing owls recorded in the California Natural Diversity Database (CNDDB) from 1989-1993. Roberts and Garber (2007) reviewed habitat description, land ownership, and reported threats to owls from the CNDDB at these sites. Roberts and Garber (2007) classified owl habitat suitability and described habitat alterations at these 35 sites. Five sites (15%) had been visibly altered in ways that would negatively affect burrowing owl occupancy, such as complete conversion to a vineyard or agricultural encroachment. Of the 23 sites in public ownership, 2 (9%) were altered, as opposed to 3 of 12 (25%) of privately owned sites with negative habitat alterations. Roberts and Garber (2007) also reviewed North American Breeding Bird Survey route data from 1968-2001 in the San Joaquin Valley, with the data suggesting a downward trend of number of burrowing owls observed per route over time. Anecdotal information from CDFG regional biologists and owl researchers indicated that the overall burrowing owl population in the southern Central Valley region at that time (2003) appeared to be relatively stable or had an unknown trend (Roberts and Garber 2007).

However, by the time of the 2006-2007 statewide surveys by Wilkerson and Siegel (2010), the burrowing owl population in the southern Central Valley region was estimated at 1,113 pairs, 20% fewer than in the 1990s study. Two areas seemed to have undergone substantial, concentrated losses since the previous study; these included six study blocks in western Bakersfield where 53 breeding pairs were lost, and agricultural land west of Rosedale and south Shafter where 42 pairs were lost on three survey blocks (Wilkerson and Siegel 2010). The area near Bakersfield underwent substantial urban land conversion between 1992 and 2001 (Wilkerson and Siegel 2010).

Wildlife biologist Chris Conard states that significant declines of breeding burrowing owls have continued in the San Joaquin Valley, with the species going from locally common to sporadic (Conrad 2023).

Madera County

Historical records confirmed breeding near Madera in 1917 and 1920, and at Chowchilla in 1900; and indicated probable breeding at Madera in 1939 (CAS 2002a). There was one breeding season observation northwest of Friant in 2000 (CNDDB 2001).

Wilkerson and Siegel (2010) located 12 pairs of owls during 2006-2007 breeding season surveys in Madera County. A search of recent (2015-2023) eBird reports in Madera County during breeding season reveals only small numbers of owls (maximum of 4) at a few locations in the vicinity of Daulton, and single birds reported along canals north of Freson and at the Madera Water Treatment Plant. There are no recent (2015-2023) observations of breeding owl pairs in Madera County in the CNDDB.

Southeastern San Benito County

In 2001, Sam Fitton reported burrowing owls to be resident in small numbers in Panoche Valley (D. Cooper, pers. comm., 2002).

Wilkerson and Siegel (2010) located 0 pairs of owls during 2006-2007 breeding season surveys in southeastern San Benito County.

There are no recent (2015-2023) observations of breeding owl pairs in southeastern San Benito County in the CNDDB. A search of eBird records for burrowing owls in southeastern San Benito County during the breeding season from 2021-2023 shows small numbers (1-3 owls) at several locations in Panoche Valley (New Idria Road, Griswold Hills, and Little Panoche Road).

Fresno County

Historical records confirmed breeding near Wheatville in 1907, around Fresno in 1912 and 1913, near Monmouth in 1917, near Selma in 1917, near Cantua Creek in 1917, near Firebaugh in 1919, and at Kettleman Hills in 1944; and indicated probable breeding at Fresno and Visalia in the 1920s and near Cantua Creek in 1940 (Tyler 1913b; Storer 1926; Wilson 1945; WFVZ 2001; CAS 2002a).

As early as 1903, Miller (1903) reported that the burrowing owl, “one of the most prevalent species formerly” in the Fresno area “is now becoming extinct wherever the country is thoroughly cultivated.” Tyler (1913a) remarked that although burrowing owls could be heard throughout most of the Fresno region around the turn of the century, “civilization, cultivation, and squirrel extermination have now crowded these little owls farther and farther out to the edges of the Fresno District, to the west side plains and a few other unsettled areas.” Tyler noted that a few owls could be found within cultivated areas, where they nested in waste fields and along roadsides, “but their numbers are limited and it seems only a matter of a few more years until we will be unable to number the Burrowing Owl among the birds of the Fresno District.” Wilson (1945), who listed the species as a “fairly common resident” of the Kettleman Hills, observed owls occasionally during the year in the hills or on the flats and confirmed breeding there in 1944. By the 1970s, burrowing owl numbers were further decreasing in the Fresno area (Remsen 1978). The population at the federally protected Mendota Wildlife Area was estimated at 30 pairs in 1978 (Remsen 1978).

By 2001 very few burrowing owls were known to breed within the Mendota Wildlife Area, but observations indicated confirmed breeding along the San Luis Drain, northwest of the Mendota Wildlife Area, in 1987 and 1989; and probable breeding near Monocline Ridge in 1994 and near Huron in 2001; a population of at least 80 pairs nested in 2002 within cracked concrete along the San Luis Drain for a three-mile stretch adjacent to the western boundary of the Wildlife Area (CNDDB 2001; R. Huddleston, CDFG, pers. comm., 2002).

Wilkerson and Siegel (2010) located 21 pairs of owls during 2006-2007 breeding season surveys in Fresno County.

There are 7 recent (2015-2023) observations of burrowing owls during breeding season in Fresno County in the CNDDB: up to 3 pairs April-July 2015 along Outside Canal S of Dos Palos; 5 adults at separate burrows March and April 2016 along the California Aqueduct near Mt. Whitney Ave.; 1 pair with 5 young June 2016 SSE of Kerman; 7 adults with 0 juveniles in 2015, and 6 adults with 7 juveniles in June 2016 near Helm Substation; 2 pairs with 8 young June 2016 near McMullin Grade Road, SSE of Kerman; 2 adults and 3 juveniles July 2016 along the California Aqueduct, 13 miles SW of Helm; and 1 adult May 2017 near Highway 33 at W Firestone Ave. A review of recent (2015-2023) eBird reports during breeding season in Fresno County found no large breeding colonies in the county. Small numbers of owls (mostly 1-4 birds) were found in Panoche Valley, Little Panoche Valley, and the vicinity of Mercey Hot Springs; some of these locales are threatened by proposed solar development. Other breeding locations were near Firebaugh and Mendota, SW of Fresno at the Water Treatment Plant, and along the California Aqueduct N of Hwy 145.

Kings County

Historical records indicated probable breeding at Hanford in 1882 (CAS 2002a). Goldman (1908) found the burrowing owl “abundant” in the region of Tulare Lake in the summer of 1907. CNDDB observations indicated probable breeding at several locations in the Kettleman Hills in 1996 and 2001, in northeastern Kings County near Visalia in 1999, and in the Tulare Lakebed area in 2001 (CNDDB 2001). At least 5-10 owl pairs were observed from 2001-2002 in the general vicinity of Corcoran along Tulare Lake Drainage District canals and evaporation basin ponds (N. Brown, pers. comm., 2002).

A significant regional owl population was at Lemoore Naval Air Station (“NAS”), where owls nested in established wildlife areas, runway buffer strips, and adjacent to runways. Approximately 14,000 of 18,784 total acres of land at Lemoore NAS was allocated to agriculture, primarily cotton. NAS Lemoore had supported a large number of owls in part due to the agricultural activities while ensuring safe areas for nesting. Rosenberg et al. (1998) estimated there to be 1,070 acres of burrowing owl nesting habitat at Lemoore NAS, and from that estimate recommended a management goal of 72 adult pairs. The number of active burrowing owl nests at Lemoore NAS from 1997 to 2000 fluctuated from 54 to 85 pairs (1999) (Rosenberg and DeSante 1997; Rosenberg et al. 1998a, 1998b); 43 active nests were located during a survey in 2008 (Rosenberg and Gervais 2009). An updated management plan for Lemoore NAS (Rosenberg and Gervais 2009) continued mowing operations, prescribed burning, and the avoidance of discing grasslands to maintain the relatively large owl population. In 2008, installed nest boxes were in disrepair, so the maintenance of the owl population depended on maintaining ground squirrels, whose population fluctuates (Rosenberg and Gervais 2009). Anticipated changes at NAS Lemoore that could lower nesting densities of burrowing owls were loss of irrigation water from Westlands Water District, which was anticipated to result in a major changes in crop type and vegetative productivity and fallowing of fields.

Smallwood reported a 50% decline of burrowing owls at Lemoore NAS from 1999-2008, when the Naval Air Station displaced this regionally significant burrowing owl population from ground squirrel burrows to offsite nest boxes (S. Smallwood pers. comm., 2010). The burrowing owl population at Lemoore peaked at 87 owls in 1999, then declined by 50 to only 37 owls through 2013; although ≥13 nest boxes were occupied in 2000, none were occupied 2003-2013 (S.

Smallwood, pers. comm. 2019). The owl decline was due to cessation of vegetation management, declines in ground squirrel abundance caused by drought, loss of nest site capacity that had been briefly generated artificially by the installation of at least 47 nest boxes that were then allowed to be damaged, destroyed, or obliterated, and efforts on the airfield to eradicate ground squirrels and evict burrowing owls (S. Smallwood, pers. comm. 2019).

Wilkerson and Siegel (2010) reported a sparse distribution and located 7 pairs of owls during 2006-2007 breeding season surveys in Kings County.

There are 5 recent (2015-2023) observations of burrowing owls during breeding season in Kings County in the CNDDB: 1 adult and 1 juvenile June 2016 at Angiola Substation, 7 miles S of Corcoran; 1 nesting pair observed throughout the 2016 breeding season with 2 juveniles present by mid-July, 3.2 miles W of Stratford; 1 nesting pair in 2016 with 2 juveniles present by mid-July, 3.7 miles WNW of Stratford; 2 owls at separate burrows on 6 March 2016, and 6 occupied burrows December 2016 through March 2017, 12 miles NW of Visalia; and 1 adult on 6 March 2016, and 4 occupied burrows from December 2016 through March 2017, NW of Visalia. A review of recent (2015-2023) eBird reports during breeding season in Kings County documents significant breeding colonies along rural roads and canals in Tulare Lake south and west of Corcoran; and smaller numbers of owls in Acebedo, Lost Hills, Tar Canyon SW of Avenal, and Lemoore Station.

Tulare County

Historical records confirmed breeding on the valley floor at Tulare in 1894 and at Tipton in 1936; and indicated probable breeding at Visalia in 1880, at Earlimart in 1903, and at Tipton in 1911 (MVZ 2001; NMNH 2001; WFVZ 2001). Burrowing owls had not been seen in Sequoia National Park since Fry observed them there in 1911 according to Dixon (1933). A former population of several pairs at Shepherd's Cove, on the north side of the Kaweah River, was gone by 1937 (USNPS 1937; Sumner and Dixon 1953). Beedy and Granholm (1985) noted a collection record from Ash Mountain, in Sequoia National Park. During the decade from 1968-1978, there was an estimated 70% reduction in burrowing owl habitat in Tulare County (Remsen 1978). Beedy and Granholm (1985) reported declines in Tulare County, but noted that burrowing owls were still fairly common in scattered localities in the lower foothills in the 1980s. There was confirmed breeding at Pixley in 1998 (Rosenberg et al. 1998a) and CNDDB observations indicated probable breeding at two locations northwest of Visalia in 1990 and 1998, and west of Earlimart in 1990 (CNDDB 2001). There were several breeding pairs at a site in Alpaugh and 3 owls at the Hebert Preserve that appeared to be resident birds (K. Kreitin, pers. comm., 2002). R. Hansen reported that the James K. Herbert Wetland Prairie Preserve, near Highway 137 and Road 168 (owned and managed by Los Tulares Land Trust) had at least 5 known burrowing owl nests, as well as at least 3 wintering owls (N. Brown, pers. comm., 2002).

A colony of owls at Colonel Allensworth State Historic Park ("CASHP") consisted of 14 breeding pairs in 2002 (Van Mantgem 2002), a significant decline from 23 pairs in 1999 (N. Brown, pers. comm., 2002). Reconstruction of historic buildings at this park in areas of occupied burrows and foraging habitat resulted in burrows being closed (N. Brown, pers. comm., 2002). At least 1 owl pair nested just north of CASHP along Highway 43 in 2000 (N. Brown, pers. comm., 2002); and 12 nesting pairs were found ½ km south of the park in 2003 (Koshear et al. 2007), but it is unclear whether these were displaced owls. Koshear et al. (2007) reported that CASHP had supported a breeding population of 10-20 pairs of owls for at least 25 years, probably longer. The reconstruction of historic buildings included a "carefully crafted" mitigation plan (including passive relocation and exclusion using one-way doors, and closing of burrows; mowing to create 0.1 ha of additional habitat, and providing 7 artificial burrows), but four years of regular disturbance from construction and park events caused a significant decline in the number of breeding pairs despite owls using the artificial burrows and the mowed mitigation area for nesting (Koshear et al. 2007). Surveys documented the decline of the CASHP breeding owl population from 20 pairs in 2000 to 11 pairs in 2003 (Koshear et al. 2007). A review of eBird data shows only 13 observations of burrowing owls at CASHP during breeding season from 2006-2011, with a maximum of 6 owls in 2006 and 2016; and observations in 2016 and 2017 of 14, and 3 owls, respectively, just south of the park.

Wilkerson and Siegel (2010) found substantial concentrations of owls (>55 pairs) during 2006-2007 breeding season surveys in Tulare County, especially in lowland survey blocks.

There are only 2 recent (2015-2023) observations of burrowing owls during breeding season in Tulare County in the CNDDB, occupied burrows observed during branchiopod surveys December 2016 through March 2017, at two locations NW of Goshen. A review of recent (2015-2023) eBird reports during breeding season in Tulare County documents significant breeding colonies along rural roads and canals off of Hwy 43, near Pixley National Wildlife Refuge, Allensworth, Alpaugh, and Angiola; also at Herbert Prairie Wetland Preserve E of Tulare, Caldwell Ave. Ponds S of Goshen, and Toledo Pits west of Tipton.

Kern County

The burrowing owl is known to have occurred historically near Buena Vista Lake, although it was “not common” there in the summer of 1907 (Linton 1908b; DeMay 1942). Sheldon (1909) reported the species to be “common” south of Poso Creek during the summer of 1908. Historical records confirmed breeding at Semi Tropic in 1917, at Tejon Ranch in 1941, at Grapevine in 1962, and in Antelope Valley in 1964; and indicated probable breeding at Walker Pass in 1891, and at Weldon in 1911 and 1984 (Wheeler et al. 1941; CSUC 2001; MSB 2001; MVZ 2001; NMNH 2001; UCSB 2001; WFVZ 2001). The California State University at Bakersfield campus had a small plot (40 acres) with burrowing owls: 23 owls were captured in 17 trapping sessions in July 1987 (Barrentine and Ewing 1988). There were observations of owls during breeding season throughout Kern County; breeding documented at the Kern National Wildlife Refuge in 1987, in the vicinity of the Tule Elk State Reserve in 1989 and 1990, near the Antelope Plain in 1994, along the California Aqueduct in the vicinity of Buena Vista Lakebed in 1998 and 1999, and in the vicinity of Grapevine in 2001 (CNDDB 2001).

Wilkerson and Siegel (2010) found substantial concentrations of owls (>130 pairs) during 2006-2007 breeding season surveys in Kern County, especially in lowland survey blocks.

The CNDDB only has half a dozen recent (2015-2018) observations of burrowing owls during breeding season in Kern County, with observations of 12 adults and 5 young, representing 5-6 breeding pairs. A review of recent (2015-2023) eBird reports during breeding season in Kern County reveals that the most significant remaining breeding colonies in the county are on Kern Ranch, private property that could be subject to massive development. There are significant numbers of owls at Wind Wolves Preserve, Kern Water Bank W of Bakersfield, and the Bakersfield Water Treatment Plant.

San Francisco Bay Area

The range of the burrowing owl in the San Francisco Bay Area encompasses all of Sonoma, Napa, and Marin Counties; the southwestern 5% of Solano County; the western 50% of Contra

Costa County; the western 80% of Alameda County; and all of San Francisco, San Mateo, Santa Clara, and Santa Cruz Counties (DeSante et al. 1996).

Although there are historical records of confirmed breeding in every county in the San Francisco Bay Area, there are little data on the overall historical abundance of the burrowing owl in this area. The burrowing owl was historically most numerous in the region in parts of Alameda, Contra Costa, and Santa Clara counties (Grinnell and Wythe 1927). The species was documented to have been locally abundant in southwestern Solano County (at Benicia) in the 1920s and 1930s (WFVZ 2001), in Alameda County (at Newark) in the early 1900s (WFVZ 2001), at the Oakland Airport in the 1960s (Thomsen 1971), in San Mateo County (Redwood City) in the 1800s (WFVZ 2001), in Santa Clara County (Palo Alto) in the early 1900s (WFVZ 2001), and in Santa Cruz County in the 1800s and early 1900s (Skirm 1884; McGregor 1901).

DeSante and Ruhlen (1995) found 165 pairs and estimated that only 165 pairs of owls remained in the entire San Francisco Bay Area (interior and coastal) in the mid-1990s, about 1.8% of the state breeding population. This likely represented a decline of about 53% from the period 1986-1990 (DeSante and Ruhlen 1995; DeSante et al. 1997). Over 65% of Bay Area owl colonies known in the 1980s were gone by the 1990s, and even when new groups located during the 1990s were included, there was still a 51% decline in colonies (DeSante and Ruhlen 1995). DeSante and Ruhlen (1995) found 0 pairs in the coastal areas of the San Francisco Bay Area. Except for a few pairs in the Livermore Valley and a population at Camp Parks in Dublin, virtually all the remaining owls were located in a crescent extending around the southern end of San Francisco Bay, from Palo Alto to Milpitas, north of Highway 101. Almost all were located in parks or in developed urban settings. Breeding owls had been extirpated from Napa, Marin, San Francisco, and Santa Cruz Counties, and nearly eliminated from Sonoma and San Mateo counties (DeSante and Ruhlen 1995). No breeding pairs had been observed on the Bay Area coast, despite the fact that small populations existed in the 1980s. Burrowing owl populations around the north end of San Francisco, San Pablo, and Suisun Bays had been reduced to remnants or extirpated.

Townsend and Lenihan (2007) used historical information, published and unpublished technical reports, CNDDB records, personal information, interviews with knowledgeable biologists, consultants, land managers, and Audubon chapters to estimate burrowing owl breeding population estimates and trends for the San Francisco Bay Area. Townsend and Lenihan (2007) confirmed that historically burrowing owls were most abundant in Alameda, Contra Costa and Santa Clara counties, with local abundance in portions of Solano and San Mateo counties. Burrowing owls were neither widespread nor historically abundant in Napa, Marin or San Francisco counties. Townsend and Lenihan (2007) confirmed that breeding burrowing owls were extirpated from Napa, Marin, San Francisco and Santa Cruz counties, and likely extirpated from San Mateo and southwestern Solano counties. Breeding owls were also near extirpation in western Contra Costa, western Alameda, and Santa Clara counties. Townsend and Lenihan (2007) noted numerous threats to burrowing owls in the Bay Area including habitat loss, eviction methods (both passive and active), inadequate replacement acreage for mitigation, pest management, and California ground squirrel poisoning. Townsend and Lenihan (2007) searched for updated information on areas for which the status of breeding owls was listed as unknown in the 2003 listing petition (CBD et al. 2003). They estimated at least 6 pairs in western Alameda County; but could find no records for western Contra Costa County and assumed they were extirpated; and estimated 101 pairs in Santa Clara County. No burrowing owls nested on east San Francisco Bay shoreline properties of the East Bay Regional Park District in 2023 (D. Bell, pers. comm., 2024).

Wilkerson and Siegel (2010) resurveyed owl habitats covered by DeSante and Ruhlen (1995), during the 2006-2007 breeding season, and documented a 28% reduction from the 1990s study, with an estimate of only 119 breeding pairs remaining in the Bay Area region. All of the burrowing owls detected were in Alameda or Santa Clara counties. The San Francisco Bay area coast was not surveyed by Wilkerson and Siegel (2010) because the species was known to be extirpated. Burrowing owl populations around the north end of San Francisco, San Pablo, and Suisun Bays had been reduced to remnants or extirpated (Wilkerson and Siegel 2010).

Sonoma County

Historical records confirmed breeding at Cotati in 1900, at Santa Rosa in 1901, at Stony Point in 1913, and near Petaluma in 1939; and indicated probable breeding at Petaluma and at Freestone in 1870, at Cotati in 1898 and 1900, and at Napa and Santa Rosa in the 1920s (Storer 1926; Grinnell and Wythe 1927; FMNH 2001; MVZ 2001; PMNH 2001; WFVZ 2001; CAS 2002a). By the 1970s, when a steady decline in numbers had been reported in Sonoma County for decades, Remsen (1978) considered the burrowing owl to be an uncommon permanent resident in the open areas of the county, becoming numerous and more widespread in winter (Bolander and Parmeter 1978). Breeding owls were nearly extirpated from Sonoma County by 1987 (Burridge 1995). An extensive survey begun in 1991 (DeSante and Ruhlen 1995) confirmed that perhaps only one or two breeding pairs remained in the early 1990s. The last confirmed breeding in the county was at Skaggs Island in 1986 (Burridge 1995).

Townsend and Lenihan (2007) reported that breeding owls appeared to be extirpated from Sonoma County.

Napa County

There are several historical non-breeding season records from Napa County, but no records of burrowing owls in northern Napa County since 1963 (Fisher 1900; Grinnell and Wythe 1927; Remsen 1978; MVZ 2001).

Breeding burrowing owls have been extirpated from Napa County since the 1980s (DeSante and Ruhlen 1995), confirmed by Townsend and Lenihan (2007).

Marin County

Mailliard (1900) as well as Stephens and Pringle (1933) noted the burrowing owl to be a year-round resident in limited areas of Marin County. Historical records indicated probable breeding at Nicasio in 1879 (CAS 2002a). The owl was still a “relatively common resident” of open fields around Tomales Bay in 1971 (R. Johnson et al. 1971). Although there were several non-breeding season observations in the 1980s, the last evidence of breeding birds was at Terra Linda in 1976 and 1977, by which time the species was considered to be a very rare, very local breeder, with a very small overall breeding population (Shuford 1993; CNDDB 2001).

Breeding owls have been completely extirpated from Marin County since the 1980s (DeSante and Ruhlen 1995), confirmed by Townsend and Lenihan (2007).

Southwestern Solano County

Burrowing owls were apparently quite abundant at and near Benicia in the 1920s and 1930s; breeding owls were documented at Benicia before 1922, in 1927, 1930, 1932, 1933, and 1936

(Stoner 1922, 1932a, 1932b, 1933a; WFVZ 2001). Burrowing owl nests were abundant enough that multiple sets of eggs were collected at Benicia; 7 sets on a single day in 1927, 4 sets over 3 days in 1930, 7 sets on a single day in 1932, and 5 sets on a single day in 1933 (WFVZ 2001). There were non-breeding season observations made northeast of Vallejo in the late 1970s and early 1980s (CNDDB 2001).

Townsend and Lenihan (2007) reported that breeding burrowing owls were likely extirpated from southwestern Solano County. Wilkerson and Siegel (2010) located 0 pairs of owls in southwestern Solano County.

Recent breeding season observations in southwestern Solano County could not be located and there were no recent (2015-2023) breeding season records on eBird.

Western Contra Costa County

Historical records indicated probable breeding at Albany in 1922 and at Richmond in 1936 (MVZ 2001).

S. Smallwood (pers. comm., 2023) found a pair of burrowing owls on Concord Weapons Station in 2005, in the hilly section south of Port Chicago. Recent breeding season observations from western Contra Costa County could not be located. Townsend and Lenihan (2007) could find no information for western Contra Costa County, and presumed the species was near extirpation.

There are no recent (2015-2023) CNDDB occurrences in western Contra Costa County. A search of recent (2015-2023) eBird records in western Contra Costa County shows a number of February and early March sightings of single owls (such as at Point Isabel, Albany Shoreline and Cesar Chavez Park), but these all represent late wintering birds, with no evidence of breeding. Breeding burrowing owls appear to have been extirpated from western Contra Costa County.

Western Alameda County

There are confirmed breeding records from Oakland in 1879 and 1881, Hayward in 1907, and numerous records in Newark from 1905 to 1914 (FMNH 2001; MVZ 2001; WFVZ 2001; CAS 2002a). Historical records indicated probable breeding in Hayward and Fremont in the 1880s, in Berkeley in 1911, in Albany in 1922, and at Livermore in 1896 (FMNH 2001; MVZ 2001; PMNH 2001). Burrowing owls were “fairly common” residents in Newark (as evidenced by large collections of eggs) through the 1950s, but suffered a “steady, marked decline” through the 1980s due to habitat loss from conversion of fields to urban and commercial development (CNDDB 2001; WFVZ 2001). Formerly large owl colonies in Alameda County along the Bay shoreline have been severely reduced in size. Thomsen (1971) found significant breeding populations remaining at the Oakland Airport and around San Leandro Bay and Bay Farm Island in the 1970s and 1980s. A large former breeding colony at Jarvis Landing in Newark in the 1970s was extirpated (CNDDB 2001).

By the early 2000s there were few nesting owls remaining along the eastern edge of San Francisco Bay, only 5-10 pairs from Newark to Fremont, and a few pairs from Hayward up to Alameda (including Don Edwards National Wildlife Refuge Warm Springs in Newark, Hayward Regional Shoreline in Hayward, Oakland Airport, and Martin Luther King Jr. Regional Shoreline in Oakland) (CNDDB 2001; L. Trulio, pers. comm., 2001, J. DiDonato, pers. comm., 2003).

The breeding owl population at the Oakland Airport studied by Thomsen (1971) from 1964 to 1966 was once “one of the largest populations of burrowing owls in the Bay Area.” The 1997 Final EIR for a late 1990s expansion of the airport noted 14 burrow sites within the airport and a burrowing owl mitigation site at the end of Earhart Road near the proposed North Field Lot parking area on Earhart Road (Port of Oakland 1997). Expansion of the airport decimated this population. There were very few birds left at the airport by 2001 (L. Trulio, pers. comm., 2001). Townsend and Lenihan (2007) knew of only 1 remaining owl pair at the airport. A further airport expansion project (construction of new terminal, aprons, parking, and associated buildings) is underway in 2023 that could impact any remaining owls (Port of Oakland 2023).

Townsend and Lenihan (2007) were able to find information about only 6 pairs of owls in western Alameda County (4 in Hayward/Fremont, 1 at Martin Luther King Shoreline, and 1 at the Oakland Airport).

The only location in the CNDDB with recent (2015-2023) observations of owls during breeding season in western Alameda County is the Don Edward NWR Warm Springs Unit, with 3 pairs and 13 juveniles in 2015, and 4 pairs and 13 nestlings in 2016. The breeding burrowing owl population at Don Edwards National Wildlife Refuge, Warm Springs Unit in Fremont was first surveyed in 2001, when there were 18 adults and young documented; and fluctuated between 7 and 64 adults observed during the breeding season from 2002-2016; it had 3 breeding pairs in 2015 and 3 successful nesting pairs in 2016 (SCVHA 2016). The Warm Springs colony peaked in 2005, when there were 111 adults and young recorded, and the high count of adults was 64 in 2008 (SCVHA 2022). The population hit an all-time low with 2 single adults in 2020; and there were no breeding adults at all from 2021-2023 (SCVHA 2022; Talon Ecological Research Group 2023, 2024; SCVHA 2024). The Warm Springs population may be extirpated. See Table 2. There were breeding owls remaining at nearby Pacific Commons Linear Park in Fremont (a maximum of 7 owls in 2015, 6 owls in 2017, but only single owls in 2018 and 2021). Most of the other recent (2015-2023) eBird records during breeding season along the east shore of the Bay in Alameda County were of single birds in February or early March, likely representing lingering wintering birds. The exceptions were: a May 2023 record of a single owl at Middle Harbor Shoreline Park in Oakland; 3-4 owls in June 2017 at Hayward Regional Shoreline; 1-4 owls from late February to mid-March in 2023 at Coyote Hills Regional Park; and 2 owls in May of 2018 at Don Edwards NWR in Newark. However, no burrowing owls nested on east San Francisco Bay shoreline properties of the East Bay Regional Park District in 2023, from Point Pinole south to at least the San Mateo Bridge (D. Bell, pers. comm., 2024).

Breeding burrowing owls seem to be nearing or at extirpation in western Alameda County.

San Francisco County

Historical records confirmed nesting in San Francisco, and indicated probable nesting on the San Francisco Peninsula in 1909 and 1915 (Ray 1916; Hansen and Squires 1917; MVZ 2001; NMNH 2001). Owls were historically observed as wanderers near Lake Merced (Grinnell and Wythe 1927), and were recorded in Golden Gate Park by Mailliard (1930). The last breeding season record from the City of San Francisco was in 1972 (MVZ 2001).

Burrowing owls historically bred on the Farallon Islands off of San Francisco. Indicative of probable breeding, Bryant (1888) recorded two birds there in the spring of 1887. Dawson (1911, 1923) found a single owl on Farallon in 1911, reporting it to be “a sole survivor, we were informed, of a former breeding colony” that had been shot off because of their persecution of smaller migrant birds. A single burrowing owl egg collected on the Farallones in spring 1911 was donated to the Point Reyes Bird Observatory in 1971 (DeSante and Ainley 1980). DeSante and Ainley (1980) presumed owls must have nested there for only a few years, since there are no other reports of breeding, although remains of owls were found on South Farallon Island in June 1958, June 1964, and May 1965 (Bowman 1961; Tenaza 1967) and single birds were collected from Southeast Island in April 1972, March 1986, and June 1988 (MVZ 2001; CAS 2002a). A small number of burrowing owls from the mainland routinely winter on South Farallon Island, arriving in late September and sometimes overwintering as late as May, but do not breed on the island (Point Blue 2010).

Breeding burrowing owls have been extirpated since the 1980s from San Francisco County (DeSante and Ruhlen 1995), confirmed by Townsend and Lenihan (2007).

San Mateo County

Historical records confirmed breeding at Redwood City in 1898 and indicated probable breeding at Menlo Park in 1906 (MVZ 2001; PMNH 2001; WFVZ 2001; CAS 2002a). Collector C. Littlejohn, who collected 2 sets of eggs at Redwood City in the summer of 1898, remarked that although owls were "very numerous" previously, the nests he found were the first seen in 25 years of looking (WFVZ 2001). Breeding owls were nearly extirpated from San Mateo County by the 1970s (Remsen 1978). Perhaps only 1 or 2 breeding owl pairs remained in San Mateo County by 2001 (DeSante and Ruhlen 1995; C. Breon, pers. comm., 2001).

Townsend and Lenihan (2007) considered breeding owls greatly diminished or absent. A search of eBird records during the 2021-2023 breeding season reveals no documentation of any breeding owls anywhere in San Mateo County.

Santa Clara County

At the turn of the century, the western burrowing owl was a common bird of Santa Clara County (Price 1898; Van Denburgh 1899; Fisher 1904). Several decades later, the species was still considered a "fairly common resident in the drier, unsettled interior parts of the region" (Grinnell and Wythe 1927); by the 1940s, burrowing owls were becoming scarce in the more settled areas due in part to ground squirrel control (Grinnell and Miller 1944).

Historical records confirmed breeding in the Santa Clara Valley in 1882, east of Los Gatos in 1890, southeast of Milpitas in 1892, in East San Jose in 1902, and near Palo Alto in 1892, 1901, 1909, 1911, and 1940 (FMNH 2001; MVZ 2001; SBMNH 2001; WFVZ 2001; CAS 2002a). There were breeding season records of owls from Milpitas in 1883, Stanford in 1893, Alviso in 1901, Stevens Creek in 1903, and Jasper Ridge at Stanford University in 1909 (MVZ 2001; CAS 2002a). Egg collector J. Snyder remarked that the species was common near Palo Alto in 1909 (WFVZ 2001). In 1927, Grinnell and Wythe wrote that the bird was still a "fairly common resident in the drier, unsettled interior parts of the [Bay Area] region," being most abundant in Alameda, Contra Costa, and Santa Clara Counties. Accounts suggest that by the late 1930s and early 1940s the species was beginning to decline in Santa Clara County. J. Snyder found burrowing owls to be "very rare" in Palo Alto by 1939, due to lack of ground squirrels to prepare the nesting burrow (WFVZ 2001). The species was noted to be further decreasing in Palo Alto in the 1970s (Remsen 1978). Hundreds of burrowing owls still nested in the Southern San Francisco Bay region when orchards and row crops in Santa Clara County began to be developed in the 1960s; estimates have suggested that there were about 1,000 nesting pairs of burrowing owls in the South Bay region in 1970 and 250 pairs in 1980 (CDFG 2003).

In Santa Clara County, detailed records of owl locations and their fate are most complete from the early 1980s onward, when the county began experiencing explosive human population growth. In 1989, the consulting firm of H.T. Harvey & Associates compiled a list of 215 sites where burrowing owls were observed between 1984 and 1988 (H.T. Harvey and Associates 1994). Many of these observations were anecdotal and many others were sites confirmed as part of on-going research or systematic owl observation. H.T. Harvey and Associates found that 97% of the sites supported fewer than 10 birds and 81% supported only 1 or 2 birds (H. T. Harvey and Associates 1994). In the summers of 1995 and 1998, Trulio (1998a) re-surveyed 123 of the 215 occupied sites identified by H. T. Harvey and Associates (1994). The sites were located in the cities of Palo Alto, Mountain View, Sunnyvale, Santa Clara, San Jose, and Alviso. Moffett Airfield and San Jose Airport, two sites not available to development, were excluded from the survey. The survey results showed a steady decline in remaining owl habitat. In 10 years, 70 of 123 sites (57%) were lost to development, an average of almost 6% per year; another 12 sites (10%) were reduced in size or habitat quality (Trulio 1998a).

From their surveys, DeSante and Ruhlen (1995) and DeSante et al. (1997) estimated that approximately 60% of known owl locations in Santa Clara County were lost between the early 1980s and 1993; with an estimated 153-167 nesting pairs remaining in the South Bay region in the early 1990s (DeSante and Ruhlen, 1995, DeSante et al. 1997. By 1997, the breeding owl population in the county had dwindled to about 120-141 pairs, distributed in a crescent around the southern San Francisco Bay, mostly in Mountain View and San Jose (J. Barclay pers. comm., 2002).

Based on a thorough survey of 50 previously known breeding locations, J. Barclay (pers. comm., 2002) estimated 43-47 owl pairs remained in San Jose in 1997 and 39-40 pairs remained in 2000. In 2002, Trulio again resurveyed 111 of the sites listed by H.T. Harvey that were located on private land. By 2002, only 27% of these 111 locations still contained suitable owl habitat; 66% had been developed completely and 7% were significantly reduced in size (L. Trulio, pers. comm, 2002). A number of large sites were not included in this survey because they were on public land and were the subject of more detailed observations. These sites, Bixby, Shoreline and Sunnyvale Baylands Parks, Moffett Federal Airfield, Mission College in Santa Clara, and the San Jose Airport, all continued to support more than 10 owls each in 2002 (J. Barclay, pers. comm., 2002). At these locations, researchers have collected specific data on the number of owls over time. These data show that the numbers of breeding owl pairs had fluctuated over the years.

At Bixby, Shoreline and Sunnyvale Baylands Parks, where little development had occurred, numbers have remained relatively stable from 1997-2002, when the owl population at Shoreline Park in Mountain View was 5 breeding pairs, up from an average of 3 pairs the previous 10 years (P. Delevoryas, pers. comm., 2002). At Moffett Airfield, which had little development, breeding owl pairs fluctuated from a high of 30 pairs to a low of 15 (Trulio 2002, amplified by pers. comm., 2002). During this period, the number of breeding pairs at Mission College declined from approximately 30 pairs (Buchanan 1996) to 9 active burrows (Trulio 2002, amplified by pers. comm., 2002); in large part due to habitat loss at Mission College to urban development.

Small colonies of owls also persisted in the 2000s in Alviso (estimated at 15 pairs), San Jose, Santa Clara, and Milpitas (CNDDB 2001; J. Barclay, pers. comm., 2002). Formerly large owl populations in the northern San Jose/Alviso area and City of Santa Clara were significantly impacted (CNDDB 2001; J. Barclay, pers. comm., 2002), and former colonies known in urban Sunnyvale in the 1980s and early 1990s had likely been extirpated (CNDDB 2001; D. Plumpton, pers. comm., 2002). Breeding owls were near extirpation from Morgan Hill as well (J. Barclay, pers. comm., 2002), with only breeding two pairs found there in 2003 (CDFG 2003).

Barclay (2007) and Barclay et al. (2011) monitored a colony of owls at San Jose International Airport from 1990–2007. Active management using passive relocation away from runway vicinities and installation of artificial burrows (113 installed from 1990-2009) reduced the occurrence of nesting owls along runways, helping avoid conflicts with aircraft and increasing the number of breeding pairs from 7 nesting pairs in 1991 to 40 pairs in 2002. However, the population declined to 17 pairs by 2007, thought to be due to increased nest predation and reduced recruitment and adult survival (Barclay et al. 2011). Since 2013, construction projects, ground squirrel eradication, and lack of active management resulted in a steady decline in the number of breeding pairs and finally no pairs in 2023.

By 2003, most of the remaining favorable potential burrowing owl habitat in Santa Clara County was threatened by urban development (CDFG 2003). Townsend and Lenihan (2007) reported on the only remaining large breeding owl populations in Santa Clara County: 31 pairs in and around Alviso in 2000; 29 pairs at San Jose Airport in 2003 (already down to 17 pairs by the time their study was published); and 41 pairs in the South Bay Study Area reported by L. Trulio.

Wilkerson and Siegel (2010) located 56 pairs of breeding burrowing owls in Santa Clara County during their 2006-2007 survey of the region, in lowland areas on two blocks in San Jose and two blocks in Mountain View covered in the DeSante 1990s study. Wilkerson and Siegel (2010) documented an additional 42% decline in Santa Clara County breeding pairs over a decade, from 97 pairs (DeSante et al. 2007) to 56 pairs. The San Jose Airport, Moffett Field, and Shoreline Park populations all had a declining trend from 2000-2010, based on adult owls each year (J. Barclay pers. comm., 2010).

Around the time the Santa Clara Valley HCP/NCCP was approved in 2013, the Santa Clara Valley Habitat Agency knew of 107 adult owls in the county, and only 4 large populations as of 2014. Higgins (2015) reported on issues with burrowing owl mitigation procedures and the status of burrowing owls in Santa Clara County, noting that of the 215 occupied burrowing owl sites in county from 1987-1988 (documented by H.T. Harvey and Associates 1989), thought to support at least 500 burrowing owls), by 2015 only 5 breeding owl sites remained, supporting an estimated 60 owls (SCCHCP 2015). Santa Clara Valley Habitat Agency surveys of burrowing owls for the HCP in four burrowing owl conservation regions (North San José/Baylands, South San José, Morgan Hill, and Gilroy) documented 74 adult owls during breeding season in 2015, and 61 breeding adult burrowing owls and 108 fledged young in 2016 (SCVHA 2016).[10]

By 2022, owls in the HCP study area had declined to a mere 33 adults and 17 pairs, a further 69% decline (Talon Ecological Research Group 2023). Emergency efforts were underway to increase numbers of breeding owls and establish new breeding sites, through captive breeding along with juvenile owl overwintering in captivity for release (Talon Ecological Research Group 2023; SCVHA 2024). By 2022 only four breeding owl colonies remained in the county: Shoreline Park, Mountain View; NASA Ames Research Center at Moffett Field; SJ-SC Regional Wastewater Facility; and San Jose International Airport (Talon Ecological Research Group 2023). During the 2023 breeding season, no breeding pairs were observed at SJC and at Moffett Field.

[10] These numbers include owls at the Don Edwards National Wildlife Refuge, Warm Springs Unit, which is in Alameda County.

A search of the CNDBB for recent (2015-2023) breeding season observations did not reveal any breeding pairs reported in Santa Clara County outside of these four known colonies. A review of recent (2022-2023) eBird records during breeding season documents a few other small breeding locations in the county: Disk Drive in Alviso (maximum of 11 owls in 2022); Alviso Bufferlands; Don Edwards NWR in Alviso; and Baylands Preserve (maximum of 2 owls from 2022-2023). Two of the county's colonies, the Wastewater Facility and Shoreline Park, are now increasing, due to active management, intervention, and emergency measures to try to rebuild breeding numbers. The other two formerly large populations, Moffett Field and San Jose Airport, have crashed due to lack of active management, among other factors.

The San Jose-Santa Clara Regional Wastewater Facility worked with the City of San Jose, Santa Clara Valley Audubon Society, and San Jose State University's Environmental Studies department to create a 180-acre bufferland preserve for owls. Since 2016, the Santa Clara Valley Habitat Agency has contracted with Talon Ecological Research Group and SCV Audubon to manage the site and has established a conservation easement there in 2023. The number of adult owls observed during the breeding season has fluctuated between a low of 2 adults in 2012 and a high of 35−37 adults in 2017. In 2022, six pairs were successful and produced a total of 36 young. Five of these pairs were soft-released as part of the Juvenile Overwintering Project. By 2022, the Wastewater Facility had an 18% increase in adult owls from the 1990s numbers, and a 200% increase in young from 2013-2022 (Talon Ecological Research Group 2023). The Wastewater Facility had 5 successful breeding pairs in 2023, with 23 young (SCVHA 2024).

Shoreline Park had 3 breeding pairs in 2015. At Shoreline Park, adult owls increased 67% from the 1990s to 2022, and there was a 275% increase in young from 1998-2022 (Talon Ecological Research Group 2023). A review of eBird records during breeding season from 2022-2023 shows a maximum of 4 owls reported at Shoreline Park. The number of adult owls observed during the breeding season has fluctuated over time with a low of 2 adult owls in 2019 to a high of 26 owls in 2003. In 2022, 3 of 5 pairs successfully reproduced a total of 15 offspring. Five of these owls were released on site as part of the Juvenile Overwintering Project. During the 2023 breeding season there were 7 breeding pairs, 5 of which were successful and produced 23 young at this site (SCVHA 2024).

The San Jose Airport had been a managed location for many years (Barclay 2007; Barclay et al. 2011; Menzel 2018), with installation and regular maintenance of artificial burrows helping the population peak at 40 pairs in 2002, with 208 adults and young documented (Talon Ecological Research Group 2023). But increased nest predation and reduced recruitment and adult survival dropped the numbers to 17 pairs by 2007 (Barclay et al. 2011), and the colony significantly declined after 2014, to only 5 nesting pairs in 2018. The airport contracted with Albion Environmental to mitigate potential collision with aircraft along the runways by passively relocating owls from the runway safety area and installing 113 artificial burrows in safer areas along taxiways and at the end of the runways. The airport subsequently ceased active management and no longer maintained artificial burrows. There was an 89% decrease in the number of adult owls at the airport from the 1990s to 2022, and an 84% decrease in young from 1990-2022 (Talon Ecological Research Group 2023). During the 2022 breeding season there were only 3 adults and 3 young, while during the 2023 breeding season, no burrowing owls were observed. (SCVHA 2024). See Table 2.

Moffett Field had 8 breeding pairs as of 2015 (SCVHA 2016). Cumulative negative effects from construction projects over the years have destroyed, degraded, and fragmented previous nesting, wintering, and foraging habitat. Other strains on this population were a lapse in non-native predator abatement (especially red foxes) and USDA's need to balance airfield safety with wildlife management/habitat protection. The number of adult owls has decreased 94% from the 1990s (when there were more than 30 pairs) to 1 pair in 2022, and 2 male adults but no breeding pairs in 2023 (Talon Ecological Research Group 2023; SCVHA 2024). See Table 2.

From 2014 to 2023, Talon Ecological Research Group has been conducting in-depth burrowing owl breeding season surveys on behalf of the Santa Clara Valley Habitat Agency throughout Santa Clara County and one location in Alameda County, the Warm Springs Unit of the Don Edwards National Wildlife Refuge. During 2014, a total 116 adults and 87 young were observed at 5-8 locations; but by 2023 there were only 48 breeding adults observed and 102 young. The adult burrowing owl population declined by 59%. The three largest historical breeding sites (Moffett Field, San Jose Airport and Warm Springs) experienced extirpation as breeding locations during the same time period (Moffett only had two male owls in 2023, while both San Jose Airport and Warm Springs had no adult breeding owls). In 2002, San Jose airport reached its peak burrowing owl population with 208 burrowing owl adults and young; 21 years later the site had no breeding burrowing owls. In 2004, Moffett Field reached its peak burrowing owl population with 93 adults and young; 19 years later the site had only two male owls. Warm Springs reached its peak in 2005 with 111 burrowing owl adults and young; 15 years later the burrowing owl population was extirpated. (Menzel et al. 2024 in prep.). See Table 2.

Intervention efforts to stave off extirpation increased in 2023 (SCVHA 2024), with owls from the Santa Clara HCP Juvenile Overwintering Project and captive breeding program released at Shoreline Park and the Wastewater Facility, as well as two new reintroduction sites in rural areas of southern Santa Clara County, POST/OSA (where 5 released breeding pairs produced 26 young in 2023) and SCCP (where 4 released breeding pairs produced 21 young in 2023). Breeding burrowing owls are nearing extirpation in Santa Clara County, with most of the recent breeding owls due to intervention, including overwintering of young, captive breeding, reintroduction of adult owls, and supplemental feeding (SCVHA 2024).

Year	Site	Number of Adults & Young	Comments
1998	Moffett	85	First Data Collection
2004	Moffett	93	Peak Population
2023	Moffett	2 adults	Present Status
1990	San Jose Airport	47	First Data Collection
2002	San Jose Airport	208	Peak Population
2023	San Jose Airport	0	Present Status
2001	Warm Springs	18	First Data Collection
2005	Warm Springs	111	Peak Population
2023	Warm Springs	0	Present Status

Table 2. Initial data, peak population, and current status of Moffett, SJ Airport, and Warm Springs colonies (from SCVHA 2024)

Santa Cruz County

Historical records confirmed breeding at Santa Cruz in 1882 and 1901 (McGregor 1901; SBMNH 2001; WFVZ 2001). Skirm (1884) described the species as "common" in Santa Cruz

County and reported collecting eggs. McGregor (1901) described it as a “fairly common” breeding bird of Santa Cruz County, noting that “fresh eggs can be found at Santa Cruz about April 15.” By mid-century, Streator (1947) reported that the species was “now rare due to the poisoning of ground squirrels” around Santa Cruz. The species had “greatly declined” in Santa Cruz County by the 1970s (Remsen 1978), with only 2 recently reported sightings – one in February 1969 on the lower U.C. Santa Cruz campus; another near Moss Landing elementary school (Gordon 1974). Warrick (1982) reported on a population of about 20 burrowing owls inhabiting grasslands on the U.C. Santa Cruz campus that apparently wintered there, as well as nested (CNDDB 2001). Burrowing owls have not been documented nesting on the campus since 1987, although owls of unknown origin still occurred there in the winter in the early 2000s (J. Barclay, J. Linthicum, pers. comm., 2002).

Breeding burrowing owls have been extirpated from Santa Cruz County since the 1980s (DeSante and Ruhlen 1995), although wintering birds are often seen in dune and coastal grasslands (L. Trulio, pers. comm., 2001). They were confirmed extirpated by Townsend and Lenihan (2007).

Central Western California

The range of the burrowing owl in central western California encompasses Monterey County; the western 75% of San Benito County; and San Luis Obispo and Santa Barbara Counties (DeSante et al. 1996).

Although there are historical records of confirmed breeding in every county in central Western California, there are little data on overall historical abundance of the burrowing owl in this area. The species was documented to have been locally abundant in Monterey County around Aromas in the 1930s (Gordon 1974), in San Benito County at Paicines in the late 1800s (Mailliard and Mailliard 1901), and in Santa Barbara County at Santa Barbara in the late 1800s (Streator 1886). Breeding burrowing owls have been eliminated from these specific locations, extirpated from coastal San Luis Obispo County, and very nearly extirpated from coastal Monterey County and the western 75% of Santa Barbara County.

DeSante and Ruhlen (1995) found only 8 owl pairs in the Central-Western coast and 10 owl pairs in the Central-Western interior. DeSante and Ruhlen (1995) estimated that only 46 pairs of owls persisted in the Central-Western region, 38 in the interior and 8 on the coast. Owls located were mostly in isolated pairs or very small groups, and facing intense development pressure (DeSante et al. 1996).

Wilkerson and Siegel (2010) did not survey the Central-Western Coast region because owls were likely extirpated (a single pair was present in Northern Santa Barbara in 1992 but it could not be located in subsequent surveys). There were no recent reports of breeding birds in the Central-Western Coast region (J. Kidd pers. comm., 2010). In the Central-Western Interior region, Wilkerson and Siegel (2010) estimated a total of 84 pairs, an apparent 121% increase from the estimate of 38 pairs during the 1991-1993 survey (DeSante and Ruhlen 1995). However, the 2006-2007 study (Wilkerson and Siegel 2010) surveyed a much greater number of upland blocks in contrast to the earlier DeSante and Ruhlen survey in the Central-western Interior region, so the apparent increase could have been an artifact of increased survey effort rather than an actual increase in owl numbers.

Monterey County

Historical records confirmed breeding near Monterey in the 1890s and indicated probable breeding in Monterey in 1903 (FMNH 2001; MVZ 2001). Burrowing owls were reported to be “fairly common” during summer (Willett 1908) and probably bred in the lower and upper Salinas Valley and surrounding foothills along the Monterey/San Luis Obispo County line (Roberson 1985; MVZ 2001). Owls were probably breeding near Big Sur in 1903-1904 and in the Jolon Valley in 1909 (Pemberton and Carriger 1915), but there are no known recent records of owls from these areas (Roberson 1985). Owls were “plentiful” around Aromas in the 1930s (Gordon 1974) and were found by Grinnell and Linsdale in 1934-1935 at Point Lobos Reserve (Drury 1953). Mowbray (1947) reported an absence of burrowing owls during two years of observations at Camp Roberts in the Upper Salinas Valley, and concluded that they must be present in very small numbers if at all, as he visited all parts of the camp that were typical habitat for the owl. Breeding was confirmed near Marina in 1972 and owls were thought to still occur within the Big Sur Planning Unit (coastal Monterey County south of Point Sur) in the 1970s (Gordon 1974; USDA 1978). Roberson (1985) reported them to be a rare resident in the mouth of the Salinas Valley, noting that widespread cultivation had limited habitat to a few remaining colonies. A likely breeding colony was reported north of Castroville in the 1980s (CNDDB 2001).

Breeding burrowing owls were very nearly extirpated (perhaps only 1 or 2 breeding pairs remaining) from coastal Monterey County by the early 1990s (DeSante and Ruhlen 1995). A 1992 breeding owl survey located only 14 pairs in the entire county, centered near the City of Salinas and rangeland east of King City (Roberson 1993). Most observations of nesting colonies in Monterey County in the late 1990s were from the Salinas River Valley (CNDDB 2001) and breeding was confirmed at the Salinas Airport in 1994 (J. Barclay, pers. comm., 2002). Wilkerson and Siegel (2010) found 0 breeding pairs in coastal Monterey County, and only 5 pairs in eastern Monterey County, in small clusters of two and three pairs of owls, in the low foothills of the Coast Range east of King City.

There is only 1 recent (2015-2023) breeding season record from western Monterey County in the CNDDB, with 2 territorial owls at a burrow site in Marina on February 16, 2023. A review of recent (2015-2023) eBird breeding season records in western Monterey County shows only two possible indications of breeding: in Fort Ord National Monument Grasslands (3 owls on March 2, 2022); and at Marina Water Treatment Plant (3 owls in Feb 2018). The CNDDB has 8 breeding season records with 28 owls total from 2016 in eastern Monterey County, in the vicinity of Cholame, Cholame Valley and Parkfield. All of these localities are threatened by industrial solar development. A review of recent (2015-2023) eBird breeding season records in eastern Monterey County confirms breeding at a few locations east of King City: along Lonoak Road, along Highway 25, and along Pine Valley Road.

Western San Benito County

The burrowing owl was listed as a “common resident” (although scarce in some years) at Paicines, from 1888-1901 by Mailliard and Mailliard (1901). Historical records confirmed breeding at an unspecified location in San Benito County in 1889; and indicated probable breeding at Paicines in 1894 and 1897, near Panoche in 1936 (MVZ 2001; OM 2001; CAS 2002a). A breeding pair of owls was observed near Hollister in 1999 (P. Delevoryas, pers. comm., 2003). There were several owl observations indicating probable breeding northwest of Hollister in the early 1990s (CNDDB 2001). In the early 2000s, burrowing owls wintered in several locations in northern San Benito County, but these locations were not known to be breeding areas; where private land access was limited, the status of burrowing owls was unknown (CFDG 2003). In the early 2000s most of the remaining favorable potential burrowing owl habitat in San Benito County was threatened by urban development (CFDG 2003).

Wilkerson and Siegel (2010) found a small cluster of three burrowing owls in Bolsa Valley, northwest of Hollister on a historic breeding block.

A search of eBird records for burrowing owls in San Benito County during the breeding season from 2021-2023 shows only 4 locations in western San Benito County with potential breeding pairs: Lake Road near Dunneville (1-4 owls); Quien Sabe Road east of Tres Pinos (up to 9 owls); Browns Valley Road east of Paicines (1-4 owls); and Dry Lake E of Pinnacles (1 pair). There are no recent (2015-2023) CNDDB occurrences in western San Benito County.

San Luis Obispo County

Historical records confirmed breeding near San Luis Obispo in 1928, at McMillan Canyon in 1930, south of Coalinga in 1934, and near Simmler in 1949; and indicated possible breeding at Morro in 1939 and Cholame before 1940 (Roberson 1985; MVZ 2001; WFVZ 2001). Breeding burrowing owls have been extirpated from coastal San Luis Obispo County since the 1980s (DeSante and Ruhlen 1995).

A substantial breeding population of owls remained in the late 1990s at the 200,000-acre Carrizo Plain Natural Area (managed by the Nature Conservancy, BLM, and CDFG) in eastern San Luis Obispo County, which is the largest area of undeveloped grassland habitat for burrowing owls in California (Rosenberg et al. 1998a; CNDDB 2001). Research by Rosenberg and others (Rosenberg and DeSante 1997; Rosenberg 1999; Rosenberg et al. 1998; Ronan and Rosenberg 1999) revealed between 32-50 active burrowing owl nests within the Carrizo Plain Natural Area during the years 1997-1999. Extensive grasslands in the Carrizo Plain study area (approximately 250,000 acres) include some of the largest remaining examples of habitat types that were at one time also characteristic of the San Joaquin Valley. CDFW provided burrowing owl spring and summer survey records at Soda Lake and Elkhorn Road in Carrizo Plain from 2004-2018, which have detected only small numbers of burrowing owls during breeding season (8 owls detected in 2004; 26 owls in 2005; 3 owls in 2006; zero owls from 2007-2010; 18 owls in 2011; zero owls 2012-2014; 4 owls in 2015; 5 owls in 2016; 14 owls in 2017; and zero owls in 2018).

Wilkerson and Siegel (2010) found 0 breeding owls in western San Luis Obispo County and small clusters of burrowing owls in the northeast corner of San Luis Obispo County (5 pairs) and on the Carrizo Plain (8 pairs).

The CNDDB has 8 recent (2015-2023) breeding season records from eastern San Luis Obispo County: 4 locations in Carrizo Plain in 2015 and 2016 (6 adults and 17 juveniles total); and 4 locations in Cholame Valley and NE of Cholame in 2016 (13 adults and 10 juveniles total). Many of these sites are threatened by proposed industrial solar development. A review of eBird breeding season records from 2015-2022 shows a maximum of 2 owls reported in the vicinity of Cholame, in May 2022. Only 3 records out of the more than 50 recent (2015-2023) eBird breeding season records in Carrizo Plain were of more than 3 owls. More recent population data for burrowing owls at Carrizo Plain could not be found; and the 2019 Land Management Plan for the Carrizo Plains Ecological Reserve (CDFW 2019) had no information on the breeding numbers or population trend. Petitioners could find no available information on the recent and current status of burrowing owls at Carrizo Plain, and submitted a Public Records Act request in October 2023 to CDFW for information; CDFW has not yet provided this information.

Santa Barbara County

Historical records confirmed breeding at Santa Barbara in 1875 and 1885 (Streator 1886; NMNH 2001). Streator (1886) noted that the burrowing owl was “common” at Santa Barbara in 1885. Bartholomew (1940) recorded 7 burrowing owl sightings in 1937 and 1938 in the upper Santa Ynez River and along the crest of the Santa Ynez Mountains. There was probable breeding at Montecito and Santa Barbara in the 1970s (SBMNH 2001), but owl numbers had drastically declined in the Santa Barbara region by then (Remsen 1978). The burrowing owl was uncommon, but not rare in the Santa Barbara area in the late 1970s and early 1980s, with owls seen at the U.C. Santa Barbara campus, Santa Barbara Airport, Goleta Slough, and Santa Barbara Community College (R. Panza, pers. comm., 2002).

Lehman (1994) noted that owls had been “formerly much more numerous,” and were “nearly completely extirpated” from Santa Barbara County by the early 1990s, when only 1 or 2 pairs nested in fields west of Santa Maria and probably also in the Santa Ynez Valley (Lehman 1994). The number of wintering birds had also declined severely during since the 1980s and an average of only 1 or 2 were seen each year along the South Coast east of Gaviota (Lehman 1994). Burrowing owls possibly nested in the San Marcos Foothills in the early 1990s (SMFA 2002). Owls once nested at Vandenberg Air Force Base (Whitney and Kudrak 1997), but had not bred there since 1979-1980 when 4-5 pairs nested in rangeland east of Pt. Arguello for two consecutive years (there were only 3 summer records at Vandenberg AFB between 1977 and 1994); although there was still significant use of habitat on the base by migrants and wintering owls (Holmgren and Collins 1999). Breeding owls were eliminated from Vandenberg likely due to changes in grazing management so that grassland habitats were no longer suitable, and elimination of ground squirrels (Whitney and Kudrak 1997).

Breeding burrowing owls had been nearly extirpated from the western 75% of Santa Barbara County by the early 1990s (DeSante and Ruhlen 1995). Burrowing owls were believed to no longer breed in the coastal portion of Santa Barbara County by the early 2000s, except for possibly in the Cuyama Valley (CDFG 2003). Kidd et al. (2007) concluded that breeding owls are likely extirpated from western Santa Barbara County and that if any remained, the populations were likely so scattered as to be non-viable in the long-term.

There are no CNDDB breeding season records of burrowing owls in all of Santa Barbara County. A search of recent (2015-2023) eBird breeding season reports shows only two locations that may represent breeding (with more than single owls or owls later than March) documented in all of Santa Barbara County: at U.C. Santa Barbara North Campus Open Space (1-2 owls) and Dangermond Preserve near Point Conception (3 owls). Breeding burrowing owls may be near extirpation in the entirely of Santa Barbara County.

Southwestern California

The range of the burrowing owl in southwestern California encompasses the southern 55% of Ventura County; the southern 50% of Los Angeles County; all of Orange County; the western 40% of San Diego County; the southern California islands; the western 25% of Riverside County; and the southwestern 5% of San Bernardino County (DeSante et al. 1996).

Although there are historical records of confirmed breeding in every county in southwestern California, there are little data on overall historical abundance of the burrowing owl in this area. The species was documented to have been locally abundant throughout Ventura County in the late 1800s (Evermann 1886), throughout western Los Angeles County from the late 1800s into the early 1900s (Willett 1912; FMNH 2001; MVZ 2001; NMNH 2001; WFVZ 2001), in western San Bernardino County (near Chino) in the early 1900s (WFVZ 2001), and throughout coastal San Diego County in the late 1800s (Emerson 1884; Van Dyke 1888; Sharp 1907).

DeSante and Ruhlen (1995) found only 26 owl pairs in Southwestern California, 8 on the coast and 18 in the interior. An estimated 263 nesting pairs (3% of California's population) persisted in in the early 1990s (227 in the interior and 36 on the coast), representing a decline of about 57-85% since the mid-1980s (DeSante and Ruhlen 1995). Breeding burrowing owls were extirpated from coastal Ventura County and nearly eliminated from Orange, San Diego, and Los Angeles Counties by the early 1990s (DeSante and Ruhlen 1995), with the species greatly reduced in numbers and quite local in coastal southern California. Owls in Southern California west of the deserts existed at very low densities (much less than 0.01 pairs/km^2). Remaining owls were found only on undeveloped federal lands, having been almost entirely extirpated from private lands by urban sprawl. These owls were mostly in isolated pairs and very small groups, and threatened by intense development pressure (DeSante et al. 1996).

Kidd et al. (2007) used records from their own extensive studies, resource agencies, consultants, local experts, literature, and museum records to infer range reductions in southwestern California. By 2007, while small colonies and single pairs persisted in eastern Los Angeles, southwestern San Bernardino, and western Riverside counties, burrowing owl populations were so highly fragmented and diminished, that long-term persistence was thought unlikely (Kidd et al. 2007). Considering the rate of habitat destruction and fragmentation, and the lack of sufficient mitigation to balance loss of occupied habitats, Kidd et al. (2007) predicted that breeding burrowing owls would soon be extirpated from southwestern California.

Wilkerson and Siegel (2010) declined to survey the southwestern California coast region because the population there was small and well-known. They estimated only 42 pairs for the Southwestern Coast region. The 1991-1993 "best estimate" for this region had been 36 pairs (DeSante et al. 2007). The apparent increase could be from the more thorough coverage provided by Lincer and Bloom (2007) or a slight but real increase in the region's owl population (Wilkerson and Siegel 2010). For the southwestern Interior region, Wilkerson and Siegel (2010) estimated 150 pairs, 34% fewer than were estimated in the DeSante et al. early 1990s study.

Ventura County

In the late 1800s the burrowing owl was a "common and generally distributed" nesting bird throughout Ventura County (Evermann 1886). Historical records confirmed breeding at Simi in 1897; and indicated probable breeding at Ventura in 1906 and in the southern part of the county in 1911 (MVZ 2001; UCLA 2001; WFVZ 2001). The species was known to occur in the 1970s in the Pine Mountain-Sespe-Wheeler Gorge area of the southern Los Padres National Forest, north of Ojai (Stebbins and Taylor 1973).

Breeding burrowing owls have been extirpated from coastal Ventura County since the 1980s (DeSante and Ruhlen 1995; CDFG 2003). The Ventura County Bird Atlas project indicated that the burrowing owl was a "localized breeder" with few known breeding sites as of the early 2000s (such as Mugu NAS). Kidd et al. (2007) confirmed that breeding burrowing owls had been extirpated from Ventura County. The only recent (2015-2023) CNDDB observations during breeding season in Ventura County have been of 4 single owls, in February and March of 2016 and 2017 (in Santa Paul and Fillmore in the Santa Clara River Valley, and in Camarillo); these likely represent overwintering birds and there is no evidence of breeding. Similarly, there are no recent (2015-2023) eBird reports of burrowing owls in the entirety of Ventura County after March. Breeding burrowing owls have likely been completely extirpated from Ventura County.

Southern Los Angeles County

Numerous historical records confirmed widespread breeding of owls throughout the entire region of what is now the urbanized Los Angeles area, from the 1880s through the 1930s (Hartzell 1888; McGregor 1898; Swarth 1900; Willett 1912; AMNH 2001; FMNH 2001; LACM 2001; MVZ 2001; NMNH 2001; UCLA 2001; WFVZ 2001; CAS 2002a). The burrowing owl was apparently once an extremely abundant resident in the Los Angeles region (e.g., Willett 1912). With urban development, burrowing owl numbers had gone way down in the Los Angeles region by the 1970s (Remsen 1978). There was confirmed breeding at Playa del Rey from the 1960s through the 1980s; probable breeding at Los Angeles and Hermosa Beach in the 1980s; and non-breeding season sightings in the Long Beach area from the 1950s through the 1970s (CNDDB 2001; CSULB 2001; LACM 2001; WFVZ 2001). There were apparently “many” burrowing owls at the California State University, Long Beach campus in the past (C. Collins, pers. comm., 2002), but this population was extirpated by the early 1980s (P. Bloom, pers. comm., 2002).

Breeding burrowing owls had most likely been nearly extirpated from southern Los Angeles County by the early 2000s. Small numbers of breeding burrowing owls persisted in the Antelope Valley, in northeastern Los Angeles County; these birds are discussed in the section on the southern desert range, below. Raptor surveys throughout most of the Santa Monica Mountains National Recreation Area in the early 2000s located no nesting burrowing owls, although owls wintered there (P. Bloom, pers. comm., 2002). By 2007 breeding burrowing owls had been confirmed extirpated from southern Los Angeles County (Kidd et al. 2007).

Orange County

Historical records confirmed breeding at Anaheim in the 1880s and in 1918; at Balboa Beach in 1920; at Buena Park in 1927, 1928, 1935, and 1938; at Newport Beach in 1931 and 1955-1964; near Sunset Beach in 1938; near Cypress in 1945, at Los Alamitos in 1958, Costa Mesa from 1955-1972, and Santa Ana from 1956-1959 (Robertson 1929, 1930; T. Howell 1964; FMNH 2001; LMDBL 2001; SBMNH 2001; WFVZ 2001; J. Bath, pers. comm., 2003). There were probable breeding records from Santiago Springs in 1903, Seal Beach in 1908, Corona del Mar in 1957, and Irvine in 1968 (CSULB 2001; LACM 2001; NMNH 2001; UCSC 2001). As early as the 1930s, the burrowing owl in western Orange County was noted to be “far less common than it used to be” according to Robertson (1931), due to the elimination of ground squirrels.

Further owl declines due to development and human impacts were evident in western Orange County before 1960, with documentation of local extirpations and habitat loss in Costa Mesa, Newport Beach, and Santa Ana (J. Bath, pers. comm., 2003). Still, the burrowing owl in Orange County between 1960-1975 could best be described as “abundant,” and for a raptor, “bordering on ubiquitous” throughout the grasslands and non-orchard agricultural areas (P. Bloom, pers. comm., 2002). Burrowing owls were at that time a “regular component” of the coastal Orange County environment in Seal Beach, Huntington Beach, Fountain Valley, Newport Beach, Irvine, Mission Viejo, Corona del Mar, Costa Mesa, Laguna Niguel, and portions of Santa Ana (P. Bloom, pers. comm., 2002). Most vacant fields or flat agricultural acreages greater than 5 acres within 5 miles of the coast had their own pair or colony of owls (P. Bloom, pers. comm., 2002).

Significant nesting burrowing owl colonies were noted along the coast of Orange County from the 1970s to the early 1990s (including Seal Beach, Bolsa Chica, Huntington Beach, Newport Beach, and Irvine), with nesting also observed in southeastern Orange County in 1973 (Wiley 1975; Collins and Landry 1977; UCI 1995; CNDDB 2001; CSULB 2001). However, by 1985 less than 10 pairs of owls remained countywide, outside of the population at Seal Beach (P. Bloom, pers. comm., 2002). Six pairs of owls regularly nested at Fairview Channel in the City of Costa Mesa since 1957, but were down to 1 nesting pair by the early 2000s (J. Bath, pers. comm., 2003) and there was no nesting and only a single wintering owl there by 2003 (CDFG 2003).

Extensive raptor nest surveys throughout the county confirmed that breeding burrowing owls had nearly been extirpated from Orange County by the early 2000s (DeSante and Ruhlen 1995; P. Bloom, pers. comm., 2002). Christmas Bird Count data demonstrated that numbers of wintering burrowing owls in Orange County also plummeted from 1970 to the early 2000s (CDFG 2003). The only remaining breeding location for burrowing owls in Orange County by the early 2000s was at Seal Beach Naval Weapons Station. Seal Beach had low numbers of nesting owls, 4-5 pairs from 1990-2000, 3 or fewer pairs in 2001 (P. Bloom, pers. comm., 2002), and 2 pairs in 2003 (CDFG 2003). Although management in the early 2000s seem to accommodate the burrowing owl as a nesting species, future management was unknown. Three breeding pairs were documented at Seal Beach in 2005, representing a small, isolated, island-like population with no connectivity; by 2010 there were only 1 to 3 pairs there (Kidd pers. comm., 2010).

Proposed urban development of Banning Ranch (which was delayed in 2017 by the California Coastal Commission) jeopardizes one of few remaining wintering areas for burrowing owls in Orange County. The development would destroy and fragment 84% of the foraging area for burrowing owls on the project site, surrounding owl wintering habitat with buildings and a road.

There is only 1 recent (2015-2023) breeding season record in the CNDDB from Orange County, a single owl on February2, 2017 in Huntington Beach; this likely represents an overwintering bird. A review of recent (2015-2023) breeding season records on eBird reveals no indication of nesting anywhere in Orange County; there were mostly single birds seen in February or early March, indicating wintering birds, and no reports of owls after March. Reports from Bolsa Chica from 2015-2023 seem to be of wintering birds and do not indicate any evidence of breeding. A search of eBird records from 2015-2023 shows only one location in Orange County with any potentially breeding owls, at Naval Weapons Station Seal Beach (1-3 owls maximum, but no owls reported after March).

Bloom (2023) reported on the functional extirpation of the Orange County breeding burrowing owl population. The earliest reports considered the species abundant along the south coastal slope, but starting about 1931, the breeding population slipped into a noticeable decline that continued until 2014, when the last known breeding attempt in Orange County occurred. Publications and reports from 1931–2016 documented a chronic, but slow trend toward extirpation of the breeding population of coastal southern California from Santa Barbara County south through northern San Diego County, due to habitat loss, degradation, and fragmentation, ground squirrel eradication, and coastal predator management at California least tern and western snowy plover nesting colonies. The impact of these factors was compounded by short natal and breeding dispersal distances and ultimately by Allee effects. Bloom (2023) documents the last known nesting attempts of burrowing owls in Orange County. Although it remains plausible that an occasional future nesting attempt may still occur, Bloom (2023) regards the species in Orange County, as well as nesting colonies in other coastal southern California counties, as ecologically extirpated.

San Diego County

The burrowing owl was once widespread and quite common in coastal San Diego County. Van Dyke (1888) claimed that in the late 1860s in San Diego, "burrowing owls stood on every little knoll." Emerson (1884) found the burrowing owl "not uncommon" in the Poway Valley in the 1880s, and Sharp (1907) noted it "common everywhere" around Escondido, based on 16 years of observations from 1891 to 1897. Historical records confirmed breeding at: Poway in 1884 and 1885; National City in 1895 and 1910; Escondido on numerous occasions from 1902 to 1931; La Presa before 1907; Point Loma in 1917, 1920, and 1922; near Santee in 1920 and 1921; Rancho Santa Fe in 1932; San Pasqual in 1902, 1906, 1907, 1910, and 1916; Oceanside in 1931; San Diego on numerous occasions from 1862 to 1936; and Crown Point in 1936. Probable breeding was documented at: San Diego in 1893 and 1894; Jacumba in 1894; San Onofre from 1904-1906; Chula Vista and San Luis Rey in 1908; Lemon Grove in 1914; Escondido in 1920; La Puerta Valley in 1922; and La Jolla in 1935 (Emerson 1884; Dixon 1906; Sharp 1907; Unitt 1984; AMNH 2001; CMNH 2001; FMNH 2001; MVZ 2001; NMNH 2001; SBMNH 2001; UCLA 2001; WFVZ 2001; CAS 2002a). Breeding was confirmed at Twin Oaks between 1889 and 1894, at Witch Creek in 1906, and in the Santa Margarita Mountains in 1931. These observations as well as a specimen collected during breeding season at Oak Grove in 1892 suggest the species had occurred in the foothill zone of San Diego County as well (F. Merriam 1896; Unitt 1984; AMNH 2001; WFVZ 2001).

Burrowing owls apparently persisted in urban areas of San Diego into the 1930s (Abbott 1930a). Abbott (1930) noted owls had been driven away from downtown, but subsisted "wherever there is any extent of vacant land" and were "common" between downtown and Mission Hills. Further declines were noted in San Diego County in the 1970s (Remsen 1978). Usually only a single pair at a time was seen at a locality, with a maximum of 5 birds observed at North Island Naval Air Station, Coronado, in May 1978 (Unitt 1984). Other localities still inhabited in the late 1970s included San Marcos, near Palomar Airport in Carlsbad, Mission Bay, Lower Otay Lake, and the Tijuana River Valley (Unitt 1984). Camp Pendleton had a small population of about 8 pairs of owls in 1972, but between 1975 and 2000 there were never more than 2 pairs there and usually just 1 pair inhabiting the entire 196 square mile reservation (P. Bloom, pers. comm., 2002). By the 1980s, owls were an "uncommon and declining resident" with only 7 definite breeding locations and 7 probable breeding locations remaining in San Diego County in 1984 (Unitt 1984). Their range still included the entire coastal lowland of San Diego County, but urbanization had "greatly restricted the extent of suitable habitat" (Unitt 1984).

The burrowing owl was on the verge of extirpation in San Diego County by the early 2000s. Only 6 confirmed breeding locations remained in the county in 2001, with one other probable breeding location, and one possible breeding location (P. Unitt, pers. comm., 2001). A single individual recorded near Upper Otay Lake (brought to the attention of P. Unitt by a bulldozer operator) was probably the last in that area, and only a single pair nested near Lake Henshaw in 2001.

By the early 2000s only two San Diego County locations were known to support "colonies" of burrowing owls (more than 5 breeding pairs) or populations with even short-term viability: North Island Naval Air Station, and the East Otay Mesa (Border area) southwest of Otay Mountain. The North Island location is owned and managed by the Navy. Although burrowing owl population sizes have historically fluctuated in response to vegetation management activities, protection is afforded under an Integrated Natural Resource Management Plan for the base. The East Otay Mesa population is in an area of ongoing disturbance by Border Patrol activities and areas zoned and slated for development. Burrowing owls at Ream Field (Imperial Beach) were hazed away from breeding locations because they predated on endangered least terns (P. Unitt, pers. comm., 2001). Outside of these locations, there were probably no more than 15 breeding pairs in the county (CDFG 2003). This very low number encompassed data from an intensive countywide effort from 1998-2002 as part of the San Diego Bird Atlas Project, coordinated by Philip Unitt of the San Diego Natural History Museum. As early as 2003 and 2004 burrowing owls were being trapped and relocated away from development projects on Otay Mesa and other breeding locations in San Diego County, translocated and hacked into artificial burrows at Ramona Grasslands and the Lower Otay Lake Burrowing Owl Management Area (WRI 2009).

A thorough assessment of the status of breeding owls in San Diego County by Lincer and Bloom (2007) determined there were only 41-46 pairs present as of 2007 and that extirpation of the species in this county seemed imminent. Primary threats were reduced habitat suitability and fragmentation of remaining habitat, conflicts with management of listed bird species (least tern and snowy plover), and disturbance by humans, pets and vehicles. Lehman et al. (2021) compiled the San Diego County Avian Records Database, updating the San Diego Bird Atlas with known avian breeding records from 2002-2020. On the San Diego coast, burrowing owls still bred in Otay Mesa (La Media Road) through 2017 (with a high of 10 owls on July 22, 2017); a family group was observed at the south end of San Diego Bay/Imperial Beach in summer 2019; and there were a few other scattered summer records, including pairs, since about 2010 from the vicinity of Otay Lake, Otay Mesa, south San Diego Bay, and North Island (Lehman et al. 2021). In inland San Diego County, an owl nesting restoration project at Rancho Jamul had up to 18 owl nests in 2020; and possible nesting in May 2019 on Daley Ranch Truck Trail in Jamul and in June 2018 on Rangeland Road near Ramona (Lehman et al. 2021).

There is only one recent (2015-2023) breeding season observation in the CNDDB for San Diego County, documenting the colony at Brown Field and Lonestar Ridge on Otay Mesa. However, recent data from the San Diego Zoo Wildlife Alliance (SDZWA) are not yet in the CNDDB (C. Wisinski, pers. comm., 2024).

The proposed redevelopment of Brown Field Municipal Airport in Otay Mesa with new commercial and aviation facilities would impact the last large extant breeding burrowing owl population in San Diego County. A lawsuit by conservationists led to a 2017 settlement agreement to set aside habitat off the airport for burrowing owls, initiate a multi-year program to help rebuild the struggling burrowing owl population on Otay Mesa, and to establish a pilot program for moving burrowing owls from development areas to other areas throughout San Diego County. A contract was executed with San Diego Zoo Wildlife Alliance (SDZWA) for 5 years, with one year for pre-construction and restoration monitoring of burrowing owls, California ground squirrels and associated habitat, and 4 years of construction/post-construction monitoring to fully assess any impacts to the regional burrowing owl metapopulation. To mitigate airport construction impacts, SDZWA proposed to (1) assess the efficacy of both passive and active translocations; (2) establish an additional BUOW breeding location through the use of active translocation; (3) monitor BUOW post-construction; (4) assess habitat and coordinate with Metropolitan Air Park LLC (MAP) land managers for artificial burrow maintenance and vegetation management; and (5) establish ground squirrel activity through encouraging natural squirrel dispersal and/or translocation. Construction and restoration had not commenced by 2022 as the SDZWA contract expired, so it has not yet been documented what impacts construction and restoration will have on the regional burrowing owl metapopulation. However, the SDZWA program to monitor burrowing owls on Otay Mesa has been active since 2013, including capturing, banding, and taking genetic samples from adult and juvenile owls, along with re-sighting banded birds during nest monitoring, remote camera monitoring, wider area surveys, and reported sightings from the public and collaborators. Stakeholders identified Rancho Jamul Ecological Reserve as the preferred site for expanding the breeding burrowing owl population (see SDZICR 2017), and in 2018 SDZWA began translocating owls to this reserve using a soft-release technique (Marczak et al. 2018). Over six successive breeding seasons, Wisinski et al. (2023) documented reproduction and retention of translocated owls, recruitment of their offspring, and recruitment of non-translocated owls.

As of 2023, SDZWA has established two burrowing owl breeding nodes in San Diego County (Rancho Jamul Ecological Reserve and Ramona Grasslands Conservation Bank) and developed a successful owl conservation breeding program at the San Diego Zoo Safari Park allowing augmentation of newly-established breeding nodes with conservation-bred owls. As of February 2024, 111 burrowing owls have been translocated, including 21 wild-to-wild translocated owls and 10 owls brought into the breeding program from the wild (C. Wisinski, pers. comm., 2024). SDZWA has also compiled a comprehensive regional monitoring dataset for burrowing owl population dynamics, and documented habitat associations and occupancy by owls and ground squirrels at Brown Field and associated on- and off-site mitigation areas. SDZWA is generating a comprehensive dataset on regional burrowing owl population dynamics since 2013. Metropolitan Airparks LLC declined to renew SDZWA's contract for post-construction and restoration monitoring of owls, which is essential to assess population changes as a result of development and mitigation actions.

During 2018 surveys, 15 adult owls were documented across at least 10 different burrows on Brown Field (SDZWA 2018). All active burrows were subsequently confirmed to be associated with nesting pairs. During breeding season, 29 breeding burrows were monitored with camera traps at Brown Field, Lonestar, and Helix Lonestar. A total of 102 owls were captured for banding, representing 36 families. Adult survival was found to be lower in 2017 and 2018, but juvenile recruitment and survival was the highest measured in 2018. SDZWA documented 28 confirmed owl mortality events across Brown Field, Lonestar, Johnson Canyon, and Helix Lonestar. The large overall number of mortalities, especially of juveniles, was most likely explained by decreased prey availability (SDZWA 2018). In 2018, 10 owls (two pairs from in the project area and 3 additional pairs from outside the impact area) were actively translocated from Brown Field Municipal Airport to Rancho Jamul Ecological Reserve (SDZWA 2018). The use of an acclimation period, installation of conspecific cues, and supplemental feeding through the breeding season were taken in an attempt to optimize settlement, retention, survival, and future recruitment of burrowing owls at the site. Though the translocation was initially successful, with breeding attempts at all five hack sites and nestlings fledged at three nests, adult mortality levels were documented. The surviving owls dispersed to overwintering sites, and though none were relocated during 2022 surveys at the preserve (SDZWA 2022), burrowing owls continued to occupy the site in 2023/2024, including descendants of previously translocated owls (C. Wisinski, pers. comm., 2024).

During the 2022 breeding season, SDZWA (2022) monitored 26 nesting attempts in the project area across Brown Field (10 attempts), Lonestar (13 attempts), and Helix Lonestar (3 attempts), with 70 juveniles fledged in total. Apparent nest success was 80% at Brown Field (with 30 juveniles fledged), 77% at Lonestar (with 26 juveniles fledged), and 100% at Helix Lonestar (with 11 juveniles fledged). Six burrows in the project area potentially occupied by 8-9 burrowing owls were passively relocated in 2022. Grading for construction in the project area is expected to begin in 2024, when significant owl relocation activities will begin: passive or active removal of owls and grading/soil compaction to make the habitat unsuitable for owl re-occupancy. At other sites throughout Otay Mesa, SDZWA (2022) documented seven nests with emerged juveniles, six of which were successful. In 2022 a total of 90 burrowing owls were captured across Otay Mesa, with 76 of those individuals newly banded in 2022. None of the burrowing owls (translocated or offspring) associated with the 2018 translocation to Rancho Jamul Ecological Reserve were observed in 2022. In 2022, SDZWA translocated a total of 24 owls to Rancho Jamul Ecological Reserve, and documented 18 adult owls that made 19 nesting attempts, and a total of 27 juveniles that fledged from six nests (SDZWA 2022).[11] In 2022, SDZWA translocated a total of 24 owls to Ramona Grasslands Conservation Bank, and documented 16 adult owls that made 14 nesting attempts, and a total of 19 juveniles that fledged from four nests (SDZWA 2022).[12] This is a an ambitious and experimental program which currently relies on supplementation of breeding nodes at preserves through translocations. A key metric of success is the retention and recruitment of offspring from translocated pairs that remain and breed at the newly established nodes; this has occurred at Rancho Jamul Ecological Reserve in 2019, 2020, and 2022; and at Ramona Grasslands Conservation Bank in 2022 and 2023 (C. Wisinski, pers. comm., 2024).

Southern California Islands

Grinnell (1915) noted that the burrowing owl occurred regularly on several of the Santa Barbara group of islands, and Dawson (1923) described the burrowing owl as “one of the characteristic birds of the Santa Barbara Islands.” Although there have been observations of owls on all the islands off southern California, probable breeding records from all the islands except for San Miguel and Anacapa Islands, and apparent documented breeding on Santa Catalina, the resident status of the species has been controversial (CBD et al. 2003). The 2003 listing petition (CBD et al. 2003) contained a summary of historical observations on the islands. Jones and Collins (2003) evaluated the historical and early 2000s status of burrowing owls on the islands. As of the early 2000s, wintering owls were found on the northern Channel Islands but no breeding owls (Jones and Collins 2003; B. Latta, pers. comm., 2003); and on the Southern Channel Islands, burrowing owls were thought to breed only on Santa Barbara and Santa Catalina Islands and were only transient or winter visitors on other islands (Jones and Collins 2003). Although some breeding owls occur the populations are not substantial and thus recent surveys have not focused on the islands.

[11] The first set of translocations (January–March) was comprised of 10 BUOW. Short-term settlement and survival was 50%, with five individuals confirmed to have settled and survived for at least 30 days post-release. Seven individuals (70%) made at least one nesting attempt after release, but only one (10%) had a successful nesting attempt (one or more juveniles survived to at least 30 days post-emergence). During the breeding season, SDZWA observed a total of 16 BUOW (eight females, seven males, one unknown sex) in addition to those that were translocated in 2022. SDZWA monitored a total of 18 adult BUOW (ten females, eight males) that made 19 nesting attempts across 15 unique pairings, and documented the return of previously translocated adults, two non-translocated adult recruits, and several juvenile recruits hatched from 2019 to 2021. A total of 27 juveniles fledged from six nests. The second translocation was comprised of 14 individuals and occurred 11–25 October. Short-term settlement and survival of individuals from the October translocation was 50%, with seven individuals confirmed to have settled and survived for at least 30 days post-release.

[12] The first set of translocations took place February–March and was comprised of 16 BUOW. Short-term settlement and survival of individuals was 69%, with 11 individuals confirmed to have settled and survived for at least 30 days post-release. Thirteen individuals (81.3%) made at least one nesting attempt after release, with five individuals (31%) having a successful nesting attempt (one or more juveniles survived to at least 30 days post-emergence). During the breeding season, SDZWA observed a total of seven BUOW (two females, five males) in addition to those that were translocated in 2022. SDZWA monitored a total of 16 adult BUOW (eight females, eight males) that made 14 nesting attempts across 11 unique pairings, and documented the return of previously translocated adults and several juvenile recruits that hatched in 2021. At total of 19 juveniles fledged from four nests. The second translocation was comprised of 8 individuals and occurred 11–21 October. Short-term settlement and survival was 12.5%, with one individual confirmed to have settled and survived for at least 30 days post-release.

Western Riverside County

Historical records confirmed breeding at Riverside from 1878 to 1890 and at Norco in 1927; and indicated probable breeding in Riverside in 1892 and 1893, at San Jacinto Lake in 1895, at Lake Elsinore in 1907, at the base of the San Jacinto Mountains in 1908, and near Moreno in 1941 (Bailey 1917; AMNH 2001; MVZ 2001; NMNH 2001; UWBM 2001; WFVZ 2001; CAS 2002a). Single nesting pairs documented in La Sierra and Norco in the 1980s were extirpated by the early 1990s (J. Bath, pers. comm., 2003). Significant breeding colonies were documented at the San Jacinto Wildlife Area, near Lakeview, and at Lake Perris State Recreation Area ("SRA") in the 1980s (CNDDB 2001; LACM 2001).

The U.C. Riverside database developed for the Western Riverside County Multi-Species Habitat Conservation Plan included approximately 82 records of burrowing owls from the early 1990s to 2002 in the area. The Western Riverside MSHCP documented that owls had been detected east of the Jurupa Mountains, along the Santa Ana River, at Lake Mathews, at Good Hope, Alberhill, Murrieta, March Air Reserve Base, the Lake Perris/Mystic Lake area, the Badlands, within the vicinity of Beaumont and Banning, San Jacinto, Valle Vista, between the San Jacinto River and Lakeview Mountains, west of Hemet, the area around Diamond Valley Lake, east and south of Lake Skinner, along Santa Gertrudis Creek and Tucalota Creek, in Long Canyon, and along De Portola Road (Dudek and Associates 2002). Historically, there were a large number of owl locations concentrated within the Moreno Valley area, however due to urban development, the number in the early 2000s was unknown (Dudek and Associates 2002).

Through 2001, there were small breeding populations of burrowing owls remaining in southwestern Riverside County in the vicinity of Perris, Lakeview, and Temecula, and a colony (15 adults and 10 juveniles in 1999) near the Pechanga Indian Reservation (CNDDB 2001). California State Parks Inland Empire District staff conducted thorough burrowing owl surveys in habitat at Lake Perris SRA and San Jacinto Wildlife Area ("SJWA") during the nesting season of 2002 (La Claire 2002). At Lake Perris SRA, a total of 12 owls and 7 sites were recorded, and at SJWA 32 owls and 10 sites were observed (La Claire 2002). Owls were nesting at March Air Force Base in artificial nest boxes; however, portions of the base were decommissioned and no agency or entity had responsibility for protecting or maintaining owl nest boxes (P. Bloom, pers. comm., 2001). Most remaining owl colonies in western Riverside County were very small, highly fragmented, unprotected, and on the brink of extirpation in the early 2000s (P. Bloom, D. Cooper, pers. comm., 2002).

Accounts from the early 2000s suggested around 300-350 owl pairs remained in western Riverside County; by 2010 the number had declined to around 150-300 pairs due to destruction of habitat and development (J. Kidd pers. comm., 2010). Owl habitat was being disked for fire prevention and to discourage owls. However, owls still nested in rocky outcrops that were inaccessible to disking. Kidd et al. (2007) identified 18 confirmed breeding season locations in western Riverside County. The most important remaining and occupied protected habitats were located at San Jacinto Wildlife Area (10 pairs), Johnson Ranch Preserve (10 pairs), March Air Reserve Base (6 pairs), and Estelle Mountain/Lake Mathews Reserve (2 pairs). Kidd et al. (2007) were aware of 106 additional breeding pairs, most of which were located between Interstate 215 to the west, Interstate 10 to the north, the San Jacinto Mountains to the east, and Temecula to the south. Smaller numbers of breeding pairs were identified west of Interstate 215 in Menifee, Perris, the Gavilan Hills, Lake Mathews, March Air Reserve Base, and the City of Riverside. Kidd et al. (2007) reported only a few remaining pairs from the westernmost portions of the county in the Eastvale area, north of Corona and approximately 50 pairs of breeding owls east of the San Jacinto Mountains and north of Interstate 10 from Desert Hot Springs to the

Coachella Valley. Between 2004 and 2006, Kidd et al. (2007) monitored 160 pairs within the Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP) area and observed a 26% decline in breeding territories, while 41 pairs were extirpated without mitigation. Of the remaining pairs, only 31 were located on reserve lands. Kidd et al. (2007) predicted that most of the remaining 88 unprotected pairs would be eliminated within five to ten years due to habitat loss and lack of protection. Kidd et al. (2007) concluded that owl populations in western Riverside County were so fragmented and diminished that long term persistence was unlikely.

There are only 6 recent (2105-2023) breeding season observations in the CNDDB in western Riverside County: 1 adult May 2015 at Cabazon, San Gorgonio Pass; 1 pair with fledged young June and August 2015 near Romoland; 1 pair with 1 juvenile May 2016 on Johnson Ranch near Skinner Reservoir; another location on Johnson Ranch with 4 nests and 5 young in 2015, and 4 nests and 10 young in 2016; a known breeding location with up to 12 owls observed in 2016 near Menifee; and 1 adult April 2017 in Perris. Almost all of these locations were threatened by development, and many had threats such as wind turbines, weed abatement, vehicle strikes, domestic dogs/cats, trash, and homeless camps.

Southwestern San Bernardino County

Historical records confirmed breeding near Highlands in 1896 and 1897, near Chino in 1916, and at San Bernardino in 1883, 1885, 1886 and 1899; and indicated probable breeding at Redlands in 1902-03, near Oak Glen in 1910, near Chino in 1915 and 1926, and near San Bernardino in 1883, 1886, 1892, and 1928 (Hartzell 1888; Stephens 1902; Willett 1912; Van Rossem 1914; CHAS 2001; CMNH 2001; FMNH 2001; MVZ 2001; NMNH 2001; WFVZ 2001; CAS 2002a). Egg collector H. Edwards reported owls to be “fairly common” near Chino in 1916, noting a colony of several dozen pairs and collecting 2 egg sets (WFVZ 2001). Scattered observations around San Bernardino County included a breeding colony observed near Lockhart in the 1970s, and probable breeding at Joshua Tree National Monument in 1961 and in the Lucerne Valley in 1981 (CNDDB 2001; CSULB 2001; UCSB 2001).

Small numbers of breeding owls in Redlands, Colton, Rancho Cucamonga, and Chino Hills were extirpated by the early 2000s (J. Bath, pers. comm., 2003). Breeding owl populations in western San Bernardino County in the vicinity of San Bernardino, Chino, and Ontario continued to decline due to impacts by development and human harassment (CNDDB 2001; J. Bath, pers. comm., 2003). As of 2003, an estimated 56+ owl pairs remained in Chino and an estimated 40+ pairs remained in Ontario; all of these owls lived in habitat threatened by development (J. Bath, pers. comm., 2003). Most remaining owl colonies in western San Bernardino County were small, highly fragmented, unprotected, and on the brink of extirpation (P. Bloom, pers. comm., 2002).

Kidd et al. (2007) reported that burrowing owls continued to decline in southwestern San Bernardino County, where they nested in native habitat and on dairy lands; of 78 known pairs in the southwest corner of the county, 26 were eliminated due to habitat loss; and of 54 known breeding pairs in the high desert portion of their study area, 21 pairs were eliminated, also from habitat loss. Most remaining breeding pairs and colonies were small, highly fragmented, unprotected, and declining rapidly in the absence of adequate mitigation for habitat loss (Kidd et al. 2007). Kidd et al. (2007) concluded that owl populations were so fragmented and diminished that long term persistence in southwestern San Bernardino County was unlikely. From 2000-2010, much of this former owl habitat was indeed converted for housing and the area lost significant numbers of burrowing owls (J. Kidd pers. comm., 2010). While there were several hundred owl pairs in southwestern San Bernardino County in 2003, by 2010 there were likely only around 50 pairs. No habitat conservation plans or other documents helped with planning, and projects in this area were not being monitored for owl conservation benefits at that time (J. Kidd pers. comm., 2010).

There are only 3 recent (2105-2023) breeding season observations in the CNDDB in southwestern San Bernardino County: 13 nesting adults observed February 2016 in Ontario; 1 adult in March and May 2016 SE of Apple Valley; and 2 adults with 7 young June 2016 SE of Chino. These sites were threatened by development, disking, vehicle strikes, and human disturbance.

Imperial and Coachella Valleys

Imperial Valley

Historically, burrowing owls within the Imperial Valley were present in low densities, similar to populations in the undisturbed deserts surrounding the valley (Garrett and Dunn 1981; DeSante et al. 1997; Rosenberg and Haley 2001, 2003). Historical records confirmed breeding at Silsbee in 1909, at Toros in 1928, at an undisclosed location in the Imperial Valley in 1931, near Westmoreland and east of El Centro in 1934, at Greeson Slough in the 1960s, at Salton Sea National Wildlife Refuge in the 1980s, and at Palo Verde in 1984; and indicated probable breeding at Calipatria in 1922 and 1988, at Westmoreland in 1956, and at Seeley in 1977 (Coulombe 1971; CNDDB 2001; CSULB 2001; LACM 2001; MVZ 2001; SBCM 2001; UCLA 2001; UCSB 2001; WFVZ 2001).

Along with the intensification of agriculture in the 1900s, the burrowing owl population in the Imperial Valley grew to one of the largest and most dense populations in California. Coulombe (1971) observed owls commonly during the 1960s along canal banks throughout the year, calling them a "conspicuous feature" of irrigated farmlands. Coulombe (1971) estimated 3.3 pairs/km^2 within an 8-km^2 area of the Imperial Valley during the 1966-67 breeding season. Population studies conducted by Coulombe (1971) southwest of El Centro revealed owl densities ranging from 1 to 16.3 owls per mile along Greeson Slough and the New River. Coulombe (1971) was able to locate and band 19 owls from one-half mile of continuous habitat along the Dahlia Drain Canal, near El Centro, and estimated a density of 20-25 owls per square mile there from 1966-1967. Coulombe (1971) also estimated that 20-25% of the Imperial Valley breeding owl population remained during the winter, with probable immigration from the north and emigration to the south. Even though there was winter immigration, Imperial Valley owls were thought to be reproductively isolated from owls in other areas (Rosenberg and Haley 2003).

DeSante and Ruhlen (1995) detected 1,045 owl pairs in the Imperial Valley during surveys from 1991-1993, and estimated a population of 6,571 pairs. There are insufficient data to determine if the Imperial Valley population declined from the mid-1980s to the early 1990s (DeSante and Ruhlen 1995). Rosenberg and Haley (2003) estimated an owl density of 8.3 pairs/km^2 at the southern rim of the Salton Sea in the Imperial Valley, one of the highest densities of burrowing owls reported. In the 1990s the majority (71%) of the state burrowing owl population inhabited the Imperial Valley (DeSante and Ruhlen 1995). Burrowing owls in the Imperial Valley are commensal with the round-tailed ground squirrel (*Spermophilus tereticaudus*) and occur almost exclusively in un-lined earthen banks along irrigation ditches.

Wilkerson and Siegel (2010) estimated 6,408 burrowing owl pairs in the Imperial Valley region in 2006 and 2007. This was 3% fewer than the 6,571 pairs estimated during the 1991-1993 survey.

In the process of the Imperial Irrigation District (IID) seeking permits for water transfers, the State Water Resource Control Board required surveys and reporting on natural resources, and a draft HCP was being developed for IID (that has not been completed or approved as of 2023) that prompted surveys for burrowing owls. The HCP study area included all of the IID rights-of-way that parallel irrigation canals, drains, and ditches within the approximately 500,000-acre IID service area, which covers the entire agricultural matrix of the Imperial Valley. The HCP planning agreement (IID 2006) required IID to survey 20% of the drainage and conveyance system in a manner that would provide a valley-wide estimate of the burrowing owl population. Bloom Biological (Manning 2009) began monitoring studies of burrowing owls in 2006 and established a methodology for monitoring the owl population within the HCP study area. A pilot study was conducted in 2006 to assess probabilities of detection and determine the best survey methodology. A vehicle survey methodology was developed to collect data and construct capture-recapture encounter histories to estimate owl territories (breeding pairs). This was the most intensive survey of Imperial Valley owls, which developed, tested, and validated a survey method that produced unbiased, precise estimates of owl abundance. Bloom Biological found that male owls restricted 97% of diurnal movements to less than 110 meters from their burrow site. Manning (2009) continued monitoring through 2008, estimating abundance of owls along IID's rights-of-way within the study area was at 4,879 male owl territories in 2007 and 3,557 male owl territories in 2008[13]. When these estimates were compared to prior estimates of owl territories, a decline in the abundance of burrowing owls within the Imperial Valley was evident. Numbers were significantly fewer than the DeSante and Ruhlen (1995) 1990s or the Wilkerson and Siegel (2010) 2006-2007 estimates, and Manning (2009) documented a further decline of approximately 27% between 2007-2008. The Manning (2009) and subsequent Imperial Irrigation District (IID 2012) surveys demonstrated that substantially lower owl populations existed in the Imperial Valley (21% to 43% lower) than had previously been estimated (DeSante and Ruhlen 1995; Wilkerson and Siegel 2010).

AECOM conducted a first year of owl surveys in May 2011, based on the refined and presumably much more accurate survey methodology of Bloom Biological (2009). A spatially balanced random selection tool was employed using GIS to choose 55 survey grids from those established by Bloom Biological, and survey grids were randomly selected from each stratum (19 low, 21 medium, and 15 high). Using two estimation methods, AECOM estimated averages ranged from 7 to 8, 19 to 20, and 35 to 39 owl territories on a low, medium, or high plot, respectively. AECOM (IID 2012) determined the entire Imperial Valley (not just IID right of ways) had 4,589 to 5,058 burrowing owl territories in 2011 (IID 2012). AECOM re-surveyed in 2012, and estimated a decreased population of only 3,776 to 4,133 territories (IID 2012). IID has not conducted focused owl population surveys since then. IID surveys in 2017 identified about 3,330 burrowing owl burrows, but did not estimate owl numbers (Gross 2019).

Estimates of densities of burrowing owl territory densities (in territories/km^2) in the Imperial Valley have shown considerable variation (see Table 3). This variation is mostly a function of variation in study area size used to make the density estimates. Some of the Imperial Valley density estimates are from a very small study area (such as Rosenberg and Haley 2004), so it would be inappropriate to extrapolate these estimates to the entire region. It is clear that

[13] The Bloom Biological survey only included burrowing owls within IID rights-of-way and did not include owls in farm fields, drains, canals, or other areas.

Imperial Valley burrowing owl numbers have declined, and likely that some of the very high densities reported in the 1990s reflected survey routes chosen with extremely abundant owl territories.

Year	Surveyor	Owl territories/km^2
1966-1967	(Coulombe 1971)	3.3
1992	(DeSante et al. 2004)	2.0
1993	(DeSante et al. 2004)	2.1
1998	(Rosenberg and Haley 2004)	9.1
1999	(Rosenberg and Haley 2004)	7.9
2000	(Rosenberg and Haley 2004)	8.0
2007	(Bloom Biological)	2.1
2008	(Bloom Biological)	1.5
2011	(AECOM 2011)	2.1
2012	(AECOM 2012)	1.7

Table 3 – Estimates of Imperial Valley burrowing owl territories/km^2

Burrowing owl habitat suitability in the Imperial Valley is changing due to altered water irrigation regimes through the 2003 Colorado River Quantification Settlement Agreement (QSA). The QSA defined the rights to a portion of Colorado River water for San Diego County Water Authority (SDCWA), Coachella Valley Water District, Imperial Irrigation District and the Metropolitan Water District of Southern California. California agreed to a water transfer of as much as 200,000 acre-feet a year from the Imperial Valley to coastal San Diego for up to 75 years (the largest agricultural to urban water transfer in the United States), transfer of 105,000 acre-feet annually between IID and Metropolitan, and transfer of as much as 103,000 acre-feet annually between Imperial and the Coachella Valley district. The transfer agreement requires water conservation, which includes 15 years of fallowing of significant areas of former crops. Barren or fallow/idle croplands are associated with relatively low densities of owls in the Imperial Valley (Audubon California 2015). IID agreed to a 15 year fallowing program (ending in 2017) to fulfill the annual water transfer delivery schedule to SDCWA and Salton Sea mitigation delivery schedule and manage their Colorado River consumptive use cap. IID used a schedule of on-farm fallowing and Salton Sea mitigation fallowing through 2017 to conserve water; by 2018 IID transitioned to system efficiency and on-farm efficiency to make up the difference, and ended the fallowing program. The agreement also provides for lining earthen canals with concrete; as of 2019, 23 miles of the All-American Canal had been lined with concrete (Gross 2019). The highest densities of owls in the Imperial Valley are along earthen canals (Audubon California 2015). Many farmers in the Imperial Valley are changing water use from flooding fields to using sprinkler irrigation, which can reduce insects available to burrowing owls as a food source.

The Imperial Valley has subsequently undergone rapid development of massive utility-scale solar, wind, and geothermal projects, with former farmland being converted to industrial energy uses. A 2012 Bureau of Land Management EIS (USBLM 2012) identified nearly 46,000 acres (186 km^2) of planned and foreseeable land conversions in the Imperial Valley, and Smallwood (2013c) noted that the extent of planned land conversions was actually even greater since the 2012 DEIR for the Imperial Valley Solar Company 2 Project included a list of 61 existing, planned, and foreseeable projects in the area. Using the range of reported burrowing owl densities in the Imperial Valley (1.5-9.1 territories km^2), the land conversions identified by the USBLM (2012) would result in the cumulative loss of 279 to 1,692 burrowing owl pairs from the Imperial Valley.

In the 2023 nesting season, there were low numbers of breeding owls observed in Imperial Valley, and owls were missing from sites where they were once more abundant (S. Smallwood, pers. comm, 2023).

Coachella Valley

The Coachella Valley encompasses the central 15% of Riverside County, the northeastern 5% of San Diego County, and the central-northern 5% of Imperial County (DeSante et al. 1996).

Forty historical locations were recorded for burrowing owls in the Coachella Valley (CVAG 2001), including confirmed breeding at Thermal and Indio in the 1920s (SBCM 2001). The majority (36 of 40) of these observations were during the spring and summer months, which probably indicated resident birds, potentially on breeding territories (CVAG 2001). However, an influx of wintering burrowing owls occurred in the Coachella Valley, and the known location information for this species did not allow a determination of wintering birds, as the month of observation was not consistently reported (4 of the known locations reported only the year of observation).

Prior to urban development, burrowing owls were regularly observed in empty lots around the Palm Springs Airport (CVAG 2001). Surveys in the early 1990s found no owl pairs in the Coachella Valley despite the fact that small populations existed there in the 1980s, and breeding owls were thought to be extirpated from the Coachella Valley (DeSante et al. 1996). DeSante and Ruhlen (1995) found zero owls in the Coachella Valley and estimated a breeding population of zero owls. There was a belief at that time that some owls may still have occurred along roads and levees in agricultural areas at the eastern end of the Coachella Valley, within lands covered by the Coachella Valley Multi-Species Habitat Conservation Plan, and there were a handful of breeding season observations (USFWS 1995; CNDDB 2001; LACM 2001). However, biologists from CDFG and the Coachella Valley Water District who routinely visited the agricultural drains and associated levees around the Salton Sea reported only one burrowing owl observation in the Coachella Valley in the early 2000s (CVAG 2001).

Data gathered during the subsequent development of a Natural Community Conservation Plan for the Coachella Valley indicated a small extant population of burrowing owls, with an estimated 10-20 breeding pairs scattered over the southern end of the valley and on some of the preserves developed by the Coachella Valley Mountain Conservancy (CDFG 2003). In addition, burrowing owl survey data collected by the USBLM over a number of years resulted in 74 total observations; however, the number of breeding pairs was not determined (CDFG 2003).

Wilkerson and Siegel (2010) found more burrowing owls than previous studies, detecting 49 pairs in the Coachella Valley region, with the highest densities of detections clustered at the northern end of the region around the town of Desert Hot Springs and south to Interstate 10. The Wilkerson and Siegel (2010) study estimated 53 pairs in the Coachella Valley region by 2007, a significant increase from 0 pairs found in the 1991-1993 survey and possibly representative of new colonization of owls there (Wilkerson and Siegel 2010). Although good habitat still exists in the region, areas of Coachella Valley have undergone significant habitat loss and loss of owl pairs since 2007; around Desert Hot Springs, owls have been passively relocated for development, leading to loss of breeding pairs (J. Kidd, pers. comm., 2010).

A review of recent (2015-2023) eBird reports in Coachella Valley during breeding season reveals breeding concentrations around Indio, Thermal, Desert Hot Springs, and around Whitewater west of San Gorgonio Pass.

Southern Desert Range

The range of the burrowing owl in southern desert areas encompasses the eastern 85% of Inyo County (excluding the Panamint Range); the southeastern 30% of Kern County; all but the southwestern 15% of San Bernardino County; the northeastern 30% of Los Angeles County; the eastern 50% of Riverside County (excluding the Coachella Valley); the eastern 50% of San Diego County; and 50% of Imperial County (excluding the Imperial Valley) (DeSante et al. 1996).

Burrowing owls in the southern desert range are in small, scattered populations, and have historically never been common (DeSante et al. 1996). Grinnell and Swarth (1913) believed burrowing owls were "very rare or entirely absent on the desert side of the [Peninsular] range." Garrett and Dunn (1981) gave an overview of the owl's distribution in southern California deserts: "It is quite scarce on the northern deserts from the [east] Mojave Desert north through Inyo Co…While it is largely resident in the region there is some winter movement of more northerly birds into the southern and coastal parts of the region…Open desert scrub is widely but sparsely inhabited."

Displacement of owls due to development in the Coachella Valley may have slightly increased owl numbers in southern desert areas, as they became merely uncommon rather than rare (Weathers 1983). Breeding bird surveys between 1980 and 1989 indicated increasing numbers of owls in the lower Sonoran deserts and lower Colorado River Valley in southeastern California (Haug et al. 1993). It was thought that the burrowing owl may have expanded into the lower Colorado River Valley with the expansion of agriculture because this species was not reported from the valley in the early part of the century (Grinnell 1914; K. Rosenberg et al. 1991). Owls became a fairly common resident in the lower Colorado River Valley (Rosenberg et al. 1991; D. DeSante, pers. comm., 2003), with a decrease in abundance in the northern areas of the valley in winter (Rosenberg et al. 1991).

DeSante et al. (1996) did not survey the southern desert range of the burrowing owl, and there was virtually no published literature on the distribution or seasonal movements of owls in the Mojave Desert (Campbell 1999). Campbell (1999) compiled 53 records (only 13 of which have specific locales and dates, with probable or confirmed breeding at 5 locales) of burrowing owls within the West Mojave Plan Area (WMPA), which were thought to represent a small sample of the locations where owls were present. Although no focused owl surveys had been done, Campbell (1999) indicated that the species was "uncommon, local or patchy in occurrence, and currently in slow decline," and believed the total breeding population within the WMPA could be in the range of a few hundred pairs. S. Myers, (pers. comm., 2002) believed that owls were "locally rare to uncommon" and declining in the West Mojave, noting they had disappeared from a number of locations due to urban development.

Crowe and Longshore (2010) estimated relative abundance and density of burrowing owls at two sites in the Mojave Desert from 2003-2004, finding densities of 0.09-0.16 territories/km^2 at an eastern Mojave Desert site, and 0.08-0.09 territories/km^2 at a southern Mojave Desert site. Crowe and Longshore (2010) made modifications to previously established survey techniques for use in desert shrublands and evaluated factors that might influence the detection of owls in desert areas.

Wilkerson and Siegel (2011) conducted the first systematic survey to assess size of populations of burrowing owls across the southeastern California desert region. Wilkerson and Siegel (2011) surveyed four regions: Northern Mojave Desert/Eastern Sierra Nevada, Western Mojave Desert, Eastern Mojave Desert, and Sonoran Desert. Wilkerson and Siegel (2011) found few or no burrowing owls in the northern Mojave Desert, eastern Sierra Nevada, or in the Sonoran Desert (excluding Palo Verde Valley). In the Eastern Mojave Desert Region, the survey found a best estimate for the region is 32 pairs. Wilkerson and Siegel (2011) documented 179 breeding pairs along the banks of water-conveyance structures in the Palo Verde Valley. Wilkerson and Siegel (2011) found large aggregations of burrowing owls in the western Mojave Desert region, concentrated in or along edges of scrublands, on the periphery of urban areas, and in active or fallow agricultural fields, with an estimate of up to 560 pairs.

Inyo County

There are historical records of breeding populations in the Owens Valley, Death Valley, and the Panamint Mountains and confirmed breeding at Bishop in 1939 (Fisher 1893; Grinnell 1923; Gilman 1934; Wauer 1962, 1964; MVZ 2001; NMNH 2001; SDMNH 2001). Pettingill (1981) reported burrowing owls nesting at Death Valley National Monument and residing all year in the Owens Valley, from Bishop southward. Garrett and Dunn (1981) reported the species "quite scarce" on the northern deserts from the East Mojave Desert north through Inyo County. There was a breeding season observation east of the White Mountains in 1994 (CNDDB 2001). There were records of breeding owls at the 500,000-acre China Lake Naval Weapons Facility from 1978 to 1984 (USBLM 2002), and there apparently was a small colony of about 6 pairs of owls there in the mid-1980s (P. Bloom, pers. comm., 2002). Burrowing owls still had a breeding population at China Lake in the early 2000s (CDFG 2003), but the 2002 base management plan offered no detailed information and did not provide any specific conservation measures since the owl was not a listed species (China Lake NAWS 2002).

The Wilkerson and Siegel (2011) 2006-2007 surveys in Inyo County in the Northern Mojave Desert/Eastern Sierra Nevada Region, detected 0 burrowing owls on surveyed blocks (1 pair was detected incidentally on an otherwise un-surveyed block). The CNDDB has documentation of only one recent (2015-2023) breeding season record in Inyo County: 4 adults observed in June 2017 on multiple visits, NE of Keough Hot Springs. A review of recent (2015-2023) breeding season records on eBird reveals only 1 location in Inyo County with more than 1 owl observed during breeding season: in 9 Mile Canyon NW of Pearsonville (4-5 owls in June 2020). Half a dozen other locations in Inyo County were records of single birds during breeding season: Chalfant Valley, Death Valley Road E of Big Pine, Owens Lake, Stovepipe Wells, and Fossil Falls.

Southeastern Kern County

Historical records confirmed breeding at the Desert Tortoise Research Natural Area, northeast of California City in the 1970s, and indicated probable breeding at Mohave in 1918 (Berry 1973; MVZ 2001). Burrowing owls were observed regularly at the Desert Tortoise Research Natural Area (M. Conner, pers. comm., 2002). Campbell (1999) compiled 23 records of burrowing owls within the 301,000-acre Edwards Air Force Base ("AFB"); all of these had no specific locale or date. Although there had been no focused surveys, burrowing owls had been seen nesting since 1999 in as many as 6 sites simultaneously on the western half of the Base, where more typical owl habitat existed; preliminary data suggested that there were far fewer owls on the eastern half of the Base (R. Montijo, pers. comm., 2003). The 2001 Base management plan did not provide any specific conservation measures since the owl was not a listed species (Edwards AFB 2001), but the known nest sites and owls were under no immediate threat from development or other activities and the population appeared to be stable (S. Myers, pers.

comm., 2002; R. Montijo, pers. comm., 2003). There were 2 known nest sites immediately to the west and south of the Base, where human encroachment and activity appeared to be a problem (R. Montijo, pers. comm., 2003).

Wilkerson and Siegel (2011) detected a few owl pairs near Ridgecrest during 2006-2007 surveys in southeastern Kern County. DTPC (2013) reported on observations of burrowing owls throughout the Desert Tortoise Research Natural Area (DTRNA) and Expansion Area during breeding season, during spring surveys focused on other species from 2005-2009, 2011, and 2012. This preserve is used as a mitigation bank by the California Energy Commission, USFWS, U.S. Bureau of Land Management, Caltrans, and CDFW.

San Bernardino County

Garrett and Dunn (1981) reported the burrowing owl was “quite scarce” in the East Mojave Desert, but “rather common in agricultural areas” within the Colorado River Valley. Burrowing owls were noted to breed in the Kingston Range, in northeast San Bernardino County, with observed owl densities of 1.4 birds/100 acres during summer surveys (Stone and Sumida 1983). There were historical reports of owls nesting at the train yards and the sewage plant in Barstow (USBLM 2002) and a burrow with up to 4 owls was observed at the train yards throughout the summer of 2002 (Rado 2002). There were breeding season records near Goffs (D. Cooper, pers. comm., 2002) and Victorville in the Mojave Desert (CNDDB 2001; USBLM 2002). Burrowing owls occurred at Twentynine Palms Marine Corps Air Ground Combat Center (“MCAGCC”), but the 1996 management plan for the MCAGCC offered no detailed information and did not provide any specific conservation measures since the owl was not a listed species (MCAGCC 1996). Burrowing owls were found around Victorville (perhaps 10-15 pairs), Apple Valley, Hesperia, and Lucerne Valley in the early 2000s, but were declining due to rapid urban development (S. Myers, pers. comm., 2002). There was a report of a resident burrowing owl near El Mirage in 1991 (BWS 1991).

Wilkerson and Siegel (2011) detected large concentrations of burrowing owls in the Apple Valley (Victorville area) and Lucerne Valley, and a few pairs near Barstow, during 2006-2007 surveys in western San Bernardino County. As of 2010, burrowing owls could still be found around Victorville, Apple Valley, Hesperia, and Lucerne Valley, but significant housing development in threatened populations there (J. Kidd pers. comm., 2010). Around Victorville, Barstow, and Hesperia, development had altered substantial habitat since 2003 causing the loss of many burrowing owl pairs. High desert populations in northern San Bernardino County were more stable. However, these populations faced threats as well. There were planned and current wind and solar development projects which threaten breeding habitat in both San Bernardino and northeast Los Angeles Counties. Power projects use passive relocation to move birds off site which is generally very harmful to burrowing owls (J. Kidd pers. comm., 2010). In eastern San Bernardino County, Wilkerson and Siegel (2011) detected 32 owl pairs during 2006-2007 surveys of 45 blocks in the eastern Mojave Desert region.

Northeastern Los Angeles County

There are historical nesting records from the Antelope Valley, in northeastern Los Angeles County (Daggett 1904; MVZ 2001; UCSB 2001). It was estimated that a minimum of 10 breeding territories were active in Antelope Valley most years between 1970-2000 (P. Bloom, pers. comm., 2002). The Antelope Valley provided the last stronghold for the species in this county with a small breeding population and a wintering population of unknown size. Field work conducted through the Los Angeles Breeding Bird Atlas Project suggested a range of approximately 20-50 pairs of owls in this area, primarily located on private lands where future urban development will occur (CDFG 2003). Small numbers of breeding owls persisted around Lancaster and Palmdale in the early 2000s, however burrowing owls in northeastern Los Angeles County were declining and threatened by development pressure (CNDDB 2001; D. Cooper, S. Myers, pers. comm., 2002).

Kidd et al. (2007) collected 9 breeding season records from the Antelope Valley on the east side of the San Gabriel Mountains in northeast Los Angeles County; and cited an additional 4 pairs reported approximately 12 km northeast of Lancaster. Owls had not been reported nesting in northeast Los Angeles County since 2003 (Kidd et al. 2007), and Kidd et al. (2007) concluded that owl populations were so fragmented and diminished that long term persistence was unlikely. However, Wilkerson and Siegel (2011) detected large concentrations of burrowing owls in the Antelope Valley (vicinity of Palmdale and Lancaster) in northeastern Los Angeles County during 2006-2007 surveys.

Eastern Riverside County

Garrett and Dunn (1981) reported the burrowing owl to be "rather common in agricultural areas" within the Colorado River Valley. Burrowing owls nested in Deep Canyon (south of Palm Desert), from the floor of the Coachella Valley to the base of the Santa Rosa Mountains (Ting and Jennings 1976; Weathers 1983). The Palo Verde Valley (in eastern Riverside County near the Colorado River) has similar agricultural practices to the Imperial Valley and the potential to support higher densities of burrowing owls than is typical for this desert (CDFG 2003). The Palo Verde Valley was thought to support the second largest burrowing owl population in southern California, speculated at on the order of 500-1,000 pairs (J. Kidd, cited in CDFG 2003).

Wilkerson and Siegel (2011) were the first to systematically survey the Palo Verde Valley in southeastern Riverside County, from 2006-2007. Wilkerson and Siegel (2011) surveyed all blocks that encompassed Palo Verde Valley (one was randomly selected and the others were historic breeding blocks), and located owl 179 pairs; their best estimate of the Palo Verde Valley population was 179 pairs. In the Palo Verde Valley, burrowing owls nest along the banks of earthen and concrete irrigation canals and other water-conveyance structures.

Breeding burrowing owls appear to have declined significantly in the Palo Verde Valley since the 2006-2007 surveys. The CNDDB has only one recent (2015-2023) breeding season observation in eastern Riverside County: one adult on February 9 and 11, 2018 at a former breeding colony location NE of Palm Springs (the numbers here have declined; 8+ adults and 3 juveniles were observed here in July 2007). A review of recent (2015-2023) breeding season observations on eBird reveals only scattered records of small numbers of owls during breeding season in agricultural areas throughout the Palo Verde Valley. Records on eBird of more than a single owl during breeding season are extremely scarce throughout the Palo Verde Valley, Blythe area, and Cibola National Wildlife Refuge since 2018: 8 records of pairs in 2018 (7 pairs at Cibola NWR); 1 pair in 2019; 3 pairs in 2020; 8-10 pairs in 2021; I record of 9 owls at the end of breeding season in 2022; and zero records of pairs in the entire region in 2023.

Eastern San Diego County

Burrowing owls once nested in the Borrego Valley and probably in the Borrego Badlands in eastern San Diego County (Unitt 1984). A couple of pairs historically observed in the Borrego Springs area were apparently extirpated by the 1980s (Unitt 1984), but small numbers of owls likely occurred in the Anza-Borrego Desert (Unitt 2002).

Wilkerson and Siegel (2011) did not detect any burrowing owls during 2006-2007 surveys in eastern San Diego County.

Imperial County, excluding the Imperial Valley

Burrowing owls were reported to be common in agricultural areas within the lower Colorado River Valley (Garrett and Dunn 1981; Monson and Phillips 1981; Rosenberg et al. 1991; D. DeSante, pers. comm., 2003).

The Bard Valley (in eastern Imperial County near the Colorado River, northeast of Yuma) has similar agricultural practices to the Imperial Valley and was thought to have the potential to support higher densities of burrowing owls than is typical for this desert (CDFG 2003). But Wilkerson and Siegel (2011) did not detect any burrowing owls during 2006-2007 surveys in the lower Colorado River Valley other than in the Palo Verde Valley, and presumably there were none in eastern San Diego County. A review of recent (2015-2023) breeding season observations on eBird reveals no concentrations of burrowing owls near Bar nor anywhere in eastern Imperial County except for the Palo Verde Valley.

<u>Population Trends</u>

This section summarizes the known information on population trends (which are discussed more thoroughly in the previous section on Historical and Recent Distribution and Abundance), based primarily on resurvey efforts consistent with statewide survey methodology. See Figure 3 for a map of status and population trends of breeding burrowing owls by region.

Extirpations

Burrowing owls have been extirpated as a breeding species from roughly 16% of their former range in California. Burrowing owls appear to no longer breed in most of the northern Central Valley (Shasta, Glenn, Colusa, Lake, Nevada, Sutter, and Placer counties). They have now been extirpated from all of the Bay Area coastal counties (Sonoma, Marin, San Francisco, San Mateo, and Santa Cruz counties) and portions of the Bay Area interior (Napa, southwestern Solano, and western Contra Costa counties). They have been extirpated from the entire central and southern coast (coastal Monterey, coastal San Luis Obispo, western Santa Barbara, Ventura, western Los Angeles, and Orange counties).

Breeding burrowing owls appear to be very near extirpation in an additional 13% of their former breeding range in California, including portions of the northern Central Valley (Tehama, Butte, and Yuba counties), middle Central Valley (Yolo, Sacramento, Stanislaus, and Merced counties), interior Bay Area (western Alameda County and Santa Clara County), central coast (western San Benito County), and southwestern coast (San Diego County).

Population Declines

Rangewide

The western burrowing owl has declined significantly throughout its range in North America (Haug et al. 1993; DeSante et al. 1997; James and Espie 1997). The species was listed as endangered in 1995 in all the provinces in Canada in which it breeds (Haug et al. 1993) and is listed as threatened in Mexico (AGFD 1995). In the United States, it is listed as a federal

Species of Special Concern. The majority of the mid-western and western states within the owl's range have listed the species: it is listed as endangered in Minnesota and Iowa (James and Ethier 1989; Marti and Marks 1989), threatened in Colorado (Anderson et al. 2001), and as a state Species of Special Concern in Arizona, Oklahoma, Montana, Wyoming, Idaho (species of greatest conservation needs), Utah, Washington, Oregon, and California (Sheffield 1997a; Sheffield 2021). It is estimated that California supports the largest remaining breeding and wintering populations of the species (James and Ethier 1989; DeSante et al. 1993; Anderson et al. 2001).

Statewide

Localized declines of burrowing owl populations were noted in portions of the state by the early 1900s, for example, in the Fresno area (Miller 1903; Tyler 1913a), in the region of Los Angeles (Willett 1912), and in Orange County (Robertson 1931). The species has been in continuous decline throughout California since at least the 1940s (Grinnell and Miller 1944; Zarn 1974a; Arbib 1976; Remsen 1978).

From the 1980s to the mid-1990s, the California breeding owl population was estimated to be declining in abundance at a rate of 8% per year (DeSante and Ruhlen 1995; DeSante et al. 1996). The winter abundance of burrowing owls in California also declined significantly since the 1970s, with Christmas Bird Count abundance data showing a mean decline of 1.2% per year from 1959-1988 (James and Ethier 1989; Sauer et al. 1996). During the first comprehensive statewide breeding survey (DeSante et al. 1996, 2007), less than half (46%) of the 165 owl breeding groups known during the 1980s were found during the 1991-1993 resurvey efforts; and even with 69 new owl groups located during the surveys, the minimum statewide decline since the 1980s was 12%. DeSante et al. (1996, 2007) also documented a 30% decrease of survey blocks that contained owls.

The 2006-2007 statewide survey and resurvey of burrowing owls by Wilkerson and Siegel (2010) found 21.6% fewer breeding pairs, and estimated a 11% decline in the statewide breeding population since 1993.

Comprehensive statewide surveys have not been conducted since 2007, but the statewide rates of decline (about 11-12% per decade) noted from the 1980s to 1991-1993, and then to 2006-2007 have likely continued, and in many places accelerated. Almost all, if not all, of the significant breeding groups of owls in the state are now known, and regional and local resurvey efforts from 2007 to present have documented widespread declines of breeding owls throughout California.

Central Valley

DeSante et al. (1996, 2007) documented a 48% decline in known breeding groups in the Central Valley from the 1980s to 1991-1993, with the decline the greatest in the Southern Central Valley. However, with the addition of newly discovered breeding groups, the overall Central Valley population was comparable to the previous decade. Resurvey from 2006-2007 by Wilkerson and Siegel (2010) found a 27% decline in estimated pairs for the entire Central Valley; with a 100% decline in the northern Central Valley, a 16% decline in the middle Central Valley, and a 20% decline in the southern Central Valley.

There has been continuous documentation of substantial declines in the middle Central Valley from 1980 to the present. DeSante et al. (1997) found a 48% decline in known owl breeding groups in the middle Central Valley from 1986-1991; and even when newly located breeding groups were included, the region still experienced an 9% decline in breeding groups. In Yolo County, where the extirpation trajectory has been well documented, there was 50% decline in breeding owls from 1980-2000 (PHBA 2002); a 20% decline from 2000-2005 (Widdicombe 2007); a 76% decline from 2007-2014 (BOPS 2015; Menzel et al. 2024); and a further 83% decline in blocks with breeding owls from 2014-2023 (BOPS 2023). In Sacramento County, there have been unquantified but substantial declines in breeding owls from the mid-1990s to the mid-2000s (HEP 2004; SCRSD 2006); and substantial declines since 2018 (Conrad 2023). At one of the largest remaining breeding owl populations in the state, at Altamont Pass in eastern Contra Costa and Alameda counties, Smallwood (2023a) reported a 45% decline in breeding owls from 2011-2019. Conard (2023, 2024) reported on two decades of declines in the middle Central Valley and the San Joaquin Valley.

San Francisco Bay Area

Breeding owls in the San Francisco Bay Area region declined about 53% from 1986-1990 (DeSante and Ruhlen 1995; DeSante et al. 1997), with more than 65% of the Bay Area owl colonies known in the 1980s extirpated by the 1990s; even when new groups located during the 1990s were included, there was still a 51% decline in colonies (DeSante and Ruhlen 1995). The Wilkerson and Siegel (2010) resurvey from 2006-2007 documented a further 28% reduction in breeding pairs in the Bay Area since the 1990s.

In Santa Clara County the extirpation trajectory has been closely studied. CDFG estimated that nesting owl pairs in the South Bay region declined by 75% from 1970-1980, going from 1,000 pairs to 250 pairs (CDFG 2003). Trulio (1998a) resurveyed known owl observation sites in Santa Clara County from 1984-1988 (H.T. Harvey and Associates 1994), from 1995-1998, documenting a 57% loss of breeding sites to development in 10 years, an average of almost 6% per year. Trulio (2002) resurveyed again in 2002, finding 66% were lost to development. Higgins (2015) estimated that by 2015, breeding owls in the 1988 sites had declined in numbers by 88% (from 500 to 60 owls by 2015). Talon Ecological Research Group (2023) documented a 69% decline in breeding owls in the Santa Clara Valley HCP area from 2015-2022.

Central-Western California

DeSante et al. (1996, 2007) documented a 33% decline in known breeding groups in the Central-Western Coast region from the 1980s to 1991-1993. When DeSante et al. (1996, 2007) surveyed the Central-Western California interior from 1991-1993 and estimated 38 pairs, they were clear that they had missed substantial owls in the Carrizo Plain and other upland valleys in the region, due to difficult access. Wilkerson and Siegel (2010) estimated 84 pairs in the Central-Western Interior region in 2006-2007, 121% more than the 1991-1993 survey. Wilkerson and Siegel 2010) surveyed a much greater number of upland blocks, so the higher number of pairs from 2006-2007 was most likely an artifact of increased survey effort rather than an actual increase in owl numbers.

Southwestern California

DeSante et al. (1996, 2007) documented an 83% decline in known breeding groups in the Southwestern Coast region from the 1980s to 1991-1993; and a 66.7% decline even when new groups of owls were factored in. DeSante et al. (1996, 2007) found a 50% decline of known breeding groups in the Southwestern Interior region, but an apparent increase with new breeding groups that were located. This was likely an artifact of better survey coverage than an actual increase of breeding owls on the interior, as owls were thought to be in decline in the southwestern interior. That was confirmed during the 2006-2007 resurveys, when Wilkerson and Siegel (2010) estimated a 95% decline in breeding pairs in the Southwestern Interior.

Imperial Valley

The Imperial Valley experienced a significant increase in breeding burrowing owls during the 1900s, commensurate with the intensification of agriculture, increasing to the largest population in the state (Rosenberg and Haley 2003; DeSante and Ruhlen 1995). DeSante and Ruhlen (1995) detected 1,045 owl pairs in the Imperial Valley from 1991-1993, estimated a population of 6,571 pairs, and had insufficient data to determine if the Imperial Valley population declined from the mid-1980s to the early 1990s. Wilkerson and Siegel (2010) estimated 6,408 burrowing owl pairs in the Imperial Valley from 2006-2007, a decline of 3%. Subsequent Imperial Irrigation District surveys (Manning 2009; Bloom Biological 2009; AECOM 2011, 2012) demonstrated that substantially smaller owl populations existed in the Imperial Valley (21% to 43% lower) than had previously been estimated. Manning (2009) documented a decline of breeding pairs in the Imperial Valley of approximately 27% between 2007-2008. IID surveys (AECOM 2012) documented an 18% decline in owl territories in the Imperial Valley from 2011-2012.

Population Increases

There were a few locations in the state where breeding burrowing owl numbers had in the past increased commensurate with the intensification of agriculture which provided concentrated habitat along irrigation canals. In two of those areas, the Coachella Valley and Palo Verde Valley, breeding owls appeared to have increased between early 1990s surveys and 2006-2007 surveys. However, the breeding populations in Coachella Valley and Palo Verde Valley appear to have subsequently decreased in the last 10-20 years.

Coachella Valley

Since no owls were detected during 1991-1993 surveys, DeSante et al. (1996) thought breeding owls were extirpated from Coachella Valley, but sampling blocks during these 1990s surveys covered only a small fraction of the valley. CDFG (2003) estimated 10-20 breeding pairs in the Coachella Valley; and from 2006-2007 Wilkerson and Siegel (2010) detected 49 pairs in the Coachella Valley region, producing an estimate of 53 pairs. Breeding owl numbers apparently increased in Coachella Valley from the 1990s to 2007; but subsequently since 2007 there has been significant habitat loss and loss of owl pairs.

Palo Verde Valley

Burrowing owls may have expanded their breeding into the lower Colorado River Valley with the expansion of agriculture. They were not reported from the valley in the early part of the century (Grinnell 1914). DeSante et al. (1996) did not survey the southern desert range of the burrowing owl. A speculative estimate, based on the highest known owl densities in similar agricultural habitats in the Imperial Valley, was on the order of 500-1,000 pairs in the Palo Verde Valley (CDFG 2003). However, Wilkerson and Siegel (2011) were the first to systematically survey the Palo Verde Valley, from 2006-2007, locating 179 pairs; with significant coverage of the region, their best estimate of the Palo Verde Valley population was 179 pairs.

Western Mojave Desert

Wilkerson and Siegel (2011) found large aggregations of burrowing owls in the western Mojave Desert region, estimated at up to 560 pairs. However, since they were the first to systematically survey this region, this likely does not represent a population increase over previous estimates.

Attempted Reintroductions

There is a thorough discussion in the section above on distribution and abundance, regarding attempted enhancement of dwindling burrowing owl breeding groups in San Diego County by the San Diego Zoo Wildlife Alliance, using a conservation breeding program and translocation of evicted owls. As of 2023, 111 owls had been translocated to Rancho Jamul and Ramona Grasslands. Since the program has only been going since 2018, it is too early to tell whether this translocation program will be successful.

Meads (2023) reported on several decades of attempts by the Burrowing Owl Conservation Society of British Columbia to reestablish a self-sustaining breeding burrowing owl population after the species had been extirpated in the 1980s. Since 1990 the reintroduction program utilized three captive breeding facilities, creation of artificial nesting burrows, and release and monitoring of captive raised birds annually. Approximately 100 owls are bred each year for release in the grasslands of the Thompson-Nicola and South Okanagan of British Columbia. Over 800 burrows have been placed on privately owned ranch lands, provincial land, and non-government conservation properties. Release techniques have been developed that have increased adult survival rates by 50% and produced increased numbers of wild-hatched offspring to fledging by 50%. Increased captive breeding production and the hundreds of owls released resulted in an increase in the number of birds returning to nest from 2015-2017, with a 50% increase from previous years. Despite this massive, decades-long effort, the population crashed again after 2018 and the goal of achieving a self-sustaining population has not yet been reached after 33 years.

The Santa Clara Valley Habitat Agency contracted with Talon Ecological Research Group to run a juvenile burrowing owl overwintering project and a captive breeding and reintroduction program. They initiated the overwintering project as a Tier 3 conservation action under the Habitat Conservation Plan in 2019 and the captive breeding program in 2021. Without these conservation actions the Santa Clara Valley burrowing owl breeding population might already be extirpated. Similar emergency intervention efforts are being conducted in San Diego.

Figure 3 – Color-coded status and population trends of California breeding burrowing owls by county as of 2023 (map by Center for Biological Diversity)

Factors Affecting Survival and Reproduction; and Degree and Immediacy of Threats

The burrowing owl is adapted to extensive open habitats that at one time were subject to natural disturbance caused by fire, grazing by endemic herbivores, and probably most important, smaller-scale soil disturbances by burrowing ground squirrels and prairie dogs. Dynamic mosaics of naturally disturbed grasslands stretched unbroken over thousands of acres in areas where burrowing owls were once common in California. Within appropriate timeframes, burrowing owls are still capable of making spatial adjustments to changes in their habitat, including host burrow distribution, prey abundance, and vegetation structure. But many current-day anthropogenic habitat changes happen too suddenly for owls to respond, or the habitat is permanently destroyed without replacement. If such changes take place at a landscape scale, owls may not be able to find suitable burrows or prey, may not be able to find mates, or may simply become vulnerable to exposure and predation.

Some habitat-maintaining processes may benefit burrowing owls when implemented at certain intensities or spatial scales (for example, mowing portions of grasslands can be beneficial in that it mimics herbivore grazing), but detrimental to owls at other levels (when the mower is set low enough so that it scrapes soil/blocks burrow entrances). There are still a lot of uncertainties about how livestock grazing affects burrowing owls. Smallwood et al. (2009, 2023) found that loss of burrowing owls followed the switching of cattle with sheep. In addition, there are undoubtedly trade-offs among habitat features. For example, bare ground or short grass that provides good vantage to owls may not adequately support prey populations. For these reasons, habitat for burrowing owls likely always has a patchy or mosaic nature.

Processes that provide ample nesting, roosting, and foraging opportunities are beneficial to burrowing owls. These processes include burrowing by fossorial animals, low precipitation that results in short sparse vegetation, and disturbance that creates small areas of bare ground. Perches can provide good vantage, urban lighting can attract congregating insect prey, and cultivated crops can support plentiful small rodent prey, all of which are conditions that can enhance burrowing owl habitat. Mowing in road easements and fire breaks is a better weed control tool compared to disking or tilling, which can destroy burrows necessary for burrowing owl persistence in an area. Some municipalities support mowing to help conserve burrowing owl colonies but many private landowners still disc or till their lands, inadvertently impacting owl colonies.

Habitat conversion to urban uses usually has detrimental effects on burrowing owls due to direct, permanent loss of habitat and increased hazards, such as traffic, and predation by urban-adapted predators (such as ravens, coyotes, skunks, and great horned owls) and by cats and dogs. Agricultural practices may result in temporary or inadvertent habitats that are subject to frequent change. Both urban and agricultural habitats can result in "ecological traps," such as fallow fields, temporary ditches, or road easements, where ground squirrels, and owls, are tolerated only temporarily, and where there is no long-term consideration of burrowing owl conservation.

The benefits of ground squirrels for burrowing owls cannot be overstated, particularly the mutual alarm-calling between owls and squirrels, and the importance of burrows (Lenihan 2007). In years of studies at Altamont Pass, S. Smallwood (pers. comm., 2023) found that owl nest success increased in the presence of squirrels, and squirrel pups lasted longer into the year where they coincided with burrowing owls; in one colony where the squirrels were eliminated by poison, the owls were quickly extirpated. See Figure 4.

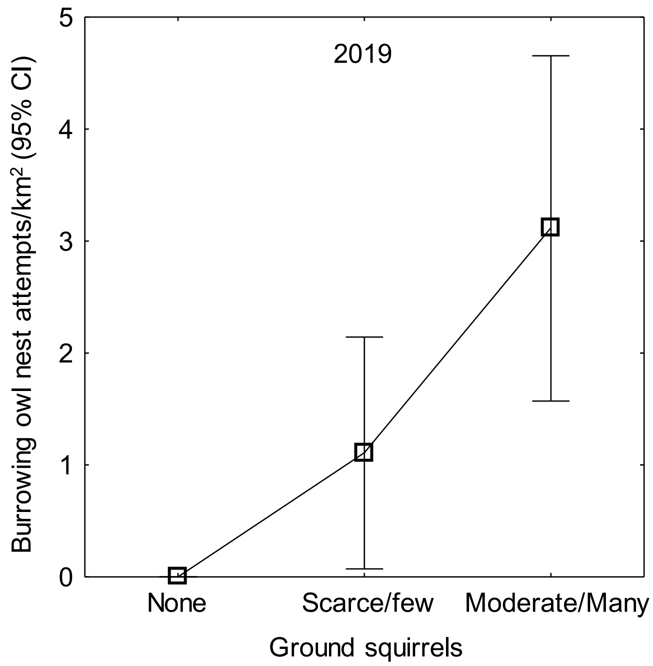

Figure 4 - Mean comparison of burrowing owl nest attempts/km^2 among plots with no ground squirrels, scarce or few squirrels, and moderate or many squirrels in 2019 among randomized sampling plots throughout the Altamont Pass Wind Resource Area, California. (Source: S. Smallwood, unpublished data)

The primary factors affecting the viability of California burrowing owl populations include:

- Loss of nesting and foraging habitat to human uses such as urbanization and incompatible agriculture, which results in direct mortality and lower population numbers as available habitat decreases.

- Destruction of nest burrows during urban development and agricultural activities by surface disturbances such as disking, blading, grading, and over covering, which may result in direct mortality of adults and young and may reduce the habitat quality and carrying capacity.

- Elimination of burrowing rodents, through means (including anticoagulant rodenticides and gassing) which may result in direct owl mortality, as well as ultimately making an area unsuitable for owls, thereby reducing available habitat.

- Active and or passive relocation of owls out of occupied habitat to accommodate urban development, which rarely results in successful breeding at the relocation sites, and crowds remaining owls onto smaller and smaller patches of habitat.

- Predation of burrowing owls by non-native and feral animals (including red fox and feral cats), which significantly reduces nesting success and productivity.

- Increased predation by native predators as more individuals compete for fewer resources in shrinking grassland habitat.

- Mortality due to industrial energy projects (solar and wind), vehicle collisions and other anthropogenic causes.

- Lack of vegetation management, including grazing, mowing, fire. This results in grasslands overgrown with tall weedy vegetation, eliminating burrowing owls and ground squirrel occupation. Novel or hybrid grassland ecosystems dominated by non-native forbs and Mediterranean grasses require regular monitoring and vegetation management for burrowing owl occupancy and nest success.

- Extended drought conditions (climate change) leading to decreased prey populations.

- Extreme weather events (climate change), such as extensive flooding killing ground squirrels and temporarily limiting roosting, breeding, and foraging habitat for burrowing owls.

<u>Direct Mortality</u>

Trapped or Crushed in Burrows

Burrowing owls occupying short, simple burrows or natural rock cavities may fly away when startled (Beltocq 1997), but few owls live under those circumstances in California. Rather, burrowing owls living in intricate California ground squirrel excavated burrow systems or long tunnels typically rely on their burrow for protection, retreating underground when alarmed, especially during the breeding season when they are incubating eggs or caring for young underground (CDFG 2003). This unique behavioral trait makes burrowing owls extremely vulnerable to being trapped or crushed underground during earthmoving or tilling activities, or rodent fumigation (CDFG 2003). For example, Catlin and Rosenberg (2006) documented inadvertent destruction (filling in or destroying) of 4 burrowing owl nest burrows by road maintenance along 800 m of road in the Imperial Valley, where 3 of 7 adult owls were killed, 2 active nests failed, and grading might have led to dispersal of the surviving adults.

Shooting

Historically, shooting was a significant source of burrowing owl mortality (Grinnell and Miller 1944). Between the 1860s up until the 1970s, collectors shot literally thousands of burrowing owls; these specimens now reside in museums and collections. Although shooting for collecting purposes is no longer permitted, shooting was still an issue until at least the early 2000s (e.g., Zarn 1974). Shooting caused 66% of the known mortality at a study of burrowing owl sites in Oklahoma (Butts 1973). Wedgwood (1978) discussed 3 burrowing owl colonies in Canada destroyed by shooting; Evans (1982) identified shooting as a problem in Sonoma County; a Boy Scout shot 4 owls at Laguna Niguel in Orange County (P. Bloom, pers. comm., 2002); and a small colony at Upper Newport Bay was apparently extirpated by shooting in the 1970s (J. Bath, pers. comm., 2003). Shooting remained a likely cause of at least limited mortality in the Mojave Desert (Campbell 1999) and in Santa Clara County up through the early 2000s (C. Breon, pers. comm., 2003).

Vandalism

Vandalism has caused significant impacts to burrowing owl colonies within urban areas. Thomsen (1971) estimated that 65% of the damage to burrows at her owl study site at the Oakland Airport was caused by humans, and cited plugging of burrows as a possible cause of loss of eggs and young. Owl declines in the Cypress Channel owl population in Chino were due to plugging of burrows (J. Bath, pers. comm., 2003). Illegal trash dumping has also been observed to impact burrowing owls (CVAG 2001; J. Bath, pers. comm., 2003). Remsen (1978) reported on an owl burrow deliberately destroyed by vandals. J. Bath (pers. comm., 2003) documented several instances of human harassment that likely contributed to localized extirpations of owls in western San Bernardino County. Human harassment of burrowing owls and vandalism of burrows will likely increase with increasing urbanization. Especially with the rise in social media and sharing burrowing owl locations on birding platforms, photographers frequently harass breeding burrowing owls, flushing owls from their burrows which can increase predation and nest failure.

Collisions with Vehicles and Structures

Vehicles

Vehicle strikes kill burrowing owls due to high use of roadside habitats by owls and their low, coursing flight. Vehicle-caused mortality has been observed in all habitat types (Konrad and Gilmer 1984; Haug and Oliphant 1987; Clayton and Schmutz 1997; Millsap 2002; Schulz 1997). Burrowing owls nesting along roadsides or parking lots may be at greatest risk; however, owls have also been observed to forage along roads over 0.6 mile (1 km) from nest burrows (J. Gervais, personal observation, cited in CDFG 2003), which increases overall risk. Vehicular strikes are often a significant source of burrowing owl mortality (Konrad and Gilmer 1984; Haug and Oliphant 1987; Millsap and Bear 1988; Haug et al. 1993; Kemper 1996; Clayton and Schmutz 1997), because owls have a relatively high tolerance for vehicular disturbance (Coulombe 1971; Plumpton and Lutz 1993) and often fly low to the ground (Anderson et al. 2001). Vehicle collisions are the primary mortality factor for adult owls in some fragmented environments (Clayton and Schmutz 1997). Vehicle strikes of owls were once common in Orange County before the near-extirpation of the species, including strikes of several banded birds in the early 1970s (P. Bloom, pers. comm., 2002). Vehicle-caused mortality is a concern for the owl population at the Carrizo Plain Natural Area (Rosenberg 1999) and has been documented frequently at Lemoore Naval Air Station (J. Gervais, pers. comm., 2003). Naive juveniles are particularly vulnerable when feeding on road-kills or on insects attracted by warm pavement at night. Rosenberg (1999) noted that as juveniles at Carrizo Plain became capable of flight, they commonly began to hunt as a family group, frequently along roads. The risk of vehicle collision is likely greater in developed areas with dense human population or along areas where owls nest predominately near roads (Anderson et al. 2001). Higher post-fledging mortality due to vehicle collisions was noted to occur in agricultural landscapes with more than 90% of the land area under cultivation compared to an un-fragmented rangeland with less than 20% cultivation (Clayton and Schmutz 1997; Paige 1998). Off-road vehicle activity is also a threat to owl habitat as their burrows can be crushed and their nest sites disturbed (CVAG 2001). K.S. Smallwood (pers. comm., 2023) found a breeding adult killed by a vehicle while the owl was looking out from its nest burrow on a wind turbine access road in the Altamont Pass. Vehicle mortality is expected to increase with more roads and traffic in and near burrowing owl habitat.

Aircraft

Burrowing owl deaths have been documented from collision with aircraft, mostly along runways (Rosenberg et al. 1998a). Burrowing owls do not seem to pose a substantial risk to the safety of aircraft due to their small size and lack of flocking behavior. However, many owls live along the runway system at NAS Lemoore, and there are records of dead owls found along the runway that appeared to have died from collisions (Rosenberg and Gervais 2009). Powerful jets have the ability to “ingest” birds from some distance away (Rosenberg et al. 1998a). Another potential cause of mortality in and around airports is the powerful “wake turbulence” from aircraft wings (J. Barclay, pers. comm., 2002). Several colonies of burrowing owls at airports nest in proximity to runways, such as at Oakland Airport in Alameda County, Moffett Airfield and San Jose International Airport in Santa Clara County, NAS Lemoore Naval in Kings County, and North Island Naval Air Station in San Diego County. Military aircraft are especially prone to strikes because they frequently fly at high speeds and at low altitudes where birds are most active. Lemoore NAS and North Island NAS reported 130 and 132 aircraft/bird collision incidents, respectively, from 1981 to 1998 (BASH 2002); and China Lake NAWS reported 27 such incidents from 1981 to 1992 (NAWS China Lake 2002); it is unclear whether any of these strikes involved burrowing owls. A study of bird-aircraft strikes at 11 naval bases in California and Arizona reported raptors composed 4.4% of known bird-strikes from 1981 to 1991 (Kuenzi and Morrison 1998). Airports in general tend to still provide habitat for burrowing owls. Some airports (for example, San Jose, Sacramento Executive, Sacramento International, and NAS Lemoore) have responded by encouraging owls to move away from runways, usually by "passive relocation" techniques. Lemoore Naval Air Station has a management plan that reduces the number of owls near the airfields by altering habitat and blocking burrows adjacent to runways (Rosenberg et al. 1998a; Rosenberg and Gervais 2009), and although large numbers of owls nested along runways and taxiways there, aircraft strikes appeared to be very rare (J. Gervais, pers. comm., 2003). San Jose Airport has had an extensive burrowing owl management plan since 1990, that passively relocated owls away from the center of runways and provided artificial burrows (Barclay et al. 2011). This management ceased by 2013. Burrowing owl strikes at San Jose Airport did not increase during the time that the owl colony increased nearly four-fold (Barclay 2007).

Electrified Fences

Electrified security fences killed more than 3,000 protected birds, including 144 burrowing owls, at 13 California state prisons from 1993 to 1998 (USFWS 1998). The highest kill was 102 burrowing owls from 1993-1997 on the electrified fence at Calipatria State Prison, Imperial County, prior to modifications by the California Department of Corrections (CDC) (CDFG 2002a; York et al. 2002). Proliferation of prisons in rural areas with electric fences can be expected to kill burrowing owls in those areas. A 50-year CDC Electric Fence Habitat Conservation Plan included modifications to the security fences such as protective netting that help to minimize impacts to burrowing owls at 13 of the state's 25 prisons (CDFG 2003). The HCP presumes that 15-17 owls will continue to be killed per year at all of the facilities combined (850 owls total), with only 72 acres of protected land proposed as mitigation (CDFG 2002a).

Direct Mortality from Industrial Energy Facilities

Wind and solar are two principal types of industrial-scale renewable energy development that affect burrowing owls, with the two principal impacts being collision mortality and habitat loss. Wind turbines pose a greater collision hazard than habitat loss, while industrial solar poses collision hazards and substantial habitat loss.

In an effort to reduce greenhouse gas emissions from energy generation, California has embarked on an aggressive effort to install utility-scale wind and solar energy projects. Wind and solar energy generation increased rapidly over the last decade. Wind and solar projects respectively produced 7.8% and 17.3% of California’s in-state energy generation, but with adverse consequences to burrowing owls due to collision mortality and habitat loss. The

California Energy Commission reports that in 2021 the installed capacities of wind and solar energy were 6,280 MW and 15,206 MW, of which 13,957.4 MW was photo-voltaic (PV) and 1,248.6 MW was solar thermal. Based on reviews of numerous fatality monitoring reports from wind and solar projects, Smallwood (2023b) determined that annual collision mortality of burrowing owls averaged 0.185/MW at wind turbines, 0.182/MW at PV solar, and at 0.104/MW at solar thermal for a total 3,700 annual burrowing owl collision fatalities. At solar projects, security fences were constructed at 0.073 km/MW and gen-ties at 0.037 km/MW, resulting in estimated collision mortalities of 0.25/km/year and 0.034/km/year, for a combined 296.6 burrowing owl fatalities/year. Thus currently constructed and operating utility-scale wind and solar energy projects kill an estimated 4,000 burrowing owls each year in California.

Wind Turbines

Avian mortality from wind turbines at energy facilities in the Altamont Pass Wind Resource Area (APWRA) in eastern Alameda and Contra Costa Counties and the Montezuma Hills in Solano County has been extensively studied. There are other major developed wind resource areas at Tehachapi Pass in Kern County and San Gorgonio Pass in Riverside County, but burrowing owl mortality is not as well-known at these locations. After 2010, the Tehachapi Pass Wind Resource Area was expanded from a 700 MW facility to its current capacity of 3,507 MW, with 5 independent wind farms and more than 5,000 turbines. It is likely having impacts to known burrowing owl habitat (S. Smallwood, pers. comm., 2010).

Altamont Pass wind turbines have killed and continue to kill large numbers of raptors through collision or electrocution, including many burrowing owls (Orloff and Flannery 1992; Smallwood et al. 2004, 2007, 2008a). The locations for APWRA first-generation wind turbines were selected without considering patterns of bird flights, perching or nest locations, all of which influence collision risks. Most wind turbines were mounted on short towers, which positioned the rotor planes at heights above ground that are often used specifically for foraging by burrowing owls. At Altamont Pass, there has never been any state or federal enforcement of the Migratory Bird Treaty Act or state Fish and Game Codes despite ongoing, well-documented take of large numbers of burrowing owls. Without state, county, or federal enforcement of environmental laws, and no consequences for take of raptors, there was little incentive to mitigate the impacts of the AWPRA's wind turbines (Smallwood 2008). None of the wind companies were fined for massive, continuous take of burrowing owls and other raptors, and none had their permits withdrawn or suspended. As a result, hundreds of burrowing owls and thousands of raptors were killed every year since the early 1980s, and it took several decades to force energy companies to start addressing the problem.

Intensive research by Smallwood et al. (2003) estimated that at least 1,080 raptors, including many burrowing owls, were killed annually in APWRA. It very quickly became clear that wind turbines at APWRA were killing very large numbers of burrowing owls (Smallwood et al. 2007; Smallwood and Thelander 2008; Smallwood and Karas 2009; Smallwood et al. 2013). Smallwood et al. (2007) suggested that the area might be functioning as an ecological sink where owls dispersing from natal populations elsewhere quickly replace wind-turbine killed owls. More refined mortality estimates (with more realistic rates of scavenger removal of carcasses and rates of detection) indicated that the numbers of burrowing owls killed annually at APWRA have been massive - up to 440 (Smallwood and Thelander 2008) to 600 (Smallwood et al. 2013) burrowing owls killed per year. The Smallwood et al. (2013) estimate that about 600 burrowing owls were killed annually between 1998 and 2011 at wind turbines in APWRA was more than previously thought, due to past high undetected proportions of fatalities and improved detection and estimation methods.

Understanding the biological significance of the burrowing owl death toll required accurate population data, including an estimate of the number of breeding pairs in the APWRA. An empirical model of breeding density predicted 35–75 pairs within the 16,760 ha of the APWRA, but that prediction proved low in spring 2011, when Smallwood et al. (2013) detected 78 breeding pairs of burrowing owls in 46 randomly selected plots totaling 2,563 ha. Smallwood et al. (2013) estimated that 3.201 breeding pairs/km^2 occupied the 46 plots surveyed in April–May. Extrapolating this density to the area of the APWRA led to an estimate of 537 pairs (90% CI¼320–753 pairs) across the APWRA, or 10x the model prediction. Counts of nestlings emerged from burrows averaged 1.2/nest on the 46 plots, but these counts were minimum numbers. Smallwood et al. (2013) estimated the APWRA supported at least 1,836 burrowing owls in 2011 (90% CI¼1,082–2,590), indicating the local owl population could conceivably be the sole source of fatalities attributed to wind turbines in the APWRA.

Smallwood (2023b) summarized burrowing owl fatalities documented in APWRA from 1998–2020, and changes over time with greater MW capacity and fewer turbines (repowering). Annual estimated fatalities/MW were 1.148 for facilities <0.66 MW; 0.796 for facilities 0.66–1 MW; and 0.307 for facilities >1 MW. Smallwood (2023b) estimates that 23,390 burrowing owls were killed in the APWRA from 1981 through 2022. Burrowing owls were killed at non-operable wind turbines at a rate that was 7.5x greater than at the most operable wind turbines, demonstrating that for burrowing owls, wind turbine structure is more dangerous than movement of rotor and blades.

Smallwood (2023b) conducted the first twilight survey of burrowing owls at APWRA in 2007, adding 7 twilight surveys in 2011, and conducting 995 hours of thermal-imaging surveys from 2012–2019. Smallwood (2023b) also conducted an APWRA-wide burrowing owl population study, a background mortality survey, and developed a collision hazard model. Smallwood (2023b) established a nocturnal observation station in each sampling plot and elsewhere to test for effects of repowering (replacing numerous smaller turbines with fewer larger turbines with larger MW capacity, more carefully sited). Using a tripod-mounted FLIR T620 thermal-imaging camera with 88.9 mm telephoto lens, Smallwood (2023b) spent 3 hours per survey, starting at dark, with 360° visual scans performed between rounds of timed surveys of animal passage rates through turbine rotors; video-recorded burrowing owls and voice-recorded attributes; and recorded flight paths, interactions with wind turbines, behaviors and interactions with other wildlife. Smallwood (2023b) found significant nocturnal observations of burrowing owls at APWRA. Smallwood (2023b) found that burrowing owls: were very active at night; routinely hover near wind turbines; were flushed from the ground by predators; harass mammalian carnivores from height; make long, high flights; interacted while in flight; struggled to control flights in strong winds; collided with a broken turbine; and attempted capture of a bat just under an operative rotor. Smallwood (2023b) found ample evidence of nocturnal collision risk for burrowing owls at wind turbines.

Researchers developed collision hazard maps and hazard ratings of wind turbines to guide relocation of existing wind turbines and careful repowering to modern turbines to reduce burrowing owl fatalities (Smallwood and Neher 2004, 2009; Smallwood et al. 2007, 2009).[14]

[14] They found that burrowing owls selected burrow sites lower on slopes and on smaller, shallower slopes. Turbine-caused mortality was up to 12 times greater in areas of squirrel control, where flights close to the rotor plane were disproportionately more common and fatalities twice as frequent as expected. Mortality was highest January through March. Observed during diurnal surveys, burrowing owls flew within 50 m of turbines about 10 times longer than expected, and they flew close to wind turbines disproportionately longer within the sparsest turbine fields, by turbines on tubular towers, at the edges of gaps in the turbine row, in canyons, and at lower elevations. They perched, flew

Moving existing wind turbines off the hazard areas and ground squirrel conservation could reduce the fatality rate of burrowing owls 10%–22%, but careful repowering to modern wind turbines would most reduce fatalities of burrowing owls (Smallwood et al. 2013). The avian mortality toll continued unabated until the originally installed wind turbines declined to the degree that select turbine removals became tolerable to the energy companies. Seasonal shutdowns of turbines were tried, but did not work, since burrowing owls run into inoperative wind turbines (Smallwood and Bell 2020). Repowering of the APWRA moved forward slowly and in piecemeal fashion. Now most of the APWRA has undergone repowering, but only after the old wind turbines operated well beyond their original permit periods. Birds killed in the APWRA by first-generation wind turbines were often killed by turbines operating at capacity factors of only 3% to 5%, or sometimes not operating at all (birds often collide with non-operating wind turbines). After years of research of bird behaviors and fatalities in the APWRA, it was concluded that careful repowering would reduce fatalities more so than the 16 mitigation measures formulated by Alameda County for continued operation of old-generation turbines (Smallwood and Thelander 2004). Careful repowering would replace old-generation wind turbines with modern turbines on taller towers and located where collision risk is minimized. Two small repowering projects were initially installed, the 20.5 MW Diablo Winds Energy Project and the 38 MW Buena Vista Wind Energy Project, which began operations in 2004 and 2007, respectively. Compared to old-generation wind turbines in the APWRA, raptor fatalities per MW per year were 54% lower at Diablo Winds (Smallwood and Karas 2009) and 91% lower at Buena Vista (Insignia Environmental 2011). Three years after repowering, burrowing owl fatalities had not been found at Buena Vista and declined 24% at Diablo Winds compared to concurrently operating old-generation wind turbines (Smallwood and Karas 2009).

Across much of the APWRA, the use of anti-coagulant poisons has substantially reduced ground squirrel populations and hence burrowing owls, and ongoing and significant wind turbine collisions with owls have exacerbated the problem. Over Smallwood's last 10 years of research in the Altamont Pass, burrowing owls declined 45% across eastern Alameda and Contra Costa counties, coinciding with a 63% retraction of the geographic extent of ground squirrel colonies (Smallwood 2023a).

Solar Farms

Both burrowing owls and solar developers select for flat terrain to gentle south-facing slopes. Industrial solar farms require earth moving to flatten the ground, which kills burrowing owls. Once constructed, utility-scale solar projects pose multiple fatality risk factors. At installed solar facilities, birds collide with solar panels, fences, overhead lines, or other infrastructure (Kosciuch et al. 2020). Wildlife can also collide with solar collectors, power block structures, project buildings, medium-voltage overhead lines, gen-tie lines (i.e., generator lead or transmission lines), and automobiles servicing the project. Some birds might collide with photovoltaic (PV) panels because of the lake effect, or the birds' perception of many closely spaced PV panels as a waterbody onto which they attempt to land (Kagan et al. 2014). Polarized light from PV panels might attract prey of insectivorous birds and hence the birds themselves (Horváth et al. 2010),

close to operating turbine blades, and collided disproportionately more often at turbines with the most cattle dung within 20 m, with the highest densities of ground squirrel burrow systems within 15 m, and with burrowing owl burrows located within 90 m of turbines. A model of relative collision threat predicted 29% of the 4,074 turbines in their sample to be more dangerous, and these killed 71% of the burrowing owls in the sample. Smallwood et al. (2007) recommended this model be used to help select the most dangerous turbines for shutdown or relocation. All turbines in the APWRA could be shut down and blades locked during winter, when 35% of the burrowing owls were killed but only 14% of the annual electricity was generated. Terminating squirrel control could also reduce burrowing owl mortality, as might replacing turbines with new-generation turbines mounted on taller towers.

or it might fool birds into trying to lick water from the panel while in flight (Horváth et al. 2009, 2010). Reflected self-images on mirrors of solar thermal projects, or even of PV panels, might elicit aggressive responses of birds motivated to defend territory (Hager and Craig 2014, Kahle et al. 2016). Collisions might result from high-speed predator-prey encounters in which the pursuer or pursued collide with a project feature (Dunn 1993). At power tower projects, birds and bats die because of acute exposure to the zone of solar flux (Kagan et al. 2014). Birds also perish because of electrocution on energized portions of the project, entrapment or entanglement with project infrastructure such as fencing, and drowning in solar evaporation ponds. A study from Southern California suggested that utility-scale solar energy facilities are having significant environmental impacts on avian diversity (Walston et al. 2016).

Before 2012, wildlife fatality monitoring at utility-scale solar projects was rare, largely because few utility-scale solar projects existed.[15] Until 2018, data needed to test hypothesized causal factors and to estimate regional fatalities were largely unavailable to the public. Kosciuch et al. (2020) analyzed data from state and federal agencies and solar energy developers and operators, looking at mortality rates at 10 different photovoltaic facilities in California and Nevada. Kosciuch et al. (2020) used the fatality estimates as reported in each report, but the methods varied too much among the reports to support the use of the estimates at face-value; the estimates needed to be adjusted for variation in methodology, and for a substantial bias noted in Smallwood (2022). Kosciuch et al. (2020) found a total of 669 avian mortalities at these sites with a maximum mortality rate of 9.26 fatalities/MW/year. Smallwood (2022) calculated the impacts of industrial solar projects in California on burrowing owls.[16] Projected to the 2019

[15] The only monitoring had been at the 10-MW Solar One project in 1982–1983 near Barstow in San Bernardino County (McCrary et al. 1986). Much has since been learned about fatality monitoring at wind projects from the late 1980s through the initial fatality monitoring plan for solar projects (Nicolai et al. 2011) and its update in 2016 (Huso et al. 2016). Managers formulated guidance documents to standardize survey methods for the purposes of accurately estimating and comparing fatalities among wind energy projects and to fatalities estimated for other forms of energy generation (Smallwood 2017b). Researchers deliberated field methods concerning their support of accurate fatality estimation (Smallwood 2007; Johnson et al. 2016; Reyes et al. 2016; Smallwood et al. 2018; Kitano et al. 2020), and the estimation methods themselves (Korner-Nievergelt et al. 2011; Kitano and Shiraki 2013, Péron et al. 2013; Warren- Hicks et al. 2013; Smallwood et al. 2018). A new framework for testing the efficacy of bat, golden eagle, and bald eagle impact-reduction strategies at wind energy projects (Sinclair and DeGeorge 2016) was also an important step in measuring and responding to utility-scale renewable energy impacts to volant wildlife. Much of what has been learned from research of wind energy impacts to wildlife can contribute to improved fatality monitoring at utility-scale solar projects, but solar projects also pose different risk factors, including to many species less vulnerable to wind energy impacts.

[16] Measurement of solar energy's impacts to wildlife has been limited to mortality caused by features of solar facilities, and has yet to include impacts from habitat loss and energy transmission. To estimate species-specific bird and bat fatality rates and statewide mortality, Smallwood (2022) reviewed reports and data of fatality monitoring from 1982 to 2018 at 14 California projects, which varied in duration, level of sampling, search interval, search method, and carcass detection trials. Because most monitors performed carcass detection trials using species of birds whose members were larger than birds and bats found as fatalities, Smallwood (2022) bridged the monitors' onsite trial results to offsite trial results based on the same methods but which also measured detection probabilities across the full range of body sizes of species represented by fatalities. This bridge preserved the project site's effects on detection probabilities while more fully adjusting for the effects of body size. The Smallwood (2022) fatality estimates consistently exceeded those reported. Smallwood (2022) obtained and reviewed reports, data, environmental reviews, and communications related to bird and bat fatality monitoring at California utility-scale solar energy projects. The variety of study designs and methods Smallwood (2022) observed inspired his own estimations of project-level fatality estimates. Smallwood (2022) became most concerned over liberal exclusions of fatalities from project-level fatality estimates, use of automobiles in fatality searches, and placements of inappropriate carcasses to measure searcher detection and carcass persistence in carcass detection trials. Projected to California's installed capacity of 1,948.8 MW of solar thermal and 12,220 MW of PV panels in 2020 (14,168.8 MW total), reported estimates would support an annual statewide fatality estimate of 37,546 birds and 207 bats, whereas Smallwood (2022) estimated fatalities of 267,732 birds and 11,418 bats. Fatalities/MW/year averaged 11.61 birds and 0.06 bats at PV projects and 64.61 birds and 5.49 bats at solar thermal projects. Fatalities/km/year averaged 113.16 birds and zero bats at generation tie-ins, and 14.44 birds and 2.56 bats along perimeter fences. Bird fatality rates averaged 3 times higher

installed capacity, utility-scale photovoltaic (PV) solar projects in California annually killed an estimated 2,224 burrowing owls by collisions and electrocution (Smallwood 2022). Smallwood (2022) estimated that in 2020 fences surrounding solar projects killed an additional estimated 226 burrowing owls statewide.

For burrowing owls in Imperial County in particular, where most of state's burrowing owls live, the estimated mean 0.182 collision fatalities/MW/year at solar PV projects applied to 1,488.5MW of solar PV installed in Imperial County as of 2019, yielded an estimate of 271 burrowing owl fatalities/year in Imperial County from solar (Smallwood 2022).

Photo 1 - Burrowing owl fatality at the Imperial Solar Energy Facility West.
Photo source: 18 June 2015 memo to BLM, CDFW, and Imperial County.

Most of the utility-scale solar projects in California have occurred in the deserts and on public land, and most solar projects are not monitored for bird fatalities. A Desert Renewable Energy Conservation Plan (DRECP) was prepared in 2016 to allow development of massive industrial-scale solar, wind and geothermal projects in the California desert, including a California Desert Biological Conservation Framework (CEC et al. 2016). An Avian-Solar Science Coordination Plan circulated in 2016, but few lessons were taken from wind turbine bird fatality monitoring. The DRECP also failed to apply the lessons from wind energy impacts to birds. The DRECP was fast-tracked, resulting in rushed and inadequate review of the environmental impacts. The plan was given no surprises assurance (i.e. no legal consequences or further mitigations needed for unforeseen impacts to sensitive wildlife species) from the U.S. Fish and Wildlife Service, despite the fact that understanding of wildlife impacts caused by renewable energy projects is still developing. For the vast majority of the desert solar projects that have been

at PV projects searched by foot rather than car. They were usually biased low by insufficient monitoring duration and by the 22% of fatalities that monitors could not identify to species. Smallwood (2022) estimated that construction grading for solar projects removed habitat that otherwise would have supported nearly 300,000 birds/year. Smallwood (2022) recommends that utility-scale solar energy development be slowed to improve project decision-making, impacts assessment, fatality monitoring, mitigation efficacy, and oversight.

approved or are in the planning process, the avoidance/minimization/mitigation measures for burrowing owls are almost always "passive translocation."

Smallwood (2015a) commented on the failures of the DEIR/DEIS for the DRECP, and its inadequate impact assessments for special-status species, particularly burrowing owls. The DEIR relied on unfounded and unrealistically low predictions of bird fatality rates at energy facilities, with no references or description of methodology. Smallwood (2015a) determined that empirically supported predictions of annual bird fatalities are 3.5 times greater than what appeared in the DEIR. The DEIR made no attempt to predict fatality rates caused by solar thermal projects or PV solar projects, and likely impacts to birds (collisions) from transmission lines, electric distribution lines, and fencing were insufficiently reviewed. The plan relies on inadequate and inappropriate pre-construction surveys for burrowing owls and allows inadequate bird fatality monitoring methods at installed projects. The plan proposes mitigation measures for bird fatalities that are ineffective, unproven, and even counterproductive, or just unrealistic (such as proposing "detection and deterrent systems" at wind turbines, configured to prevent bird and bat species from flying into the project's rotor-swept area, when no such proven deterrents exist).

Smallwood (2023b) began predicting burrowing owl collision mortality at proposed solar projects in 2011. Fatality monitoring and reporting from utility-scale solar projects had been unseen by the public until data was turned over in response to FOIA and PRA requests. Smallwood (2023b) agreed to process and analyze these data, looking at fatality monitoring methods (which varied widely) among 14 utility-scale solar projects. Smallwood (2023b) found that bird carcass detection trials at these projects were deeply flawed by using unrepresentative "dummy" carcasses placed for observers to find, including holiday ornaments and carcasses that were larger than the fatalities found; revealed gross under-sampling; and concluded that monitoring deficiencies would have resulted in under-estimation of bird mortality. Smallwood (2023b) concluded that impacts from utility-scale solar projects are likely much greater than from wind energy, with some solar and wind projects likely serving as ecological sinks. Smallwood (2023b) believes that the impacts are excessive and warrant focused research and conservation action, that fatality monitoring must be improved and expanded to more solar projects, and that causal factors of bird collisions with solar facilities need to be understood.

Geothermal

Multiple geothermal projects are currently undergoing review under the Warren-Alquist Act. These projects are in the Imperial Valley right where the highest densities of burrowing owls were documented in earlier studies.

High Speed Rail

High speed rail is planned to be constructed over hundreds of miles in California (State of California 2011). This will cause destruction of burrowing owl habitat but also may provide some habitat creation for the species due to the construction of berms for the rail (S. Smallwood, pers. comm., 2010). However, burrowing owls are susceptible to collisions with fast-moving objects, and this high-speed train will likely make the owls vulnerable to collision. Currently, trains kill an unknown number of burrowing owls, as they have been documented to nest along rail lines, and high-speed rail might pose an even greater danger (S. Smallwood, pers. comm., 2010). A larger potential impact might be the borrow pits needed to construct the berms for the tracks.

Other Mortality

Burrowing owls have been found dead apparently trapped in pipes and PVC mining claim posts (Brattstrom 1995; CNDDB 2001). Falconers flying their birds at rabbits once commonly killed burrowing owls in southern California (P. Bloom, pers. comm., 2002). There is a long history of anti-predator measures at least tern colonies in coastal San Diego County, conducted by the Wildlife Services Agency (formerly Animal Damage Control), under the U.S. Department of Agriculture. The activities of this federal agency have contributed more to the extirpation pulse of burrowing owls along the San Diego coast than any other known form of mortality (P. Bloom, pers. comm., 2002). Burrowing owls in San Diego observed preying on least tern chicks at Naval Air Base Coronado were for many years shot and killed (even owls breeding nearby with young), with no attempt made to capture or relocate the owls (P. Delevoryas, pers. comm., 2003).

Habitat Loss

Permanent habitat loss and fragmentation, as well as local habitat degradation, appear to be the primary factors responsible for loss and declines of burrowing owl populations in California. One of the main threats to burrowing owls continues to be sustained loss of habitat caused by urban and agricultural development, as well as loss of burrows due to eradication of ground squirrels. Ground squirrels continue to be poisoned all over California. Habitat degradation from invasive plants can make formerly occupied sites unsuitable for burrowing owls, especially if the sites become overgrown with tall vegetation. Vegetation management such as appropriate levels of grazing is often necessary for burrowing owls to persist.

Urban and Suburban Development

The vast majority of breeding burrowing owls in California are found on agricultural land in the Imperial Valley, Central Valley, and the Palo Verde Valley (DeSante and Ruhlen 1995; Wilkerson and Seigel 2010). Unfortunately, the flat open grasslands preferred as habitat by burrowing owls are prime development sites and owls currently have little protection from powerful economic development pressures. Human population growth and development is rapidly converting open fields and agricultural lands to residential and commercial uses. Each year California loses an average of 50,000 acres of agricultural land to urban and suburban development (CCAN 2023). Loss of nesting and foraging habitat for owls is the biggest consequence of urban development (Zarn 1974; Konrad and Gilmer 1984; Barclay et al. 1998). Burrowing owls can persist in some urban and suburban environments, but they are especially vulnerable there to vehicle collisions and predation by feral animals, in addition to loss of burrows and foraging habitat.

To measure the effects of urbanization on species richness and numerical abundance, Smallwood and Smallwood (2023) surveyed vertebrate wildlife at sites of proposed development projects and organized in a before-after, control-impact experimental design. Smallwood and Smallwood (2023) found that development projects reduced vertebrate species richness 48% within the project area and 66% on the project site, and reduced counts of animals 89% to 90%. Reductions were greatest for terrestrial species, including ecological keystone species, such as the California ground squirrel which burrowing owls in California depend upon for burrow availability. Reductions were next greatest for grassland birds and raptors. Where development preceded second surveys by Smallwood and Smallwood (2023), California ground squirrels were not observed and neither were any of the burrowing owls that they had seen at those sites prior to development.

After decades of growth, California's overall human population is projected to remain flat over the next 40 years, but several areas are expected to have continued significant population growth (CDF 2020b). Regions with the majority of the state's burrowing owls are urbanizing the fastest. For example, the entire Central Valley has been the most rapidly urbanizing area of the state over the last four decades and will continue to have some of the highest human population growth through 2060, according to California Department of Finance population growth statistics (CDF 2020a,b).

In the Imperial Valley, which supports the vast majority of the state's breeding burrowing owls, human population increased 95% between 1980 and 2020 (CDF 2020a). Burrowing owls in the Imperial Valley are facing significant habitat loss to development of utility-scale solar and geothermal projects.

The southern Central Valley supports a relatively large number of the state's burrowing owls, with most of the region's owls in Tulare and Kern counties. Human population there increased dramatically between 1980 and 2020: by 148% in Madera County; 126% in Kern County; 107% in Kings County; 96% in Fresno County; and 93% in Tulare County (CDF 2020a). Wilkerson and Siegel (2010) reported on major loss of breeding owl colonies from areas near Bakersfield that underwent substantial urban land conversion between 1992 and 2001. The City of Bakersfield opted to not renew the Bakersfield Metropolitan HCP in 2023.

In the middle Central Valley, significant remaining owl colonies are in eastern Contra Costa, eastern Alameda, and San Joaquin counties. Human population increases between 1980 and 2020 were: 124% in San Joaquin County; 109% in Merced County; 102% in Sacramento County; 93% in Solano County; 91% in Yolo County; 78% in Contra Costa County; and 52% in Alameda County. According to CDFG documents, from 1995-2001, at least 9,000 acres of occupied owl habitat and over 15,000 acres of potential owl habitat in San Joaquin County were lost to development; an unknown amount of occupied habitat and over 13,000 acres of potential habitat were lost in Sacramento County, and at least 460 acres of occupied habitat and over 600 acres of potential habitat were lost in Solano County during the same time period (CDFG 2002a). The middle Central Valley region is expected to have one of the fastest human population growth rates over the next 40 years, with expected increases of: 25.1% in San Joaquin County; 24.0% in Contra Costa County (mostly the eastern county); 20.4% in Merced County; 18.0% in Alameda County (mostly the eastern county); 16.2% in Sacramento County; 13.3% in Solano County; and 11.6% in Yolo County (CDF 2020b). California Forever is a proposed massive new city development in eastern Solano County that would likely extirpate many of the region's remaining burrowing owls; Flannery Associates LLC has purchased 60,000 acres of pastureland and likely owl habitat for attempted development.

In the San Francisco Bay Area, the most significant breeding owl colonies remain in Santa Clara County. Human population increased 50% in Santa Clara County between 1980 and 2020 (CDF 2020a). The development of more than half of the valley floor and conversion of agricultural land in Santa Clara County resulted in a 60% decline in the owl population in just a decade (Bell et al. 1994; DeSante and Ruhlen 1995; Trulio 2002). Since 1984, the Bay Area has lost 217,000 acres of agricultural land to sprawl development and 200,000 more acres of farm and ranchland are still at risk of development (Greenbelt Alliance 2023). CDFG identified at least 84 owl pairs within the southern and eastern portions of the Bay Area (Contra Costa, Alameda, and Santa Clara Counties) directly impacted by development activities in just 3 years (CDFG 2002a). In Santa Clara County, where extant colonies near the Bay are highly impacted by development, the one hopeful action is the protection of parts of Coyote Valley in the southern part of the county. The Santa Clara Valley Open Space Authority (SCVOSA 2019), through a partnership with Peninsula Open Space Trust and the City of San Jose, has protected 1,000 acres of open space in North Coyote Valley, creating the North Coyote Valley Conservation Area.

In southwestern California, planned developments in the Inland Empire (western Riverside and southwestern San Bernardino counties) threaten many of the significant breeding owl colonies remaining in that region. There was explosive human population growth in this region between 1980 and 2020, with a 265% increase in Riverside County and 144% increase in San Bernardino County (CDF 2020a). The cities and towns of Apple Valley, Hesperia, Lancaster, Palmdale, Ridgecrest, Victorville, and Yucca Valley, along with many other smaller communities have grown rapidly in recent decades, with the populations of Lancaster, Palmdale and Apple Valley all growing by approximately 36% between 2000 and 2018, Yucca Valley growing by 29.5% and Victorville by a staggering 93% during that same time period (SCAG 2019).

The Western Mojave is currently undergoing a period of rapid growth and expansion, posing a significant threat to the natural habitat of burrowing owl populations. Burrowing owls are found primarily in the periphery of urban areas, and the cities and towns of Apple Valley, Hesperia, Lancaster, Palmdale, Ridgecrest, Victorville, and Yucca Valley, along with many other smaller communities have expanded into burrowing owl habitat. There was explosive human population growth in this region between 1980 and 2020, with a 265% increase in Riverside County and 144% increase in San Bernardino County (CDF 2020a). Given the relative affordability of land, projections indicate that the human population will continue to increase over the coming decades. The Southern California Association of Governments (SCAG) estimates that populations in these region will grow disproportionately compared to the rest of the state: San Bernardino County’s population is set to grow 21% by 2050, while Riverside County will expand by 25%, whereas California statewide is projected to grow by only 11 percent. (SCAG 2023). Habitat loss from such development is considered the primary cause for species extinctions at all scales: local, regional, and global (CDFW 2022b). SCAG has identified new construction and development as the “engine of growth” for the West Mojave region. (SCAG 2023). The USFWS (2018), when studying the loss of Joshua tree habitat in this same region, estimated using the Environmental Protection Agency's Integrated Climate and Land-Use Scenarios (ICLUS) modeling tool that approximately 41.6% of habitat for Joshua trees in the Mojave region would be lost to housing development by the year 2095. See Figure 5. This translates to a considerable loss of burrowing owl populations, considering that burrowing owls in the Western Mojave tend to live in the periphery of existing urban areas, which are inevitably the first to be developed as these communities expand. It's worth noting that the ICLUS model primarily focuses on housing density and may underestimate the full extent of development impacts by not considering industrial, military, or other forms of development.

The Western Mojave region has also experienced a significant surge in warehouse and logistics development in recent years, driven by its relatively low land costs compared to more densely populated areas, transportation infrastructure, and proximity to major urban centers. Many West Mojave cities – including Hesperia, Apple Valley, and Palmdale—have made a concerted effort to attract additional warehousing development with the hopes of becoming local logistics hubs. The transportation and warehouse sector is now the largest employer in both San Bernardino and Riverside Counties (SCAG 2023). As a result, the construction of large-scale warehouse facilities is rapidly transforming the landscape of the western Mojave, and is accompanied by the development of supporting infrastructure such as highways, railroads, and distribution networks. Without an HCP, there has been no large-scale planning effort to protect intact desert lands from ad hoc, piecemeal warehouse development that destroys intact desert lands and inhibits wildlife connectivity.

These numerous warehouse projects in the Inland Empire and high desert along Highway 15 jeopardize breeding burrowing owl colonies. The CEQA review for these projects generally defers surveys to preconstruction and if burrowing owls are found then the project proponent prepares a burrowing owl translocation plan; but the CEQA analyses never identify where burrowing owls will be translocated and it is unclear what the fate of these owls is. For example, for both the Town of Apple Valley 1M Warehouse and the Hesperia Commerce Center II warehouse projects, both had an undetermined number of burrowing owls on site; both deferred owl surveys to preconstruction and if owls are found a translocation plan will be developed, but it is unclear where burrowing owls would be moved or how. The West Valley Logistics warehouse project in the City of Fontana had a burrowing owl located on site, and deferred surveys to preconstruction with a promise to consult with CDFW if owls are found again. For the City of Ontario Development Plan (around Ontario Airport where there is an isolated breeding burrowing owl population), neither the project nor the project environmental review disclosed existing baseline conditions for the burrowing owl, or the suitability of the project habitat to support burrowing owl; the project EA mentioned that burrowing owl surveys were completed in 2019 and 2020 and that a 2022 protocol study was conducted to determine the current number of burrowing owls on site. But nowhere were the results of these surveys disclosed to the public, or discussed in the EA. Another example is the proposed Villages of Lakeview, a massive 8,725-unit sprawl development adjacent to San Jacinto Wildlife Area.

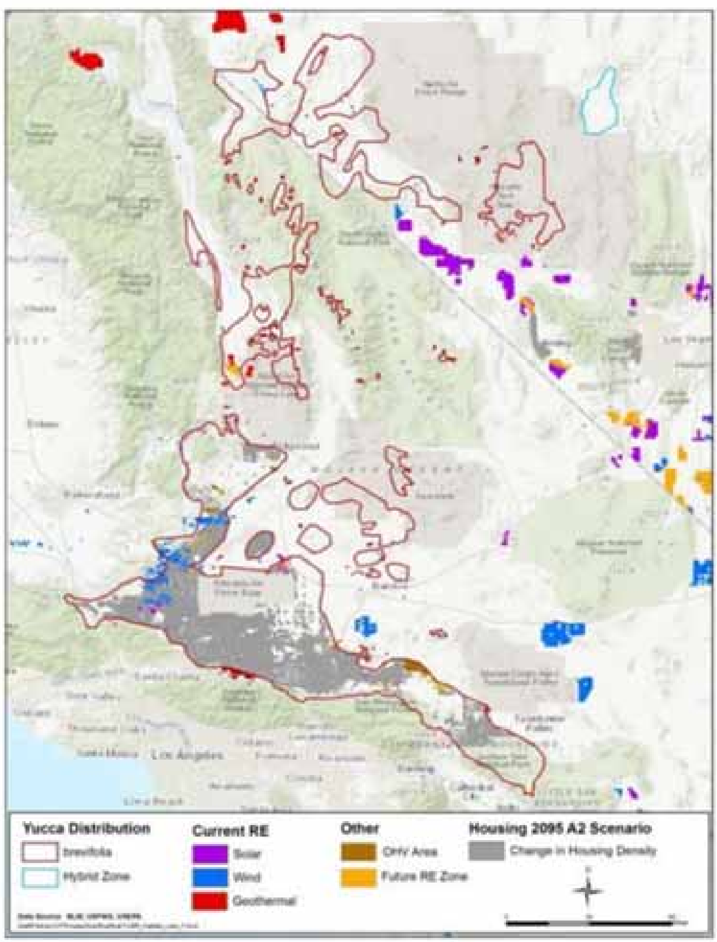

Figure 5 – Projected Joshua tree loss in Mojave Desert, from USFWS (2018)

Habitat Loss from Industrial Energy Development

Burrowing owls continue to lose habitat and due to oil and gas development, particularly in Kern County. The Nuevo-Torch HCP in Bakersfield, Kern County covers 21,800 acres of burrowing owl habitat. ARCO Western Energy has 120,320 acres slated for oil and gas development in Kern County, formerly covered by an HCP, which was withdrawn. Kern County recirculated a supplemental EIR in 2021 for its Oil and Gas Ordinance, which predicted 1,003 acres per year of habitat disturbance from future oil and gas drilling in the county.

Massive and numerous industrial solar and wind projects are proceeding in the California desert and southern California. Nearly all of the large-scale solar sites in California's deserts have burrowing owls on them (Ileene Anderson, pers. comm., 2010). Burrowing owls, in particular, face significant impacts from habitat loss caused by development of utility-scale solar. Burrowing owls happen to select terrain conditions for breeding and foraging that are also sought by developers of solar projects: flat to gentle southwest- or south-facing slopes. Almost all of these projects use passive relocation, i.e., eviction, of burrowing owls, which has been demonstrated to lead to extirpations of burrowing owls. No plan exists for monitoring these owl relocations for success.

Smallwood (2023b) calculated the burrowing owl habitat that has already been lost to industrial solar and wind projects in California as of 2021. The California Energy Commission reports that in 2021 the installed capacities of wind and solar energy were 6,280 MW and 15,206 MW, of which 13,957.4 MW was photo-voltaic (PV) and 1,248.6 MW was solar thermal. Habitat that is lost directly to construction grading for access roads and infrastructure amounts to 2 ha/MW of wind turbines where wind turbines were built in burrowing owl habitat on complex terrain (506 MW for 1,012 ha) and 0.67 ha/MW on flat to rolling terrain (5,103 MW for 3,419 ha), 2.67 ha/MW of solar PV for 37,266 ha, and 3.48 ha/MW of solar thermal for 4,345 ha, or 46,042 ha total (Smallwood 2023b). Assuming a mean of 0.02067 nesting pairs/ha among 3 large-area California studies, this rate extended to wind and solar projects in habitat statewide would predict loss of 952 nesting pairs (Smallwood 2023b). Assuming an average generation time of 8 years and 3 nestlings fledged/nest attempt, Smallwood (2023b) estimated that habitat loss from renewable energy is taking 3,094 burrowing owls annually. Many of these burrowing owls are likely the same ones directly killed by collision with renewable energy infrastructure, so the true annual loss of burrowing owls to renewable energy is likely between 3,094 and 7,091 owls and declining as the statewide population declines (Smallwood 2023b).

The Desert Renewable Energy Conservation Plan (DRECP) was prepared to allow development of massive industrial-scale solar, wind and geothermal projects in the California desert, including a California Desert Biological Conservation Framework that is supposed to mitigate impacts (CEC et al. 2016). The plan has noble goals for burrowing owls: conserving natural and agricultural habitats that support burrowing owls at a landscape scale; maintaining a stable population in the Imperial Valley; and maintaining size and distribution of extant burrowing owl populations in the other burrowing owl conservation areas (Palo Verde Valley; and the northern, western, and eastern portions of the Mojave Desert). But this is extremely unlikely to happen. The DRECP defers environmental review, impacts analysis, and determination of appropriate mitigations to each project and lead agency. But CEQA review for individual projects typically claim that the HCP already analyzed the impacts and provided an adequate means of mitigation. See the discussion below regarding the inadequacies of identifying and mitigating impacts to burrowing owls during the CEQA process, particularly with fast-tracked industrial solar projects in the California deserts. The CEC (2016) acknowledges that the burrowing owl is a species that is not well represented within the biological conservation framework map for the DRECP, and that specialized conservation strategies and priorities need to be developed, which has not yet happened despite industrial energy development proceeding at a fast pace.

The CEC claims that the Desert Biological Conservation Framework will protect 53% of the burrowing owl acreage in the plan area (CEC et al. 2016), but this is extremely misleading. The DEIR for DRECP estimated 5,269,000 acres of habitat were available for burrowing owls in the DRECP area, but this was solely derived from a crude geographic range map, with no modeling of habitat or information about the actual distribution of burrowing owls or areas that are truly important for the species. The DEIR did not address the fact that the best solar project sites correspond with conditions that are favored by breeding burrowing owls (relatively low on generally south-facing slopes). The DEIR estimated 123,000 acres of habitat loss for burrowing owls but made no attempt to translate this to an actual impact in terms of likely numerical decline of burrowing owls. Smallwood (2015a) calculated the likely impacts by reviewing burrowing owl surveys performed over the last several years at proposed renewable energy projects throughout the DRECP area. Based on the average nesting density in the DRECP area (8.47 pairs/km^2)[17], the loss of 123,000 acres (497.8 km^2) of habitat would likely result in the destruction of 4,216 pairs of burrowing owls (Smallwood 2015a).

Renewable energy development, specifically large-scale solar farms and wind energy facilities, drives significant development of desert lands in the Western and Eastern Mojave regions. In contrast to the encroachment of urban areas into wildlands, energy projects are typically sited in largely untouched public lands, which poses the risk of deteriorating and fragmenting relatively pristine habitat (Lovich and Ennen 2011). Between 2010 and 2021, CDFW issued 36 Incidental Take Permits (ITPs) for 49 renewable energy projects in the desert, the majority of which are solar farms (CDFW 2024). In 2022 alone, CDFW completed ITP permitting for six renewable energy projects within San Bernardino and Riverside counties that have a total footprint of about 10,600 acres, or approximately 17 square miles; and by October 2022, CDFW was presented with an additional 14 renewable energy projects in Riverside and San Bernardino counties, with potential footprints of up to 20,750 acres, or approximately 33 square miles (CDFW 2024). For solar farms in particular, CDFW assumes these sites will lose all of their biological resources, including any burrowing owl habitat. Nor does this trend show any sign of slowing. According to CDFW, there is “increasing demand to use land within the Mojave Desert for renewable energy projects, specifically high impact solar farms” (CDFW 2024).

A 2012 Environmental Impact Statement prepared by the Bureau of Land Management for a solar project in the Imperial Valley (USBLM 2012) identified nearly 46,000 acres of planned and foreseeable land conversions in the Imperial Valley. The 2016 DEIR for the DRECP did not address the fact that the majority of state's burrowing owls occur within the Imperial Valley, where the plan proposed massive conversion of burrowing owl habitat to solar and geothermal uses. With 1,488.5MW of solar PV installed in Imperial County as of 2019, and with an average 2.67 ha/MW, Smallwood (2022) calculated that utility-scale solar in Imperial County has already destroyed 3,974.3 ha of burrowing owl habitat. (DeSante et al. 2007) reported an average density of breeding attempts at 8.13/km^2 (0.081/ha). Assuming the estimate of burrowing owl breeding density from DeSante et al. (2007) still applies, Smallwood (2022) estimated this level of habitat loss reduced the capacity for breeding attempts by 322 and the number of breeding adults by ≥644. Assuming an average generation time of 8 years and an average 3 nestlings

[17] This average was based on nesting densities derived from 7 surveys performed for solar projects proposed within the DRECP area.

produced/breeding attempt, that equates to an estimated annual loss of 1,073 burrowing owls in Imperial Valley due just to habitat loss. When owl fatalities were combined with the estimated impact of habitat loss, Smallwood (2022) estimated utility-scale solar in Imperial County removed 1,344 burrowing owls annually as of 2020. The DEIR for the DRECP predicted 71,000 acres (287.3 km^2) of future terrestrial impacts from the DRECP in the Imperial Valley. Smallwood (2015a) calculated that this level of habitat loss would result in the loss of 2,434 pairs of burrowing owls from the Imperial Valley population.

An increasing number of industrial-scale solar projects are being proposed in the southern Central Valley. The Pelicans Jaw project is proposed on 3,371 acres of private land in northern Kern County, and would generate 500 MW of renewable energy and up to 300 MW of energy storage. Burrowing owls are known to occur on this project site as they were observed during 2021 and 2022 surveys. The Chalan Solar project is proposed on 618 acres of private land, also located in the northern portion of Kern County. It would generate up to 65 MW and include 25 MW of battery storage. Burrowing owls have been documented within 2 miles from the project site and potential burrows/burrow surrogates were found on the project site.

Destruction of Ground Squirrels

Numerous researchers have identified elimination of ground squirrels in California and prairie dogs in other states through control programs as the primary factor in the recent and historical decline of burrowing owl populations (Anderson et al. 2001). Farmers and ranchers, with help from the federal government, have long practiced all-out warfare against burrowing rodents. For example, persecution of the prairie dog has reduced populations to just 2% of their previous abundance (Trulio 1998a). Widespread ground squirrel control programs were begun in as early as 1869 in California, when the state legislature authorized the payment of bounties on squirrels (Gordon 1996), and by the 1980s control programs were carried out on more than 9.9 million acres in California (Marsh 1987). In some primarily agricultural counties, the ground squirrel population has been reduced and maintained at perhaps 10-20% of the carrying capacity. No protections exist for ground squirrels (often still considered vermin), which are the target of ongoing eradication campaigns. Individual landowners and managers on grazing, vineyard, and crop production lands conduct extensive rodent control programs involving shooting, poisoning with acute toxicants, anticoagulants, gas bombs and fumigants, trapping, and sealing burrows (Butts 1973; Salmon et al. 1982; Rosenberg et al. 1998a). Burrowing owls have been incidentally poisoned, gassed, and their burrows destroyed during eradication programs aimed at rodent colonies (Zarn 1974b; Remsen 1978; Collins 1979; Gordon 1996; P. Bloom, pers. comm., 2002).

Acute toxicants used to eliminate squirrels have included zinc phosphide and Compound 1080 (which is no longer registered for use in California), and strychnine for pocket gophers. These poisons may adversely affect burrowing owls. In Kings County, anticoagulants and fumigants were usually used (Rosenberg et al. 1998a). Anticoagulants include chlorophacinone, diphacinone, Fumarin, Pival, and warfarin. More effective second-generation anticoagulants such as brodifacoum, difenacoum, and flocoumafen are also used to kill rodents, primarily in bait forms (Rosenberg et al. 1998a). Primary poisoning and secondary consumption through the ingestion of poisoned rodents are possible for burrowing owls. In an experiment where mice killed by anticoagulants were fed to Northern saw-whet (*Aegolius acadicus*), great horned (*Bubo virginianus*), and barn owls (*Tyto alb*a), all the owls exposed to diphacinone and brodifacoum showed symptoms of poisoning and death resulted, while 1 of 6 died from ingesting bromadiolone-killed rats (Medenhall and Pank 1980). Barn owls also showed significant mortality when fed rodents killed by Flocoumafen and brodifacoum (Newton et al. 1994; Wyllie

1995). Fumigants used on ground squirrel burrows include aluminum phosphide, carbon bisulfide, and methyl bromide, with unknown, but potentially harmful effects on owls.

Photo 2 - Typical bait station used to poison ground squirrels. Treated bait is dropped through the vertical tube, and spills out to the lateral tubes, which squirrels enter to access bait.

Photo 3 - Baits treated with anti-coagulant toxicants are often spread on the ground. Such baits are dyed blue to signal that the toxicant is an anticoagulant. The intended target is ground squirrels. The bait in the photo was broadcast onto the ground in the Altamont Pass Wind Resource Area.

Healthy colonies of burrowing rodents are an essential attribute for burrowing owl habitat. Periodic elimination of ground squirrels inhibits the persistence of owls, which rely on squirrels for nest and roost burrows (DeSante et al. 1996). Ground squirrels also benefit burrowing owls in the form of burrow maintenance between nesting seasons and shared alarm calling behavior (Trulio 1994). Henderson and Trulio (2019) studied interactions of California ground squirrels and burrowing owls at Moffett Federal Airfield in urban Santa Clara County during two owl breeding seasons in 2012 and 2013, concluding that healthy ground squirrel populations may provide important predator alert services to burrowing owls, especially in the context of increasing populations of urban predator species. Henderson and Trulio (2019) found that ground squirrels called in response to predator approaches before owls did 66% of the time, which was approximately proportional to the abundance of ground squirrels and owls; when squirrels called first, an estimated 75% of owls exhibited alert responses, including alarm calling, running to the burrow, and scanning, indicating that owls benefited from ground squirrel alarm calls in response to approaching predators.

In agricultural areas such as the Central Valley and the Imperial Valley, anticoagulant rodenticides are often used on levees to control numbers of ground squirrels, which can undermine levees through their digging. Exposures to rodenticides and direct killing of owls by gassing (Zarn 1974a) could be problematic in areas like the Imperial Valley, where a large proportion of owls nest on or near levees.

Understandable efforts to remove ground squirrels from flood control levees have had impacts on owl populations, especially those persisting in urban areas. During the 2006-2007 statewide survey, in Sacramento County alone, 40% of occupied sites were on levees (Wilkerson and Siegel 2010), and all of these sites were subsequently eliminated by increased levee maintenance and ground squirrel control (C. Conard pers. comm. 2024).

Agricultural Practices

Agricultural environments can support very high densities of burrowing owls (Rosenberg and Haley 2003), but they may also pose threats to owl populations through pesticide exposure, destruction of nest burrows by farm equipment, seasonal food scarcity exacerbated by farming practices, or extermination of burrowing mammals (Desmond et al. 2000). Although intensive agricultural practices can have impacts on the productivity of burrowing owls, current agricultural practices in California are not thought to be a significant threat to the persistence of viable breeding owl populations, as evidenced by the apparent coexistence of high concentrations of burrowing owls with agricultural operations in the Imperial Valley and southern Central Valley. The California Endangered Species Act includes an agricultural exemption (California Fish and Game Code §2087(a)) allowing for "accidental take of candidate, threatened, or endangered species resulting from acts that occur on a farm or a ranch in the course of otherwise lawful routine and ongoing agricultural activities."

The dramatic alteration of 98% of the original prairie habitat in the United States has been linked to the reduction in western burrowing owl populations (Evans 1982; Sheffield 1997a; Trulio 1998a). As long ago as the 1930s, it was recognized that intensive cultivation of grasslands and native prairies was a major factor in declining burrowing owl populations (Bent 1938). Conversion of pastures to cropland (Grant 1965; Konrad and Gilmer 1984; Ratcliff 1986), and cultivation of grasslands (Grant 1965; Faanes and Lingle 1995) limit burrowing owl populations through the destruction of nesting habitat.

Although many of the state's remaining burrowing owls survive in the margins of agricultural areas, such as along roadside embankments and earthen irrigation canals and drains, intensive agriculture can be detrimental to the survival of burrowing owls. The apparent strong selection of irrigation canals for nesting by burrowing owls in agricultural areas may not indicate that this habitat is preferred over habitat well removed from the canals, but rather because of the intensive agriculture and disking and plowing of fields, the levees may provide the only available nesting habitat (DeSante and Ruhlen 1995). Ninety percent of California's burrowing owls are concentrated in wide, flat lowland valleys, basin bottoms, and coastal plains – terrain where the majority of agricultural development has occurred and is expected to expand. Intensive agriculture has been shown to result in the loss of burrows, loss of foraging habitat, creation of sub-optimal nesting habitat, and increased vulnerability to predation, and may also reduce the chance that unpaired owls will be able to find mates (Haug and Oliphant 1987; Haug et al. 1993). Because burrowing owls in agricultural systems spend a large proportion of their time foraging in fields (Rosenberg and Haley 2003), heavy pesticide use will also remain a potential threat to these populations.

Burrowing owls are affected by changes in agricultural crops, which may decrease the amount of habitat available to owls. Large-scale conversions of field crops to nuts and vineyards have recently reduced vast areas of burrowing owl habitat in California (see photo 4). Also detrimental to burrowing owls has been the intensification of agricultural practices such as increasing applications of pesticides and elimination of post-harvest crop residue.

Changes in agricultural practices could impact a large proportion of the breeding population of owls in the Imperial and Palo Verde Valleys. Within the Imperial Valley agricultural matrix, fields where vegetables (onions and corn) and cattle feed (grass, hay, and alfalfa) are grown are framed by a system of concrete water-delivery ditches and canals, and earthen drains (Rosenberg and Haley 2001). Burrowing owls nest almost exclusively within or along drains, ditches, or canals. These owls are vulnerable to earthmoving, burrow destruction, and flooding.

Burrow control and vegetation management practices along water conveyance structures determine whether burrows persist through the breeding season (Rosenberg and Haley 2003). Nests have been known to be destroyed by dredging of drains, grading of roads, and flooding caused by overflow of delivery ditches (Coulombe 1971, Rosenberg and Haley 2001), and development of tall woody vegetation along the banks of the drains will prevent owls from nesting there. The high density of owls in the Imperial Valley is almost certainly due to agricultural practices, and these populations are unlikely to remain at current levels if water conveyance structures are buried, if drain maintenance results in more frequent or larger disturbance of the substrate, if the agricultural matrix is converted to housing developments, or if less acreage is allocated to farming (Rosenberg and Haley 2001). Water transfers in the Palo Verde Valley have already resulted in fallowing of some agricultural fields, which decreases crop acreage that supports abundant burrowing owl prey. Fallowed fields eventually change through natural succession to Atriplex dominated communities, which are not burrowing owl habitat. In such a changing agro-ecosystem, reductions in total habitat available to burrowing owls will likely result in a decreasing owl population.

Photo 4 - A burrowing owl from Wild Horse Agricultural Buffer in the City of Davis perches atop a newly planted orchard in 2016. These seedling trees soon grew tall enough to destroy the habitat of the burrowing owls that nested on the Wild Horse Golf Course and the adjacent agricultural buffer. This and another orchard planted east of the golf course eliminated foraging opportunities for the owls, which were often observed flying into these fields to acquire prey items for their nestlings in the nests. The growing trees provided increasing cover for hawks and owls capable of taking burrowing owls. The orchards ensured the extirpation of burrowing owls from Wild Horse Golf Course.

Research by Bartok and Conway (2010) suggests that the probability of burrowing owls nesting along a roadside in the Imperial Valley appeared to be influenced more by the presence and management of the water delivery systems in the adjacent agricultural field than by the types of crops growing in the field. Roadsides with a higher number of banks were more likely to have burrowing owls present; transects with two parallel trenches side by side (and hence four banks) were more likely to have owls than transects with fewer trenches parallel to the road. The number of banks along a roadside appeared to influence whether owls were present, as the number of banks was positively correlated with the number of occupied burrows. Ground squirrels may find it easier to burrow in the disturbed ground (or in the gaps between the concrete and the soil) associated with these trenches. Bartok and Conway (2010) found that burrowing owl nests occurred less frequently along roadsides that did not have crops of any kind. Bartok and Conway (2010) did not find an association with alfalfa, but Rosenberg and Haley (2004) reported that owls foraging far from their nests were more likely to forage in hay and alfalfa fields and speculated that alfalfa fields may have higher rodent densities. The results of Bartok and Conway (2010) suggest that the methods and frequency with which irrigation trenches are maintained (i.e., cleared of vegetation, scoured of soil) can affect the occurrence of burrowing owl nest sites. Management of the irrigation system has been identified by others as the largest management concern for burrowing owls in the Imperial Valley (Rosenberg and Haley 2004).

Conversion of rangeland to vineyards and almond orchards is a threat to burrowing owls. Orchard and vineyard crops are not habitat for burrowing owls, even if prey is available there, due to taller vegetative structure and trees that can provide hides for avian predators of burrowing owls. This has occurred on land that previously supported burrowing owls in San Luis Obispo County on Highway 46 between Cholame Valley and Paso Robles. Also, rangeland is being converted into vineyards in the foothill portions of Yolo County and along the east side of the Central Valley (S. Smallwood, pers. comm., 2010). While some urban development occurred in Yolo County since the last statewide burrowing owl survey in 2006-2007, the most pervasive form of habitat loss was probably from land conversion to fruit/nut orchards and vineyards, which increased by 63,000 acres between 2007 and 2014; dry pasture decreased by 120,309 acres during this timeframe (Yolo County 2023; Menzel et al. 2024)).

Disking, Plowing, and Mowing

One obvious impact of intensive agriculture is disking and plowing of owl burrows. Disking or tilling of the land destroys burrows and potentially entombing the owls in these burrows. In some situations (where shallow discing does not destroy ground squirrel burrows) disking can create mortality sinks where owls are attracted to recently disced land; owls that move in to occupy or nest in burrows after ground squirrels reopen them are then vulnerable to subsequent disking. Mowing is a preferable alternative, but tractors used to pull mowers, and occasionally the mowers, can cause mortality. The use of large-tired mowers when mowing grasslands can reduce the risk of nest damage and restricted use of mowing when young emerge (May-June) prevents destruction of young (Rosenberg et al. 1998a). In addition, fields which may be used as foraging habitat may be disked and left fallow, reducing the prey base during a period when nestlings and fledglings would need the most amount of food for growth.

Livestock Grazing

Livestock grazing can contribute to burrowing owl habitat, as researchers have noted that burrowing owls prefer grasslands grazed by cattle or rodents (Anderson et al. 2001). Grazed areas attract ground squirrels (Smallwood and Bell 2022), increasing burrow availability, and also provide habitat with low vegetation height and reduced ground cover, allowing owls to stand near the burrow entrance and effectively watch for approaching predators (Coulombe 1971; Green and Anthony 1989; Trulio 1994). One of the largest populations of burrowing owls in the San Joaquin Valley was found in grassland on private land that was heavily grazed, although not to the point of exposure of bare soil (Rosenberg et al. 1998a). However, heavily grazed pastures tend to diminish prey abundance; thus, heavy grazing in burrowing owl foraging areas may be detrimental to the species (Dechant et al. 1999). The major negative impact of livestock grazing is control of ground squirrels to enhance livestock production. Range management practices associated with grazing potentially affect population densities of prey species for burrowing owls, such as California vole (*Microtus californicus*), western harvest mouse, and deer mouse; these species do poorly in heavily grazed pastures, as they need a minimum build-up of thatch to achieve moderate population densities (Holmgren and Collins 1999). Grazing can positively affect owls if it is effectively managed and monitored (Rosenberg et al. 1998a), but the complete effects of grazing on burrowing owl habitat and populations are unknown (Anderson et al. 2001; Smallwood and Bell 2022).

Other Agricultural Impacts

Many owls nesting along the California Aqueduct in the Central Valley face threats from maintenance and repair of embankments. Heavy irrigation has been known to drown both squirrels and owls (Miller 1903). Robertson (1931) noted instances of burrowing owls drowning in irrigation pipes (where they were forced to nest for lack of nesting holes) in western Orange County. The federal government and private landowners undertake extensive eradication programs to rid agricultural lands of predators and "pest" species. Although not targeted, burrowing owls were occasionally taken in leg hold traps (ADC 1993, 1994, 1995). Burrowing owl mortality from entanglement in barbed-wire fencing has also been documented (Lohoefener and Ely 1978). Deliberate destruction and filling in of owl nest burrows have been noted along irrigation canals in agricultural areas in Arizona, specifically in Tucson, Phoenix, and Yuma (Brown and Mannan 2002), and in Davis, California (S. Smallwood, pers. comm., 2023), and similar vandalism may be occurring in other agricultural areas in California.

<u>Relocation of Owls</u>

Burrowing owls in California are commonly evicted or discouraged from nesting at existing breeding locations to accommodate urban development. This is usually done through active or passive relocation. Active relocation, or translocation, is the process of moving owls from occupied burrows to other burrows off-site (natural or provided artificial burrows), by trapping owls and temporarily holding them in enclosures on relocation sites, then releasing them at the relocation sites. Passive relocation is the process of encouraging owls to move from occupied burrows to other natural or artificial burrows, and may entail using one-way devices on burrows that force the subject owls to self-relocate. Eviction is forcing owls to evacuate previously occupied burrows by physically preventing them from re-occupying those burrows, without any provision of alternative burrows. Such relocation activities are intended to avoid direct "take" (overt mortality or harm to owls) and are often encouraged by regulatory agencies such as CDFW (CDFG 1995, 2012). However, take of owls is often merely delayed or disguised by eviction or relocation, and the potential for take is only part of the impacts of development projects. Relocation of owls is not designed to mitigate for the habitat loss, habitat fragmentation, and reduced owl survivorship caused by development.

Many active relocation efforts for burrowing owls that have been subsequently monitored have failed to establish viable owl populations at the relocation sites, with owls either disappearing completely, attempting to return to the capture site (where their burrows have often been destroyed), or exhibiting low breeding success at the relocation site (e.g., Harris 1987; Delevoryas 1997; Trulio 1997). One of the reasons for this is that burrowing owls are very site tenacious and are not easily forced to move to a different burrow, especially during nesting season (Trulio 1997). Such burrow fidelity is a widely recognized trait, with owls regularly reusing burrows from one year to the next (Martin 1973; Wedgwood 1976; Green 1983). A study by Green (1983) found an average of 76% of owl burrows were reoccupied the next year. Trulio (1994) reported that over a 3-year time span at a site in northern California, 73% of nest burrows or burrows within 100 meters were reoccupied the next year.

Many active relocation efforts involve moving owls to artificial burrows. A significant problem with artificial burrows is that they require permanent maintenance to provide long-term nesting habitat, otherwise they can become buried (Belthoff and Smith 2003; Menzel 2014). See the discussion in the next section. Another potential problem with active relocation is that moving owls in this manner likely stresses the birds (Trulio 1997). Another failure has been the lack of requirement for long-term management of owl habitat at release sites.

Harris (1987) noted that only 1 of 8 (12.5%) previous active burrowing owl relocations in California was even remotely successful in terms of establishing breeding at the new location, with 2 of the 6 relocated owls in that instance remaining and breeding on the site for up to 3 years. Owls released during 2 spring relocations returned to the capture site within 1 month of release (Feeney 1997). Three of the relocations were done in the fall, and the timing of the other relocations was unknown (H. T. Harvey and Associates 1993).

Delevoryas (1997) reported on the failed active relocation in 1990 of 5 pairs of owls from Mission College in Santa Clara to 2 sites 31 kilometers to the south. The owls were trapped in mid-February and released in mid-March, just as breeding season was getting underway. The first season 2 of the 5 pairs (40%) bred successfully, with only 2 nestlings surviving to fledging (it is unclear if the fledglings survived to the following breeding season). Of the 10 translocated owls, 5 left the site, 1 was killed, and 4 adults plus the 2 fledglings remained at the relocation sites in 1991. By 1992 only 2 owls remained, and by 1994 only 1 owl remained. The site was not maintained for burrowing owls after the first year, was disked, and artificial burrows were not maintained (P. Delevoryas, pers. comm., 2003).

Trulio (1997) compiled known information on active burrowing owl relocations conducted in California as of 1997. Of 27 owls relocated to new burrows, 17 (63%) disappeared within a year of release and 7 (26%) flew back to their original site. Only 4 owls (14%) attempted to breed at their new locations (1 owl bred at the new site before disappearing). Only 2 owls (7%) bred successfully, and only 1 owl (4%) stayed on the site for 2 breeding seasons. In addition to the failure of 93% of these owls to successfully breed at the relocation sites, the fate of most of the relocated owls was unknown, as the majority disappeared and there was no monitoring program.

In 1997 H. T. Harvey & Associates successfully translocated 8 owl pairs to a relocation site at the San Jose/Santa Clara Water Pollution Control Plant buffer lands. All but 1 pair (which may have been moved too late in the breeding season) remained on the relocation site, and successfully raised young to the age of fledging; about 11 pairs nested at this relocation site in 2002, most of which nested in artificial replacement burrows constructed in 1997 (D. Plumpton, pers. comm., 2002).

The unfortunate result of most active relocation efforts has been the loss of known occupied owl habitat to development, with very little proven nesting success at relocation sites and the ultimate fate of most translocated owls unknown. Clearly, the practice of active relocation of burrowing owls as a “mitigation” for development impacts is detrimental to preserving owl populations.

For most passive relocations conducted in California, there is no way of knowing where the evicted owls go or whether they are able to breed successfully in other areas. The lack of knowledge on the results of passive relocation is largely due to the failure to require studies in areas where owls are evicted. The consultants that are hired to do this work rarely conduct studies (e.g., color banding or radio-tracking) that evaluate the success of passive relocation. There is no legal requirement to do this, and developers rarely have any interest in the fate of the owls beyond moving them out of the way of development projects. For example, in the City of Chino, consultants put one-way door devices on burrows to eliminate owls before the CEQA process started, so that projects could go through with a Negative Declaration instead of an EIR (J. Bath, pers. comm., 2002). There are many other examples, such as the use of a Negative Declaration for development impacting a significant owl colony at Camp Parks in Dublin.

Due to high burrow fidelity of burrowing owls, evicted owls are put at increased risk of predation or heat-stress during the eviction process. Owls may concentrate on trying to get back into the burrow to the detriment of vigilance behavior; or they may lose the option to thermoregulate by retreating into the burrow.

However, if the process of passive relocation is properly refined and used appropriately, it has the potential to be an important conservation tool, for example when applied to permanently protected lands such as large military reservations, where it is used to discourage nesting in proximity to airport runways, or used to avoid take for temporary disturbances (such as pipelines, paving, etc.) by moving owls short distances (Barclay 2007). Passive relocation of owls can work if the birds are moved very short distances and the habitat they are moved to is managed for them. Trulio (1995) found that passive relocation was successful when owls were displaced less than 100m (i.e. within their existing home range). Burrowing owls should never be translocated or forced to move to unprotected private property or to non-habitat (such as owls at Lemoore NAS moved to a landfill cap). Predators must also be taken into consideration - if owls are moved from an urban area where they have only been exposed to feral cats, red-tailed hawks, and northern harriers, they will probably do poorly if moved to an area with coyotes or red foxes (P. Delevoryas, pers. comm., 2003).

There have also been several failed reintroduction attempts (long distance movement to formerly occupied parts of their range) of burrowing owls. DeSmet (1997) reported that of 169 young and 85 adults captured in South Dakota and released into temporary aviaries and artificial burrows in Manitoba, Canada, only 1 of these birds (0.4%), a juvenile, was seen the next year. Martell et al. (1994) reintroduced 104 fledgling owls from South Dakota to hack sites in Minnesota, distances of 450 and 600 kilometers away. None of these birds were seen after the summer they were released. After a decade of owl family relocations from Washington State to British Columbia (Dyer 1988; Dyer pers. comm. as cited in Trulio 1997) the program had not successfully established a self-sustaining population.

The mixed results of active relocation, the failure of reintroduction efforts, and the misuse of passive relocation techniques indicates that it is imperative to protect remaining occupied burrowing owl habitat and owl populations in situ. Current state policy is informally encouraging translocation of owls from occupied habitat in rapidly urbanizing areas (e.g., in Santa Clara County). The practice of translocating owls as “mitigation” eliminates occupied habitat without adequate mitigation for the true impacts of development. As a relatively adaptable species, all that burrowing owls must be afforded in order to survive is habitat, and if that habitat is systematically removed for the convenience of development, owls will predictably disappear.

CDFW has acknowledged that few active relocation attempts have had the desired outcome of redistributing burrowing owls to protected habitats (CDFG 2003). Current policy is to advocate for avoidance of owls where possible and acquisition of habitat set asides contiguous with occupied burrowing owl habitat site, as mitigation for projects under CEQA. CDFW recommends "passive relocation" to appropriate habitat set asides when needed.

Bendix (2007) reported on attempted burrow exclusion and passive relocation of owls from a 57 ha site in the Altamont Hills in eastern Alameda County over three years, that was to be graded and developed for a golf course.[18] The project demonstrated that passive relocation of owls

---

[18] The site previously had up to 4 pairs of nesting owls, as recently as 2000, and with an estimated 6,000-8,000 ground squirrel burrows in the construction and disturbance area. The project proponent attempted passive relocation

from a large site with numerous ground squirrels was possible, but the methods used to ensure no take of owls or listed species were time consuming and very expensive, and most developers are unlikely to go to such lengths or expense.

Doublet et al. (2022) tracked the fates of 42 resident (non-translocated) burrowing owls and 43 translocated owls from 2017–2019, using high frequency radio-telemetry across 4 release sites in southcentral Arizona. Annual survival was consistently lower for translocated owls compared to resident owls. Site fidelity was lower for translocated owls compared to resident owls in 2018, but similar in 2017. For translocated owls, the number of males in release cohorts negatively affected survival and fidelity, with breeding season releases that included owl groups and multiple males within cohorts resulting in agonistic interactions, high mortality, and low fidelity. Doublet et al. (2022) recommended substantial changes to the current translocation methodology for burrowing owls in Arizona, which should be restricted to male-female pairs or single individuals; earlier releases may allow owls time to become established on release sites prior to the breeding season, which could promote fidelity.

Desmond et al. (2023) evaluated the effectiveness of a translocation program in Arizona that relocates owls from construction sites to artificial burrows, by comparing survival, fidelity, and nesting of translocated owls with local non-translocated owls using VHF radio-telemetry. Desmond et al. (2023) included the study from Doublet et al. (2022), so there is substantial overlap in the information. Desmond et al. (2023) tracked 85 adult owls across 4 sites from 2017-2019 and found that annual survival and fidelity were lower for translocated owls than non-translocated owls. The owls were soft-released in groups of 10 owls/cage. The most influential factor contributing to low survival/fidelity rates of the translocated owls was the number of males in each release cage. Annual survival, for instance, decreased from 0.70±0.11 for groups with the fewest males to 0.02±0.02 for groups with the most males. In addition, Desmond et al. (2023) monitored 129 nests and found that translocated owls had lower cumulative nest survival and productivity compared to non-translocated owls. However, owls translocated in prior years had similar nest survival and productivity compared to non-translocated owls, suggesting that owls that survive the first year of translocation can thereafter join the breeding population. To improve the success of translocation, Desmond et al. (2023) recommend releasing owls individually or as pairs at high-quality release sites prior to the start of the nesting season to allow them time to establish territories.

Hennessy et al. (2022) evaluated the consequences of two primary translocation methods, displacement (i.e., exclusion from burrows) and translocation, against control owls, using a suite

---

in 2001, but ground squirrel burrows could not be closed before the 2001 nesting season, because of the presence of federally listed California tiger salamanders (*Ambystoma californiense*). In 2001, half of the site was treated for passively evicting owls: biologists counted about 3,000 ground squirrel burrows suitable for owl nesting. One-way doors to exclude owls were put on any burrows within an 8 m radius of burrows with observations of owls or owl sign, with an escape route for salamanders. After this treatment, no owls were observed to nest within the treated area in 2001, though 7 pairs were observed immediately adjacent to the site. Passive relocation succeeded in preventing owls from nesting, but the site was not graded due to lack of grading permits. In 2002, a passive relocation was implemented for the entire 57 ha site, with surveys for owls and immediate closing of ground squirrel burrows if no owls were present. One-way doors were installed on burrows with owls or owl sign; after 96 hours these were hand excavated and then closed. No owls nested on the 57 ha site in 2002, but grading was again delayed due to lack of permit .No passive relocation or burrow closure was done in 2003, and no owls attempted to nest on site. Single owl pairs were detected on site and just off site in 2003, requiring implementation of no-disturbance buffers, and grading was completed from July through September. The project resulted in short-term loss of nesting habitat, but was only successful because there was habitat available nearby for the evicted owls. Post-construction observations revealed that owls returned to nest on the newly created golf course site from 2005-2007, in burrows adjacent to a green, in non-landscaped areas, and in irrigated areas of the golf course (14 owls including 6 juveniles seen in 2005; 2 nesting pairs and 6 juveniles in 2006; and 3 owl pairs in 2007).

of success metrics focused on dispersal, survival and reproduction. Hennessy et al. (2022) also tested the provision of visual and acoustic conspecific cues to dampen owl dispersal away from release sites. Within the displaced group, burrowing owls settled closer to the origin site if burrows were available nearby. Although translocated burrowing owls dispersed farther from the release site than displaced owls, this difference disappeared when conspecific cues were present. Owls were 20 times more likely to settle at the release site when conspecifics or their cues were present. Translocating owls over longer distances (>17.5 km) reduced the incidence of them returning to the origin site. Hennessy et al. (2022) advocate the increased use of evidence in mitigation translocation to guide management decisions and policies.

Because passive relocation/eviction has long been the primary form of burrowing owl mitigation in California and the practice does not require marking, monitoring or meeting success criteria, outcomes are rarely known or reported. Kidd (2023a) described the methods and results of an "augmented eviction" of owls conducted during the courtship period in 2022. During this process one pair of owls was trapped, uniquely marked, and evicted from a development site prior to egg laying, followed by weekly surveys. Kidd (2023a) later found the evicted pair together and confirmed they produced at least four young that were last observed at 60 days of age when monitoring ended. Kidd (2023a) did not imply that the augmented eviction was "successful" and does not promote the use of passive relocation (eviction) as a form of mitigation, but are suggesting CDFW should incorporate similar marking and post eviction monitoring measures into future evictions. This is necessary to better evaluate the efficacy of this CDFW-endorsed mitigation tool that has not resulted in sustaining a stable or increasing population throughout highly fragmented landscapes in southwestern California.

Kidd (2023b) reported on relocation of 196 burrowing owls between 1992 and 2022, in seven counties throughout central and southern California. Kidd (2023b) did experimental relocations using single owls, paired owls, and family groups. Owls were opportunistically obtained from rehab centers, predator management programs, airport raptor strike avoidance programs, and construction projects, and relocations were authorized by CDFW and USFWS to help establish an alternative method to passive relocation. After years of refinement, Kidd (2023b) found one specific process that regularly results in successful breeding and reasonable site fidelity of surviving young and adult owls, "active translocation." This process includes the capture of wild pairs during the courtship period and relocating them to conservation lands that are managed for burrowing owls, where owls are maintained daily in protected release enclosures where on-site, captive breeding occurs. Kidd (2023b) recommended that owls should not be released from their respective enclosures until they are well into incubation. Similar to other sensitive species recovery programs, burrowing owl active translocations require predator management activities to increase fledging success, annual survivorship and site fidelity Kidd (2023b). Wisinski et al. (2023) used similar techniques (with wild-to-wild translocations and releases of conservation-bred owls), but also provided supplemental food through at least the first breeding season to ensure survival of newly translocated adults and their offspring, and cues/conspecifics to promote retention.

Current CDFW policy regarding relocation of owls is to discourage, but not prohibit, passive relocation or eviction (CDFG 2012). In its updated staff report and guidance policy, CDFG (2012) concluded that evicting owls from nesting, roosting, and satellite burrows may lead to indirect impacts or take; and that temporary or permanent closure of burrows may result in significant loss of burrows and habitat for reproduction and other life history requirements. Depending on the proximity and availability of alternate habitat, loss of access to burrows will likely result in varying levels of increased stress on burrowing owls and could depress reproduction, increase predation, increase energetic costs, and introduce risks posed by having to find and compete for available burrows (CDFG 2012). Therefore, exclusion and burrow closure are "not recommended" where they can be avoided. CDFG (2012) also decided there would be no authorization for capture and relocation of burrowing owls (active relocation or translocation) except within the context of scientific research or a NCCP conservation strategy.

Failure to Maintain Artificial Nest Boxes

To avoid direct ''take'' under the MBTA or California Fish and Game Codes, development projects often have biologists evict burrowing owls detected during pre-construction surveys from land where habitat will be permanently lost to residential, commercial, and industrial projects (Bendix 2007) or temporarily lost to infra-structure maintenance (Catlin and Rosenberg 2006). Evicted owls are expected to self-relocate nearby or they are coaxed to targeted location(s) via active translocation or provisioning of artificial nest burrows (Trulio 1995; Smith and Belthoff 2001; Barclay 2007; Koshear et al. 2007). Artificial nest burrows typically consist of buried utility boxes connected to the ground surface via tubing, an elevated mound, and a short perch structure (Collins and Landry 1977; Smith and Belthoff 2001; Barclay 2008).

Though burrowing owls will readily occupy newly installed artificial burrows, burrows can quickly fill with soil from fossorial mammal activity, or erosion and silting during winter storms, and require regular maintenance in order to be available for longer-term occupancy by burrowing owls (Collins and Landry 1977). Land management agencies frequently do not maintain burrowing owl nest boxes, so that owls populations inhabiting artificial burrows eventually abandon the burrows and/or the site. What was thought to be mitigating for development project impacts, has no long-term benefits to the owls. For example, of 72 artificial burrows installed in burrowing owl habitat at Lemoore Naval Air Station in Kings County in 1997-1998, nearly all were fairly quickly occupied by owls, but none were occupied in 2010-2011; most of these burrows were destroyed by feral dogs and ground squirrels within 5-6 years of installation (S. Smallwood, pers. comm). At Dixon Naval Radar Transmission Station in Solano County, 15 artificial burrows were constructed in 8 large mound structures prior to 2006; 6 of these burrows were occupied by burrowing owls in 2006, but by 2009 the burrows were abandoned by owls and overgrown by tall weeds; none have been occupied since then (S. Smallwood, pers. comm). Many other examples of burrow creation failures are available. Belthoff and Smith (2003) found that with periodic maintenance and cleaning, artificial burrows remained suitable for use by burrowing owls during the duration of a 5-year study, but this study lacked a control group of unmaintained artificial burrows to compare the effects of maintenance versus non-maintenance on occupancy rates. What often happens is, where possible, the owls relocate from the artificial nest structure to the nearest ground squirrel burrow system.

Menzel (2014) assessed artificial burrows at two study sites in northern California, showing that artificial burrows that received annual surface maintenance were occupied for a significantly greater number of years (mean of 1.9 years) than non-maintained artificial burrows at the other site (mean of 0.45 years). Even with maintenance, occupancy rates dropped from 31% during the first year to 8% during the third year post-installation, meaning that regular maintenance or reinstallation of the entire artificial burrow system (every 3 years) appears to be crucial for longer-term use. The number of artificial burrows at a management site must be sufficient to provide opportunities for owls to move between nest burrows from year to year, and to disperse to satellite burrows, especially when young emerge during the nesting season. Menzel (2018) further analyzed long-term datasets biologists collected from 1990 through 2012, including demographic data, band re-sightings, and burrow maintenance records. Artificial burrows that received annual surface maintenance were occupied for a significantly longer time (2.1 ± 1.9 yr) than unmaintained artificial burrows (0.5 ± 1.0 yr) during the first 8 years post-installation. Even with surface maintenance, occupancy rates declined from 44% of burrows occupied during the first year post-installation, to 28% of burrows occupied during the fourth year post-installation. Of 120 burrowing owls raised in maintained artificial burrows, 70% were re-sighted occupying artificial burrows during subsequent breeding seasons; only 3% of these owls occupied their natal burrow during the first nesting season post-fledging, and of those owls that were re-sighted during two or more nesting seasons, almost half (48%) occupied different artificial burrows from one year to the next (Menzel 2014, 2018).

Artificial burrow design, placement, and installation depth are important factors in occupancy probability by owls and reproductive success, which varies within and among artificial burrow installations. Nadeau et al. (2015) evaluated the possibility that depth below ground might explain differences in occupancy probability and reproductive success by affecting the temperature inside the nest chambers. They found that burrowing owls seemed to prefer burrows at moderate depths because these burrows provide a thermal refuge from above-ground temperatures and are often cool enough to allow females to leave eggs unattended before the onset of full-time incubation, but not too cool for incubating females that spend most of their time in the burrow during incubation. Nadeau et al. (2015) suggest that depth is an important consideration when installing artificial burrows; however, additional study is needed to determine the possible effects of burrow depth on reproductive success and on possible tradeoffs between the effects of burrow depth on optimal temperature and other factors, such as minimizing the risk of nest predation. There have been extensive recent studies in San Diego on the effects of burrow design and materials on microclimate, compared to natural squirrel burrows (Swaisgood et al. 2014; Hennessy et al. 2015; Wisinski et al. 2016).

Smallwood and Morrison (2018) studied a high-density population of burrowing owl nests at the National Radio Transmission Facility (NRTF) in Dixon in Solano County from 2006–2011. They compared owl density at NRTF to densities elsewhere, and nest-site use and reuse to available nest substrates. Breeding pairs numbered 24–44 per year, averaging 34 pairs on 83 ha, the fourth-highest density on record. Occupancy of eight artificial burrows installed in 2000 declined from six pairs in 2006 to one pair in 2007 and 2008, and none after 2008. Declining use of artificial burrows over the study period may have resulted from: insufficient spacing between artificial burrows; growth of tall dense stands of plants on the overlying mounds after the Navy contractors abandoned weed control efforts post- 2006; destruction or clogging of burrow tunnel pipes caused by colonizing ground squirrels, or; naturally low nest-site reuse. The nearest-neighbor distance among artificial burrows averaged half the distance among nest sites in fossorial mammal burrows and concrete half-rounds covering aboveground power cables. Undisturbed clay soils supported pocket gophers but few ground squirrels, whereas disturbed soils supported both ground squirrels and burrowing owls. The presence of both ground squirrels and burrowing owls was associated with backfill soils over buried cable, cable covers, and areas where soils bordered impervious surfaces. Nest-site reuse was low, with only 12% of the sites occupied in all study years. Most (78%) nest sites reused in a subsequent year involved nests in a different burrow or cable cover opening 1 m from the previous year's nest. Smallwood and Morrison (2018) recommend research on whether concrete half-rounds might outperform buried utility boxes as artificial burrows, especially in conjunction with efforts to conserve the fossorial mammals that naturally excavate burrows.

Although the installation of artificial burrows may be a useful short-term management tool in some situations, artificial burrows require on-going maintenance and may act as ecological traps. Natural burrows within close proximity to live ground squirrels tend to be better buffers from outside conditions compared to artificial burrows.

The results of numerous studies of artificial burrows suggest that they are not a suitable substitute for burrows excavated by ground squirrels, and that protecting or reestablishing ground squirrels as ecosystem engineers is the most ecologically sound and cost-effective method of creating burrows for burrowing owl nesting in the long-term (Ronan 2002; Ronan and Rosenberg 2014; Smallwood and Morrison 2018; Swaisgood and Wisinski 2023). Ground squirrels additionally benefit burrowing owls in other ways, such as mutual predator alarm-calling, predator dilution effect, hosting of prey species within the same burrow complexes, and provisioning of alternate and satellite burrows, food-cache sites, and refuge burrows during the nonbreeding season.

Pesticides

Pesticides have negative effects on wildlife and their populations, including burrowing owls, through direct exposure to pesticides, secondary poisoning of owls after consuming prey exposed to pesticides, or via the indirect effects of pesticides on habitats and ecosystems that burrowing owls rely upon. Pesticides have been identified as a threat to burrowing owl populations (Sheffield 2021).

The largest breeding concentrations of burrowing owls in California are located in some of the most intensively farmed lands in the United States. Some of the most toxic pesticides are heavily used in California's agricultural areas, which overlaps with large areas of the burrowing owl range (see Figure 6 below). For example, the annual reported agricultural pesticide use, in pounds applied in 2021, for the following counties in the range of the burrowing owl totaled: Fresno (29,462,927) Kern (25,133,091), Tulare (18,159,350), Madera (9,254,734), Merced (8,694,336), Kings (6,853,561), Imperial (4,993,910), and Riverside (2,994,621).

The pervasive use of agricultural chemicals, such as organophosphate and neonicotinoid insecticides, and the existence of trace elements such as selenium, can impact individual owls and the ecosystems they depend upon. Agricultural intensification, in particular pesticides and fertilizer use, are the main pressures for most bird population declines, especially for invertebrate feeders such as burrowing owls (Rigal 2023). It is unclear whether burrowing owls selectively use agricultural fields and whether they will do so following pesticide application, when large pulses of dead and dying invertebrate prey may suddenly be available (Gervais 2002).

Use of insecticides and rodenticides in burrowing owl habitat can reduce the food supply and the number of burrowing mammals, and can be toxic to owls (Ratcliff 1986; James and Fox 1987; James et al. 1990; Baril 1993; PMRA 1995; Hjertaas 1997; Sheffield 1997b). Burrowing owls have been reported to ingest poisoned rodents and to forage on the ground for insects in areas littered with poison grains (Butts 1973; James et al. 1990).

Owls can be exposed by direct contact, ingestion from preening feathers, and through their diet, which includes insects, small vertebrates, crayfish from irrigation ditches, and potentially contaminated fish carrion (Gervais et al. 1997). Burrowing owls are known to scavenge dead rodents and other prey items, making them highly susceptible to secondary poisoning (Sheffield 1997b). Even low levels of chronic pesticide exposure may be detrimental to burrowing owls when combined with other stressors (Gervais and Anthony 2003).

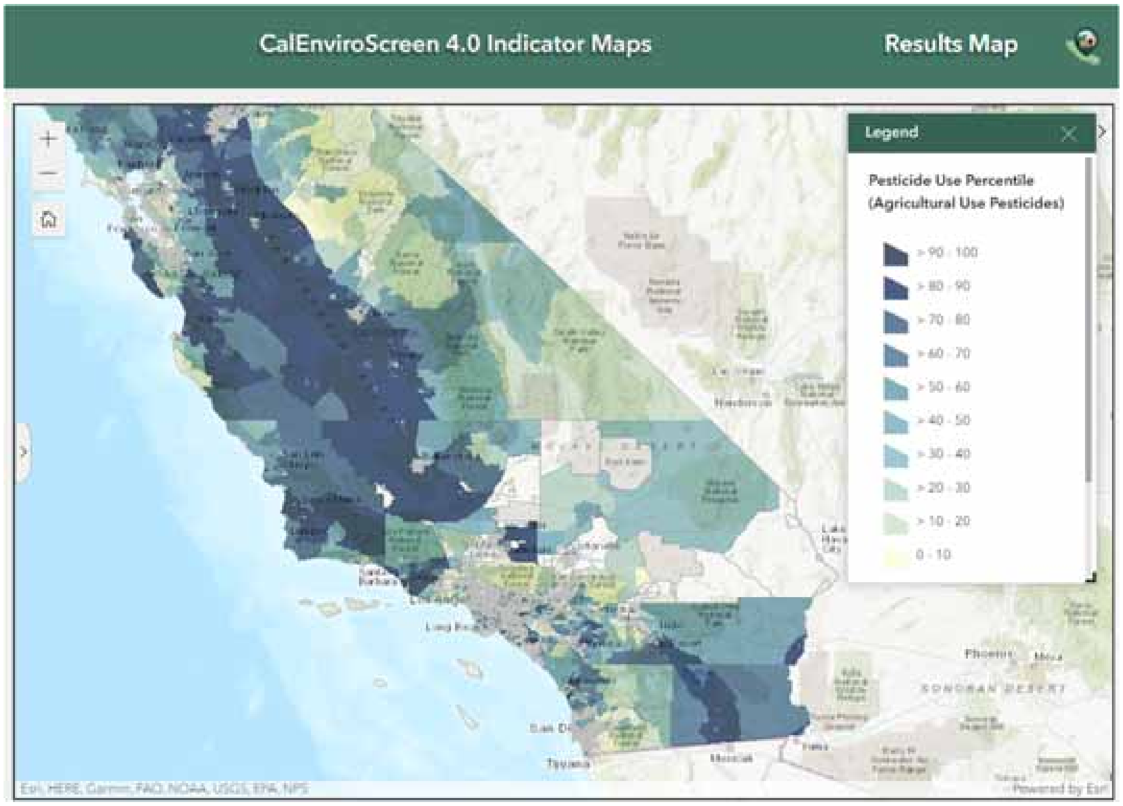

Figure 6 - Relative use of 132 of the most toxic pesticides in California agriculture for the years 2017-2019 as reported by the California Department of Pesticide Regulation and compiled by the California Office of Environmental Health and Hazard Assessment (OEHHA 2021).

Pesticides also have indirect effects on burrowing owl populations through reductions in prey availability, habitat modification, or elimination of beneficial insects. Indirect effects include, for example, herbicides that may reduce food, cover, and nesting sites needed by insects, birds, and mammals; insecticides that may diminish insect populations fed on by bird populations or prey of bird populations; and insect pollinators that may be reduced, thereby affecting plant pollination in owl habitat (Purdue 2008).

While there are a range of pesticides that impact owl populations some examples described below emphasize the magnitude of that threat from pesticides currently registered in California.

Organophosphate pesticides are a class of insecticides, several of which are highly toxic, and have been documented to negatively affect wildlife in California. Organophosphates poison insects and other animals, including birds, amphibians and mammals, primarily by phosphorylation of the acetylcholinesterase enzyme (AChE) at nerve endings. Some organophosphorus pesticides bioaccumulate in the environment (Mercado-Borrayo 2015), causing harm to raptors such as vultures (Plaza 2019). Birds are particularly sensitive to organophosphate pesticides, as they have a reduced ability to metabolize and excrete these toxicants from the body (Walker 1983). Organophosphate insecticide exposure was documented to cause red-tailed hawk mortality in California orchards (Hooper et al. 1989). Exposure to the organophosphate pesticide chloropyrifos was detected at Lemoore by footwash samples (Gervais et al. 1997) even though none was reported used within 1 kilometer of the study site prior to the sampling. A range of organophosphate pesticides are still available for use in California. Despite restrictions in food usage for chlorpyrifos it is still registered for use in nine pesticide products in California, as of 2023 (CDPR 2023).

Neonicotinoid pesticides can have adverse effects on birds through direct mortality, secondary exposure through prey species, and indirect habitat modification (Mineau 2023). Among non-target species likely to be affected by neonicotinoid insecticides, birds are exposed via multiple routes. Insectivorous species are thought to be most indirectly impacted by pesticide application through diminution of their food supply (Boatman et al., 2004; Hallmann et al., 2014; Humann-Guilleminot, S. et al., 2021). Increase in neonicotinoid use led to statistically significant reductions in bird biodiversity and population growth, particularly for grassland and insectivorous birds such as burrowing owls (Li 2020).

Chemicals used for rodent control or as pesticides can adversely affect the reproductive success, survivorship, and prey base available to owls as they rear their offspring in agricultural areas (Peakall 1970; Henny et al. 1984; James and Fox 1987; Wiemeyer et al. 1989). Rodenticides and herbicides are often used to control numbers of ground squirrels and plant growth on levees. This is problematic in areas where a large proportion of owls nest in levee banks, such as in the Imperial Valley. In pastures where strychnine-coated grain is used to control pocket gophers, weights of breeding burrowing owls were found to be significantly lower than on control pastures and owls had slightly decreased breeding success compared to control owls (James et al. 1990), suggesting a sub-lethal effect or that less food was available.

Anticoagulant rodenticides (such as brodifacoum) and other types of rodenticides (such as strychnine) have been shown to cause mortality in many different owl species, including burrowing owls, with the ingestion of as little as one poisoned prey item (Sheffield 1997b, Justice-Allen 2017). Anticoagulant baits that are intended to kill rodents have been known to cause death in a variety of small and large owl species (Medenhail and Pank 1980). Even with greater restrictions on second generation anticoagulant rodenticides at the federal level there is continued exposure to owls, including species that are protected under state law (Justice-Allen 2017; Gomez 2023).

Despite a long-standing ban on the use of DDT, its degradation product DDE remains a threat to wildlife in the San Joaquin Valley (Anderson et al. 2001). DDE has been documented in the eggs of terns, egrets, and herons in San Francisco Bay (Ohlendorf and Fleming 1988; Ohlendorf and Marois 1990; Hothem et al. 1995), of herons and egrets in the Imperial Valley (Ohlendorf and Marois 1990), and of prairie falcons in Pinnacles National Monument, where it was associated with impaired reproduction (Jarman et al. 1996).

Burrowing owl populations in the San Joaquin Valley (Lemoore Naval Air Station), the Imperial Valley (Salton Sea National Wildlife Refuge), and Carrizo Plain Natural Area were sampled for contaminants in 1996 (Gervais et al. 1997). Gervais et al. (1997) found that burrowing owl eggs from Lemoore contained high concentrations of DDE. Eggs from Salton Sea NWR and Carrizo Plain contained up to 0.38 and 3.4 ppm DDE, respectively. Eggs collected near Pixley in Tulare County in 1998 also contained traces of DDE (Rosenberg et al. 1998b). Contaminant loads may make owls much more vulnerable to unrelated stresses, such as exposure to other toxicants or weather. Some owl populations maintain substantial body burdens of persistent pesticides that may inhibit reproduction (Gervais et al. 2000). Gervais and Catlin (2004) compared levels of DDE contamination in the eggs of burrowing owls from the Imperial Valley in 2002 to levels detected in eggs collected at the same site in 1996.

In a follow-up study from 1998 to 2001, Gervais et al. (2006) sampled burrowing owl eggs at Lemoore Naval Air Station, and found levels of DDE varying over 4 levels of magnitude, but only 2 eggs with DDE levels worthy of serious concern. DDE levels were not by themselves associated with reproductive failure, but contaminant concentrations in combination with low rodent abundance in the diet were related to reduced productivity (Gervais et al. 2006).

Gervais et al. (1997) also compared current eggshell thickness to burrowing owl eggs from 45 nests from central and southern California collected prior to 1937, and found that eggshell thickness in 1996 had declined over 20%. Eggs from Lemoore in the San Joaquin Valley were significantly thinner than those from the Salton Sea NWR or Carrizo Plain.

The burrowing owl's habit of feeding on aquatic organisms from agricultural drainage ditches makes it vulnerable to selenium, a naturally occurring element that is leached from soils through irrigation. Selenium has caused considerable damage to other bird species in the Central Valley (Ohlendorf et al. 1986, 1987, 1988).

The U.S. Environmental Protection Agency initiated a Vulnerable Species Pilot program in 2023, which has identified an initial set of "pilot" listed species and is proposing pesticide mitigation measures designed to reduce the pilot species' exposures to conventional pesticides from non-residential outdoor uses of those pesticides (e.g., agricultural, rights of way, and mosquito adulticide) (USEPA 2023). The EPA is proposing pesticide use limitation areas for several ESA listed California species that may overlap with and provide some benefit for burrowing owls by reducing pesticide use: more than one million acres for Riverside and San Diego fairy shrimp; more than 1 million acres for Buena Vista Lake ornate shrew in the Tulare Basin in the San Joaquin Valley; and vernal meadows/pools in grassland habitats in portions of the Central Valley for Palmate-bracted bird's beak (USEPA 2023).

Introduced Predators

Predation by introduced red foxes (*Vulpes vulpes*) and feral cats is a serious problem for the burrowing owl, and urbanization has increased predation upon owls by domestic dogs (*Canis familiaris*) and domestic cats (*Felis domesticus*) (Coulombe 1971; Martin 1973; Green and Anthony 1989). Domestic cats accounted for 6 (30%) of the known owl deaths at a Florida study site (Millsap and Bear 1988). In some urban areas, domestic cats have been thought to be responsible for high burrowing owl mortality (Johnson and Schulz 1985). Feral cats were reported to be killing burrowing owls at Shoreline Park in Mountain View, Santa Clara County (P. Delevoryas, pers. comm., 2002). Google has had feral cat feeding stations near Shoreline Park that have caused problems for burrowing owls (Talon Ecological Research Group 2023). Dogs can also damage owl habitat: Thomsen (1971) estimated that dogs caused 20% of the observed damage to burrows at a study site in Oakland.

Population Isolation and Demographic Stochasticity

Small population size is a significant concern for California's burrowing owl population, since owls persist mostly in small fragmented and remnant colonies or small numbers of breeding pairs throughout the majority of their range in California. Although there is no good information on what population size of owls is vulnerable to local extinction, the viability of small populations partially depends upon the likelihood of immigration. A small effective population size predisposes small owl populations to a higher risk of extinction. Based on the data collected from reports of density estimates, S. Smallwood (pers. comm., 2023) estimated that a dozen pairs is the smallest effective population size for burrowing owls.

It is a widely recognized ecological principle that, in general, small isolated or fragmented populations are more vulnerable to extinction than large ones (Pimm 1991; Noss and Cooperrider 1994). Noss and Cooperrider (1994) identified four major factors that predispose small populations to extinction: (1) environmental variation and natural catastrophes like unusually harsh weather, fires, or other unpredictable environmental phenomena; (2) chance variation in age and sex ratios or other population parameters (demographic stochasticity); (3) genetic deterioration resulting in inbreeding depression and genetic drift (random changes in gene frequencies); and (4) disruption of metapopulation dynamics (i.e., some species are distributed as systems of local populations linked by occasional dispersal, which wards off demographic or genetic deterioration).

Regional owl populations in California are presumed to be reproductively isolated populations, making them more vulnerable to localized extirpations, absent the possibility of significant immigration of breeding owls from other areas (DeSante et al. 1997). High densities of breeding owls in the Imperial Valley are thought to be reproductively isolated from other populations to the west and thus not available as a source population to augment the very small and declining populations inhabiting southwestern California and other areas of the state (DeSante et al. 1997).

Small owl populations have an increased likelihood of extirpation due to natural or anthropogenic impacts, can suffer from reproductive isolation and inbreeding, and are susceptible to increased predation. Stochastic environmental factors such as drought or prey reduction are more likely to eliminate small populations of burrowing owls (Buchanan 1997; DeSante and Ruhlen 1995).

The persistence of burrowing owl colonies in Saskatchewan was strongly correlated with higher habitat continuity and more neighboring colonies (Warnock 1996, 1997; Warnock and James 1997). Fragmentation of remaining grassland habitat has been shown to increase populations of burrowing owl predators in Canada (Wellicome and Haug 1995; Warnock 1997) and may allow predators to find owl nests easily (James et al. 1997; Warnock and James 1997). In fragmented landscapes, burrowing owls may forage greater distances within larger home ranges and spend more time away from the nest, making them more vulnerable to predators (Haug 1985). In Saskatchewan, crowding of owls into smaller habitat patches may increase nest abandonment through events such as depredation (both intra- and inter-specific), foraging interference, and aggression (Warnock and James 1997). Fragmented agricultural landscapes may also increase vehicle collisions with owls (Clayton and Schmutz 1997) and access by people.

Many of the remaining burrowing owls in California persist in small, fragmented habitats that tend not to support large owl populations. Surveys by DeSante and Ruhlen (1995) and DeSante et al. (1996) suggested that many small outlying breeding groups of burrowing owls disappeared by the 1990s while larger groups remained. Likewise, research in San Diego County indicated that drops in burrowing owl colony size to six or fewer pairs increases risk of colony extinction (P. Bloom, pers. com., cited in CDFG 2003). Johnson (1997a,b) observed a burrowing owl population in Yolo County decline from 22 pairs to one individual during a 10-year period, which was half the time predicted by deterministic analytic population models. Even large burrowing owl populations can decline at rapid rates. Owl numbers in Canada declined at a staggering rate of 16% per year nationwide since the early 1980s, and in excess of 20% per year in the Prairie Provinces (Saskatchewan, Alberta, and British Columbia) (Haug et al. 1993; Shyry et al. 2001; Wellicome and Holroyd 2001). In Nebraska, a population of burrowing owls in one area fell by 63% between 1990 and 1996 (Desmond et al. 2000). This suggests that stochastic variation in demographic traits (possibly caused by weather), along with changes in genetic structure, also contribute to dynamics and persistence of burrowing owl populations.

Dispersal among local populations regulates regional dynamics in many species, but it is very difficult to estimate dispersal for wild populations, especially for nocturnal owls. Banding studies conducted at NAS Lemoore indicated that some burrowing owls are capable of dispersing widely (Gervais 2002), but the degree of demographic and genetic connectivity among populations of California burrowing owls remains unknown. Genetic analyses of burrowing owls from 3 demographic study sites (Lemoore NAS, Carrizo Plains, and the Imperial Valley) failed to identify population differentiation or evidence for genetic inbreeding or population isolation (Korfanta 2001; Korfanta et al. 2005). However, a population of burrowing owls studied in Davis, California showed higher genetic similarity than a collection of geographically separated owls, suggesting that some inbreeding was occurring in this wild population, likely as a result of small population size due to population subdivision (B. Johnson 1997a, 1997b). Barr (2023) and Barr et al. (2023) analyzed population structure and genetic diversity in western burrowing owls using low coverage, whole genome data, and found significant genetic differences between resident and migrant owls. Barr found genetic structure was linked to the migratory phenotype, with resident owls being highly structured and migrant owls having no structure. Among resident populations, Barr observed significantly higher genetic differentiation, significant isolation-by-distance, and significantly elevated inbreeding.

Harassment from Humans

As burrowing owl populations have declined into small isolated colonies or pairs in the Sacramento Valley, interest increased among enthusiasts wishing to view or photograph these increasingly rare, charismatic animals. Word spread of burrowing owl locations via eBird and personal communications, hence increasing visitation rates to remaining owls. Photo 5 below shows one of the signs posted on a County Road north of Davis, ostensibly placed to protect the owls known to have been attempting to nest there, but ultimately pointing the way to photographers and enthusiasts, too many of whom approached to within only a few feet of the nesting owls.

Photo 5 - A sign alerted birders to the location of a pair of burrowing owls attempting to breed on the edge of a small grassland patch (out of sight, left of road) along a County Road in north Davis, California. Many people arrived to look at the owls and to photograph them from only a few feet from the nest burrow. The owls quit the nest attempt.

In their surveys of many California sites proposed for various projects, Smallwood and Smallwood (2023) documented 25% of them to have been recently treated in one or more ways that suppressed wildlife. At many of these sites, burrowing owl occupancy would have been likely prior to the actions that were taken, usually consisting of disking and ground squirrel control by use of anti-coagulants.

Predation and Disease

Because of their ground-dwelling behavior, burrowing owls are susceptible to predation by terrestrial and avian predators, especially in habitats in which burrowing owl vantage is limited by tall vegetation and where trees or shrubs provide perches for hawks and larger owls. Although natural predation on burrowing owls may be significant in grassland habitats such as the Carrizo Plains (Ronan 2002), natural predators such as large raptors and coyotes may actually benefit owl populations in more urban areas by checking numbers of feral and domestic cats. Changes in concentrations of natural predators due to anthropogenic ecosystem changes have impacted burrowing owls and continue to be a threat. As habitats have been altered and top predators exterminated, subsequent increases in mesocarnivores such as foxes, coyotes, and badgers may be taking a large toll on burrowing owls (Sheffield 1997a; Wellicome 1997). On Santa Barbara Island, California, a small population of approximately 20 burrowing owls was extirpated by barn owls in 1984 and again in 1987 following crashes in the deer mouse (*Peromyscus maniculatus elusus*) population (Drost and McCluskey 1992). In healthy burrowing owl populations natural predation is probably not a significant threat, but it may cause a significant decrease in viability for fragmented and remnant owl populations, especially when combined with other impacts, such as development, edge effect, persecution of fossorial mammals, pesticides, or predation by nonnative species.

Increasing common raven populations are becoming problematic for many at-risk species (see Sanchez et al. 2021). Raven predation on burrowing owls has been documented every year but one (2023) from 2013-2023 in San Diego; across those 11 years, ravens accounted for 25% (47 of 185) of all observed mortalities, with annual percentages ranging from 0-58% (Hennessy et al. 2015; Wisinski et al. 2016; Marczak et al. 207; Marczak et al. 2018, Wisinski et al. 2020).

Burrowing owls in California may be vulnerable to the West Nile Virus (Flavivirus spp.). West Nile Virus (WNV) emerged in the United States in the late 1990s, causing sometimes fatal disease in a variety of bird species. By 1999, WNV was identified in more than in 138 species of birds found dead in the United States, including 7 species of owls (CDC 2002). Birds of prey may become infected by bites from mosquito vectors or by the ingestion of infected prey. Diurnal burrowing owls may be less available to questing mosquitoes at night because they roost in burrows. Burrowing owl susceptibility to WNV is unknown. Dusek et al. (2010) investigated the prevalence of WNV-neutralizing antibodies and infectious virus, and the occurrence of overwinter transmission in kestrels and burrowing owls at the Salton Sea in Imperial County, California. They captured and evaluated 116 burrowing owls, and 31% were positive for WNV-neutralizing antibodies. Infectious WNV, consistent with acute infection, was not detected in any bird. Dusek et al. (2010) noted that burrowing owls that spend time during the winter in nest burrows may be subjected to blood-feeding *Ornithodorus* ticks in their burrows. These ticks, once infected, have been shown to remain infected and capable of transmitting virus for at least 4 months, providing a potential source of WNV to burrowing owls through the winter. The high WNV antibody prevalence in raptors around the Salton Sea suggest this virus is well-established in this area among wild birds, and WNV transmission is occurring over the winter months in the Salton Sea (Dusek et al. 2010). The U.S. Centers for

Disease Control and Prevention screened 420 deceased owls (including 12 burrowing owls) from throughout California between 2006 and 2014 for WNV and determined a 14% prevalence of WNV in dead-owl populations; 7% chronically infected and 7% acutely infected. There was a high WNV prevalence in dead birds in Yolo County, California from 2012–2013. Despite the known susceptibility of owls to WNV, the California Raptor Center at UC Davis received surprisingly few burrowing owls with the disease. Captanian et al. (2017) found that WNV antibodies were virtually absent in 71 plasma samples (including 2 burrowing owl samples) from 7 species of owls from northern California

Epizootics of sylvatic plague (*Yersinia pestis*) that affect rodent colonies could negatively impact and even eliminate burrowing owl populations indirectly by reducing available habitat (Dechant et al. 1999).

In response to West Nile Virus, mosquito abatement has increased in the Sacramento Valley, likely resulting in widespread declines of arthropod populations.

Parasites, particularly sticktight fleas (*Echidnophaga gallinacea*) are frequently mentioned in the literature as common inhabitants of owl burrows, and some birds have been known to carry lice (*Colpocephalum pectinatum*) (Thomsen 1971) and feather mites (Belthoff and King 2002). Sticktight fleas have been identified as an emerging threat to burrowing owl survival and productivity in wild and translocated owls; application of deltamethrin or diatomaceous earth to burrow substrates or infested owls, as well as direct application of triple antibiotic ophthalmic ointment to fleas on affected owls, have proven efficacious (Marczak 2023). Wisinski et al. (2020b) examined return rates of banded adult female burrowing owls observed in 2018 in San Diego, finding that a higher proportion of females that did not experience a flea infestation (14/29 [48%]) returned and were observed in 2019 compared with those that did have fleas (1/6 [17%]); conversely, 5 of 6 males associated with the flea-infested females (83%) returned in 2019. These numbers suggest there may be sex-based survivorship differences, with possibly a longer-lasting negative effect of sticktight flea infestations to females, even after receiving treatment (i.e. removal of the fleas and dusting of the affected birds and burrows).

<u>Other Anthropogenic Factors</u>

Fire Control

In many urban areas with burrowing owl habitat, open fields are disked for weed control to reduce the threat of fires. Disking or tilling of the land destroys burrows and potentially the owls in these burrows (Trulio 1998b). Mowing is a viable alternative that does not destroy birds or burrows. Several Bay Area entities, such as Moffett Federal Airfield and the cities of Palo Alto, Mountain View, Davis, and San Jose have changed from disking to mowing on their lands to prevent the destruction of owls. However, most cities within the range of the owl have no such ordinances or policies. Private landowners throughout California are still permitted to disk their lands, and an estimated 91% of burrowing owls are on private land (DeSante et al. 1996).

Climate Change

Climate and habitat models developed by the Audubon Society (2019) predict that the western burrowing owl could lose 77% of its current breeding range due to climate change by 2080, including a significant loss of range in California.

Macías-Duarte and Conway (2015) used data from the North American Breeding Bird Survey to document changes in the distributional limits of the western burrowing owl, finding a southward shift in the northern half of its breeding range, contrary to what is predicted by most species niche models and what has been observed for many other species in North America. The breeding range of the western burrowing owl has been shrinking near its northern, western, and eastern edges. Modeling by Macías-Duarte and Conway (2015) detected population declines observed in California and eastern Washington, in locations where maps based on route-specific estimating equations had predicted significant population increases. Macías-Duarte and Conway (2015) suggest that the northern boundary of the breeding distribution of the western burrowing owl has contracted southward and the southern boundary of the species' breeding distribution has expanded southward into areas of northern Mexico that were formerly used only by wintering migrants.

Sales and Parrott (2024) estimated the burrowing owl's potential future distribution using ecological niche models, calibrated with climate and soil information and projected onto future scenarios of climate change (low versus high greenhouse gas emission). Sales and Parrott (2024) simulated environmental sorting using habitat filter masks derived from information on habitat use and forecasts of future land use change, focusing on grasslands as nesting and breeding habitat. They found that the burrowing owl could expand its geographic distribution by 3 to 10-fold towards Northern latitudes, especially under high-emission scenarios of climate change. However, nearly half of the suitable environments (up to 53,593 km^2 of locations with suitable climate and soil) might not be covered by grasslands, due to conversion to agriculture and other human land uses which may prevent the establishment of breeding populations. The results of Sales and Parrott (2024) shed light on the pervasive effects of neglecting the preservation of grasslands across western North America, which could provide critically needed habitat for migrating species from lower latitudes.

Inadequacy of Existing Regulatory Mechanisms and Management Efforts

Federal Regulatory Mechanisms

Species of Conservation Concern

The burrowing owl was designated as a Species of Special Concern (SSC) under the Endangered Species Act since 1996. Since that designation, the U.S. Fish and Wildlife Service (USFWS) included the western burrowing owl in its 2002 and 2021 reports on Birds of Conservation Concern (USFWS 2002, 2021). Western burrowing owl populations in coastal California and the Sonoran and Mohave Deserts are designated as 2021 Birds of Conservation Concern. These reports identify bird species that deserve prompt conservation attention to stabilize or increase populations or to secure threatened habitats. The designation was developed to assist efforts by federal and state agencies, conservation organizations, private companies, and landowners to protect and restore bird habitat and reduce the impact of their activities on species of concern. This designation allows landowners and other project proponents the opportunity to plan early for the conservation of certain species, and the USFWS encourages these species to be considered during federal consultations, but has little authority to impose measures.

Some Habitat Conservation Plans, completed under Section 10 of the ESA by project proponents in order to obtain a permit for take of species that would otherwise be prohibited under Section 9, do contain some mitigation for SSC species. But neither the protections of Section 9 of the ESA (prohibiting "take" of the species) nor the protections of Section 7 (requiring all federal agencies to ensure that their activities do not jeopardize the continued existence of the species) apply to SSC species. SSC species will not have critical habitat designated, nor will they receive recovery plans. Although the SSC designation may provide some impetus for providing mitigation for impacts to burrowing owls, provisions are usually implemented at the discretion of the project proponent, and do not necessarily provide sufficient protection for the burrowing owl. Since 91% of the burrowing owls remaining in the state are located on private lands (DeSante et al. 1996), the threats to these populations are not subject to any federal regulation.

In 2003, the USFWS published a "Status Assessment and Conservation Plan for the Western Burrowing Owl in the United States" (Klute et al. 2003). This publication attempted to summarize the status of the western burrowing owl and outline critical needs for its conservation. Data for the report were gathered from scientific literature and from targeted mailings of a questionnaire to state resource agencies and burrowing owl researchers. However, contributors to the California State Summary section of the report represented only two research groups and many burrowing owl experts in California were never contacted. As a result, data in the California State Summary section of the report were not comprehensive. The report gave the misleading impression that the burrowing owl status was secure in California, highlighting that California had one of the largest populations of burrowing owls in the United States, without acknowledging declining population trends and risks to burrowing owl persistence. The estimate of California burrowing owl population size presented in the report was actually similar to those in nine other states and provinces in which the species was considered to be a species of concern, threatened, vulnerable, or imperiled.

Federal Listing of Other Species Within the Range of the Burrowing Owl

Listing under the federal ESA for other species that overlap with the burrowing owl in habitat and range could conceivably provide some protection to the species. Habitat for burrowing owls overlaps somewhat with habitat for federally listed species and species of concern such as the San Joaquin kit fox (*Vulpes macrotis mutica*), blunt-nosed leopard lizard (*Gambelia sila*), listed and special-status kangaroo rats (*Dipodomys ingens, D. stephensi*, *D. nitratoides nitratoides, D. n. exilis, D. n. brevinasus*), San Joaquin antelope squirrel (*Ammospermophilus nelsoni*), San Joaquin pocket mouse (*Perognathus inornatus inornatus*), Tulare grasshopper mouse (*Onychomys torridus tularensis*), desert tortoise, and Mohave ground squirrel (*Spermophilus mohavensis*). The primary way in which the burrowing owl could benefit from the listing of these species is through protection of owl nesting and foraging grasslands habitat shared with these species. Such protection is most likely within the context of multiple species Habitat Conservation Plans, but habitat overlap may occur in only a small portion of the burrowing owl's range. Many, if not all, of these overlapping species have continued to decline since their listing, raising questions as to whether federal listing has adequately protected these species themselves, let alone conferred benefits to other unlisted species that merely overlap somewhat in range. Additionally, the vast majority of remaining burrowing owls live in the margins of agricultural areas, most of which are not protected habitat for any listed species.

Migratory Bird Treaty Act

The burrowing owl is a migratory species protected by the Migratory Bird Treaty Act (MBTA) of 1918 (16 U.S.C. 703-711). The MBTA makes it unlawful to take, possess, buy, sell, purchase, or barter any migratory bird listed in 50 C.F.R. Part 10, including feathers or other parts, nests, eggs, or products, except as allowed by implementing regulations. To avoid violations of the take provisions of these laws generally requires that project-related disturbance at active nesting territories be reduced or eliminated during the nesting cycle. Disturbance that causes nest abandonment and/or loss of reproductive effort (e.g., killing or abandonment of eggs or young) may be considered take and is potentially punishable by fines and/or imprisonment. The MBTA provides a strong legal basis for regulatory agencies such as CDFW and USFWS to make recommendations on CEQA related projects to conserve breeding owls. Of course, regulatory agency recommendations on CEQA related projects are routinely ignored, as discussed below. Petitioners are unaware of any enforcement of the MBTA for take of burrowing owls in California or any prosecution for take under the MBTA for burrowing owls, though massive and significant documented take occurs regularly (for example the hundreds of burrowing owls killed annually at Altamont Pass wind turbines).

Habitat Conservation Plans

The Habitat Conservation Plan (HCP) program, which is intended to allow development to the extent compatible with conservation, forces the USFWS to mediate conflicts between development and the conservation of endangered species. As originally enacted in 1973, the Endangered Species Act (ESA) flatly prohibited the "take," of endangered animal species. A 1982 amendment (Section 10) provided for exception to the take prohibition, authorizing the issuance of permits for the incidental take of listed species under certain circumstances. To obtain an incidental take permit, the applicant must submit an HCP. HCPs are supposed to allow development to proceed if plans specify with scientific credibility that the impacts of proposed habitat changes are minimized to the maximum extent practicable and/or mitigated. Permits are required only for the incidental take of federally listed species, but the wildlife agencies strongly encourage permittees to include state-listed, proposed, candidate, rare, and other species in their HCPs. Voluntary inclusion of unlisted species in HCPs provides more planning certainty to the permittee in case of future listing and can increase the biological value of the plan. Unlisted species are supposed to be “adequately covered” by an HCP, i.e., addressed as if they were listed under the ESA.

The HCP provisions of the ESA were intended to provide a net benefit to threatened and endangered species, in return for providing landowners with regulatory certainty and permits to impact or otherwise “take” listed species and their habitats. In theory, HCPs can help protect and restore habitat, including habitat for non-listed species covered under the plan. Unfortunately, some HCPs fail to live up to this promise, and simply function as exemptions from the ESA’s species and habitat protection policies. Arguably, a few HCPs make the best of difficult situations on private lands, and may even help species’ recovery to some extent. However, since HCPs are not required to have a net benefit to listed species or contribute to their recovery, there is considerable reason to be skeptical of the ability of HCPs to protect populations and habitat for covered non-listed species such as the burrowing owl. HCPs are explicitly not required to benefit non-federally listed species. None of the California HCPs have adequately monitored the effectiveness of mitigation directed to burrowing owls.

As of 2023, there were 35 approved federal HCPs in California that cover the burrowing owl as a non-listed species (USFWS 2023). Eleven of these HCPs cover areas encompassed by larger regional HCPs and 7 cover very small areas (from 25.5 to 650 acres). That leaves 17 HCPs in California that could potentially cover significant acreage within the range of the burrowing owl. However, many of these cover areas with very few remaining breeding owls. In reality, only five of these HCPs can be expected to have the potential to provide significant burrowing owl conservation, by protecting large areas of owl habitat that have biologically meaningful numbers of remaining breeding burrowing owls: none in the Central Valley region; two in the Bay Area region (Eastern Contra Costa and Santa Clara); two in the Southwestern California region (western Riverside and San Diego); one in Coachella, and none in the Southern Desert region. But regional owl populations in Santa Clara, western Riverside, and San Diego counties and in their respective HCP areas are all in serious decline or nearing extirpation. It is questionable whether the Coachella HCP will adequately protect the owl population there; and the western Riverside HCP is failing to conserve burrowing owls and the populations there are declining rapidly – see the discussions below about each HCP.

Central Valley

Department of Corrections HCP

The Cal. Dept. of Corrections Statewide Electrified Fence Project HCP covers 2,937 acres on 25 prison sites throughout California (mostly the Central Valley plus a few in Southern California) with electrified fences and 4 sites where future electrified fences were anticipated; it was approved 6/12/2002 for 50 years (CDC 1999; USFWS 2023). The HCP includes modifications to security fences such as protective netting that had already helped to minimize electrocution of burrowing owls at 13 of the state's 25 prisons by 2003 (CDFG 2003). The HCP presumes that 15-17 owls will continue to be killed per year at all of the facilities combined (850 owls total over 50 years), with only 72 acres of protected land proposed as mitigation (CDC 1999).

Western Placer County HCP

The Western Placer County Conservation Plan/Natural Community Conservation Plan covers 269,118 acres in western Placer County and a small portion of Sutter County, for urban, suburban and rural development and infrastructure; it was approved 12/04/2020 for 50 years

(Placer County 2020; USFWS 2023). This is an HCP that seems to attempt to accommodate and improve conditions for burrowing owls, but breeding burrowing owls are very rare in the plan area, and owls occur primarily as overwintering birds. Breeding had only been documented at one location in the plan area, in the Swainson's Hawk Preserve in 2012, 2013, and 2015, with 1-2 nesting pairs. The HCP anticipated direct effects to 16,444 acres of potential burrowing owl habitat within the 55,101 existing acres of potentially habitat in the plan area. The HCP allows passive relocation of owls during the non-breeding season, which will be authorized only if all alternative avoidance and minimization measures are exhausted. The HCP has a goal of protecting sufficient habitat to maintain or increase the population size of overwintering western burrowing owls within an interconnected reserve system with habitat linkages, and to promote the expansion of a breeding population of burrowing owls onto the reserve system. The HCP will protect existing vernal pool complexes and attempt to increase ground squirrel populations. The HCP has a goal to protect and manage at least three ground squirrel colonies on three separate sites, within protected grasslands providing habitat for western burrowing owl; or alternatively provide artificial burrows for owl nesting.

Natomas Basin HCP

The Natomas Basin Revised HCP (which also covers the Natomas Basin and Metro Air Park) covers 53,342 acres in Sacramento County and Sutter County for urban development; it was approved in 2003 for 50 years (USFWS 2023; City of Sacramento 2003). The Natomas Basin HCP had not conducted systematic surveys for burrowing owls as of 2015, and they are not a "monitored" species, but annual observations in the HCP area and the basin have been recorded since at least 2004 (ICF 2010-2023). The Natomas Basin site in Sacramento has an estimated 247 miles of canals and ditches and associated agricultural fields that are potential burrowing owl habitat, and 2,187 acres of "enhanced upland reserve habitat" would be established for the owl. The primary impact of the HCP on the burrowing owl will be the loss of potential nesting and foraging habitat along canals. The HCP claims that loss will be offset by the protection and restoration of upland habitat in the reserves and management of canals within the reserves to benefit the owls and ground squirrels. The plan also prohibits disturbance of owls during their nesting season and provides for relocation of owls. The Natomas Basin Conservancy has acquired two blocks of habitat known to be occupied by burrowing owls; one of which was described as the largest colony of owls in the basin. As of 2015, the Natomas Basin Conservancy had set aside 4,125 acres of land for burrowing owls, with half of that acreage considered "ideal burrowing owl habitat." But there are no longer breeding owls in the HCP preserve lands (Natomas Basin Conservancy 2021). Even with the loss of some canals and ditches and adjacent foraging habitat, a majority of the canals in the basin will remain unaffected by the HCP permits. The HCP claims that remaining habitat combined with the higher quality habitat made available to the owls on reserve lands should offset any take that results from the HCP. It also makes the claim that given the very large range of this species, the impacts of any take of the owl within the basin on the species as a whole will be negligible. Mitigation measures include not disturbing occupied burrows during the nesting season unless juveniles are determined to be able to survive on their own, and maintaining a 300 foot buffer around occupied burrows during construction (relocation will take place if that is not "feasible"). Thus, the HCP permits urban encroachment to within 300 feet of burrows, and allows for relocation.[19] Burrowing owls were known to breed and winter at low density in the Natomas

[19] The National Wildlife Federation filed suit against the Natomas Basin HCP, including claims that the USFWS finding that the plan would mitigate impacts to covered species to maximum extent practicable was arbitrary and capricious, and that the USFWS finding that funding for the plan was assured was arbitrary and capricious. The court held that the USFWS had not fulfilled its duty to determine that the plan would mitigate impacts to covered species to the maximum extent practicable where the mitigation fees were set "at the minimum amount necessary to meet the minimum biological necessities of the covered species," and where the record was "devoid" of evidence that the

Basin historically, primarily along the eastern terrace and in the southeastern portion; and 15 pairs of owls were observed on non-reserve lands during basin-wide surveys in 2009 (ICF 2023). Breeding pairs peaked in 2011 and substantially and steadily declined in the reserve area and throughout the basin, with no documented breeding in the HCP area since 2014; and three formerly large burrowing owl colonies in the basin on non-reserve lands declined and were extirpated by 2019 due to disturbance, development, and invasive weeds (ICF 2023). Burrowing owls are occupying fewer places in the Natomas Basin and are no longer resident in some areas where they historically have been, both on and off reserve lands (ICF 2023).

The 1,892-acre Metro Air Park development project HCP establishes 2% of the project area as habitat reserve land, only one quarter of which would be potential habitat for the burrowing owl. If burrowing owls are found during surveys on the other 98% of the project area, the "mitigations" include not disturbing occupied burrows during nesting season (as already required by state Fish and Game Code) unless "approved by a biologist;" acquiring and permanently protecting a minimum of 6.5 acres of foraging habitat adjacent to occupied burrowing owl habitat per paired or unpaired bird (although it is not specified whether this will be on-site); enhancing existing or creating new burrows at a 2:1 ratio when destruction of a burrow is "unavoidable;" use of passive relocation techniques (i.e. preventing owls from reoccupying nests); and a caveat that the project sponsor "should" provide funding for long term management and monitoring. The amount of habitat protected and mitigation measures proposed do not inspire confidence that burrowing owls will persist on this site to be managed and monitored. Though historically numerous burrowing owls "in significant numbers" were observed during spring, summer, and fall at many locations on the Metro Air Park lands, they had not established nest sites on Metro Air Park Habitat Conservation Plan lands (Cribbs and Associates 2016-2023). By 2015, no burrowing owls were observed at any of the usual sites where they had been in past years; during spring and fall of 2018 burrowing owls were observed at drainage inlets along North Metro Air Parkway and at other drainage structures in the area; no burrowing owls were observed in 2019; 5 burrowing owls were observed in 2020; and in 2021 only 3 owls were documented (Cribbs and Associates 2011-2023). The number of burrowing owls observed on Metro Air Park is only a fraction of the numbers observed in past years; reasons for this decline are unknown but anecdotal information and regular field observations by the HCP biological monitor strongly indicates a significant decline in prey species numbers on the Metro Air Park area (Cribbs and Associates 2016-2023).

South Sacramento HCP

The South Sacramento HCP covers 317,655 acres in southern Sacramento County for urban development and associated infrastructure. It was approved in 2018 for 50 years (County of Sacramento et al. 2018). The HCP noted 97 documented occurrences of western burrowing owl within the Plan Area. The HCP presumed that outlying areas of Sacramento County still provide habitat for the species, with burrowing owls known to occupy patches of habitat in the western part of the Plan Area that extend from the Sacramento Regional County Sanitation District Bufferlands to The Nature Conservancy's Cosumnes River Preserve, as well as patches of habitat in the rolling grasslands in eastern Sacramento County; and that the Meadowview and Pocket areas within the City of Sacramento (outside the Plan Area) support disjunct, isolated populations north to Florin Road. As discussed above in the section on Sacramento County, by

---

USFWS conducted its own examination of the practicability of the proposed fee base or "attempted to determine if a higher fee base would also be practicable." The court also held that the City had not ensured adequate funding, as required by ESA section 10, because the City had not guaranteed that adequate funding would be available, but instead relied on funds to be provided by subsequent participants. A litigation resolution required more mitigation, which came in the form of wetlands north of the airport.

there were only two breeding pairs of burrowing owls reported in the entirety of Sacramento County during the 2021-2023 breeding seasons.

The permanent direct and indirect effects of covered activities on burrowing owl will include modification or removal of modeled habitat, increased human activity, invasive plants and animals introduced into modeled habitat, vehicle and aircraft collisions with owls, and increased risk of wildlife disease. The HCP anticipates direct loss of 30,086 acres of total modeled nesting/foraging habitat for burrowing owl, with most impacts (22,000 acres) to valley grassland habitat type, which is the primary habitat used by burrowing owl. Indirect effects outside the urban development area would be along improved roads supporting higher traffic densities and speeds that increase the risk of vehicle collisions, human activity, trash, and utility strikes. To mitigate impacts to the burrowing owl, the HCP proposes to preserve approximately 33,132 acres of modeled wintering/nesting habitat (22,014 acres of valley grassland, 6,947 acres of cropland, 2,749 acres of irrigated pasture-grassland, 47 acres of blue oak savanna, 966 acres of vernal pool, 105 acres of seasonal wetlands, 278 acres of swale, and 26 acres of stream/creek) throughout the plan area. A majority of this preservation will occur outside the urban development area. The HCP asserts that 7 occupied burrowing owl sites and at least 200 acres of land surrounding each burrow site will be preserved under the HCP, but there are no longer 7 occupied breeding sites in the entire county, let alone the HCP area. For the 200 acres of modeled habitat preserved for every burrowing owl or burrowing owl pair passively relocated, the HCP proposes to establish a ground squirrel colony and augment the site with artificial burrows. Since the burrowing owls is near extirpation as a breeding species in Sacramento County, the promised mitigations may not be achievable.

Yolo HCP

The Yolo Natural Heritage Program HCP covers 653,629 acres in all of Yolo County, including the cities of Davis, West Sacramento, Winters, and Woodland, for urban and rural development and infrastructure. It was approved 09/24/2018 for 50 years (YHC 2017; USFWS 2023). The Plan Area includes 103,854 acres of “modeled” burrowing owl habitat, including 37,694 acres of primary habitat and 66,160 acres of other habitat. Comprehensive owl surveys have not been conducted, but the Burrowing Owl Preservation Society and Institute for Bird Populations conducted surveys in 2014. Although these were not comprehensive county-wide surveys, the results indicated that the majority of known owl breeding locations were in the southern portion of Yolo County, centered in and around the City of Davis (in the Davis planning unit), the Yolo Bypass Wildlife Area (in the Yolo Basin Plains planning unit), and the South Yolo Bypass planning unit. Menzel et al. (2024) surveys documented a precipitous 76% decline in the Yolo County’s burrowing owl population as compared to the previous survey in 2006–2007. The Burrowing Owl Preservation Society reports that breeding burrowing owls appear to be near extirpation in Yolo County and that most of these former breeding locations in 2014-2015 had no breeding owls by 2023 (Menzel et al. 2024). Breeding burrowing owls appear to already have been extirpated from the City of Davis area (S. Smallwood, pers. comm, 2023).

Covered activities under the HCP will remove up to 3,172 acres of modeled owl habitat, including 861 acres of primary habitat and 2,311 acres of other habitat. This loss represents 3% of the total owl habitat in the Plan Area (YHC 2017). An estimated 19% (621 acres) of the owl habitat loss will result from development in the Woodland, Davis, West Sacramento, and Winters urban planning units. The remainder of the loss will be distributed throughout modeled habitat in the Plan Area, and will result from various activities such as rural development in Dunnigan Hills, Monument Hills, and Madison, and mining in the Lower Cache Creek planning unit. Covered activities will not substantially reduce modeled habitat near known population centers of burrowing owls, or result in fragmentation of burrowing owl habitat. Burrowing owls may be displaced from up to four occupied sites (an occupied site is a breeding or wintering burrow or burrow complex occupied by a single breeding pair or nonbreeding individual). Mitigation measures include habitat reserves, preconstruction surveys, avoidance of active nests, and buffer zones to avoid disturbance. The HCP allows for passive relocation of owls, including collapsing burrows, and installing one way doors during non-breeding season. It also allows for active relocation upon wildlife agency approval. Up to 17% of the habitat in the Plan Area will be conserved on categories 1 and 2 public and easement lands, including baseline and newly protected lands. Of these lands, at least 5,500 acres will consist of newly protected lands supporting modeled owl habitat, which will be incorporated into the reserve system, and an additional 1,100 acres of pre-permit reserve lands supporting modeled owl habitat will be enrolled into the reserve system. All reserve system lands will be monitored and adaptively managed to sustain habitat value for this species.

The Yolo HCP claims to minimize and mitigate impacts on western burrowing owl, to the maximum extent practicable, and provide for the conservation of this species in the Plan Area, but breeding owls appear to already be near extirpation. Since its permitting in 2019, the Yolo Habitat Conservancy has no occupied burrowing owl conservation easements as of August 2023 (Menzel et al. 2024).

East Contra Costa HCP

The East Contra Costa County HCP/NCCP provides permits for covered activities (mostly urban development and rural infrastructure) in the 175,435-acre inventory area in eastern Contra Costa County. The HCP/NCCP was approved by USFWS and CDFW in 2007 for a 30-year permit term (Jones & Stokes 2006a; USFWS 2023). As of 2023 the HCP had protected approximately 8,400 acres of annual and alkali grassland habitat potentially suitable for burrowing owls, however the acres protected were not all identified as core burrowing owl habitat (S. Menzel, pers. comm., 2024). The East Contra Costa County Habitat Conservancy, the agency responsible for implementing the HCP/NCCP, conducted multiple years of population surveys for burrowing owls as of 2023 (A. Fateman, pers. comm., 2024). While habitat for western burrowing owl is found throughout the inventory area, occurrences in the southeast portion near the Byron Airport are best known. The estimated impact to burrowing owl habitat permitted through the HCP/NCCP will be a 9% (3,805 acres) to 13% (5,755 acres) loss of breeding and foraging habitat outside parks and open space (Jones & Stokes 2006a). However during the first 15 years of plan implementation impacts to grassland and alkali grassland habitat has been less than 200 acres (ECCCHC 2022). Expansion of unincorporated portions of the county near Byron and Discovery Bay have the potential to affect known owl populations and limited-use habitat. Expansion of the Byron Airport would also adversely affect a known population and its breeding habitat, as would the Los Vaqueros Reservoir Expansion. The habitat conserved through the HCP/NCCP is expected to be 38% (16,675 acres) to 45% (19,844 acres) of existing breeding and foraging habitat, outside of existing conserved parks and open space. A network of preserves will protect large blocks of grassland habitat, with linkages created suitable for dispersal and colonization. To attract and retain burrowing owls, artificial burrows and perches may be installed, where appropriate. Under permit conditions of the HCP/NCCP, developers engaged on private properties shall prioritize avoidance of occupied burrows during the breeding season, but are allowed to engage in passive relocation, using one-way doors and burrow destruction during the non-breeding season.

San Joaquin HCP

The San Joaquin County Multi-Species Habitat Conservation and Open Space Plan covers urban and rural development, utility infrastructure, mining, and water supply activities on 896,000 acres in Stockton, Tracy, Lathrop, Lodi, Manteca, Escalon, and Ripon in San Joaquin

County; it was approved 05/31/2001 for 50 years (SJCOG 2000; USFWS 2023). It also encompasses the 1997 Teichert Vernalis Project HCP. The HCP estimated there were 195,325 acres of burrowing owl habitat in the county; 84,749 acres of occupied habitat and 110,576 acres of potential habitat; and estimated that covered activities would convert 28,722 acres, taking 15% of the total available owl habitat (SJCOG 2000). The majority of the habitat conversion expected to impact the burrowing owl was anticipated to occur in the Southwest Zone of the HCP area. As mitigation, the HCP proposed to prohibit development or conversion of more than 10% of the known occupied and potential burrowing owl habitat (19,533 acres) unless certain conditions are satisfied: avoidance of anticipated impacts due to project redesigns to lower anticipated take to less than 10% of available habitat; demonstrate that the range of the burrowing owl has expanded within areas where take is not anticipated sufficient to allow additional take to occur; or provide biological documentation that incidental take of more than 10% of the total occupied and potential habitat for the burrowing owl will not jeopardize the long-term survival of the entire species. The HCP proposes to avoid direct take of owls by discouraging use of construction sites by owls or ground squirrels, by planting or maintaining high vegetation, discing or plowing the entire project site to destroy any ground squirrel burrows, or trapping or poisoning ground squirrels with anticoagulants, fumigants and rodenticides. If owls are already present on construction sites, their burrows can be destroyed when owls are absent, or they will be evicted using passive relocation. The HCP proposes to avoid direct impacts by establishing setbacks of at least 250 feet from each owl burrow occupied within the past five years; and mitigate for habitat losses by preserving 6.5 acres of foraging habitat per burrowing owl pair, contiguous to the owl population. The HCP proposed creation and maintenance of artificial owl burrows in valley grassland preserves, vernal pool preserves and row and field crop/riparian preserves.

The San Joaquin HCP is a habitat-based plan that does not contain species-focused management, thus has no specific management to benefit or maintain burrowing owl habitat (Menzel 2015). Smallwood (2023c) found that EIRs for proposed new projects under the San Joaquin HCP are routinely using reconnaissance-level species surveys and that protocol-level detection surveys are rarely completed at sites; and found no evidence that baseline species surveys at new preserves qualified as detection surveys. Analysis of the HCP’s annual reports reveal flawed study design, deficient implementation, and poor reporting including poor quality control, and failed to include the results of biological effectiveness monitoring over the first five years of the HCP (Smallwood 2023c). No trend analysis has been performed over 23 years of the HCP and none of the annual reports compare biological effects monitoring among preserves or among years. The annual reports fail to report the most fundamental methodological details that the reader needs to interpret the monitoring results.

The HCP had not conducted any surveys for burrowing owls as of 2015, but owl pairs were known to occur on the HCP preserves (Menzel 2015). Focused surveys for burrowing owls on SJMSCP preserves were finally conducted in 2021, two decades after approval of the HCP. There is obviously no baseline against which to compare the findings of the 2021 survey. On 16,667 acres of preserves acquired by 2021, only 2 breeding owl pairs were found. Failure to adequately complete focused surveys as required by the HCP hampers the ability of managers to react to emerging deficiencies such as the failure to conserve burrowing owls. Smallwood (2023c) concluded that the San Joaquin HCP has failed in its implementation and has proven ineffective at conserving its covered species.

The Teichert Vernalis Project, Phases 1&2 HCP (now covered by the San Joaquin HCP) is a small HCP, but is worth noting for its treatment of burrowing owls. It covers 300 acres of mining activities in Tracy, San Joaquin County; it was approved 01/09/1997 for 50 years. The HCP concedes that the preservation and persistence of the burrowing owl is “not a priority,” and offers no mitigation for loss of burrowing owl habitat. The plan advocates destroying ground squirrels and their burrows and planting vegetation taller than 36”, so as not to attract burrowing owls to the site. If no burrowing owls, California red-legged frogs, California tiger salamanders, or San Joaquin kit foxes are found during surveys, plowing or disking of the land is authorized. If owls are found, they will not be disturbed during breeding season unless “approved by a biologist,” and passive relocation (i.e. preventing owls from reoccupying nests) is the preferred option. The stated intent of this HCP was to remove burrowing owls from the project site and destroy burrowing owl habitat. This HCP was encompassed by the later San Joaquin MSHCP, which did not result in better owl protections.

PG&E San Joaquin HCP

The PG&E San Joaquin Valley Operations & Maintenance HCP covers utility infrastructure in 276,350 acres in portions of San Joaquin, Tuolumne, Mariposa, Madera, Fresno, Tulare, Kern, Stanislaus, Merced, and Kings Counties; it was approved 12/14/2007 for 30 years (Jones & Stokes 2006b; USFWS 2023). This is a small impact HCP with regards to the burrowing owl; the HCP anticipates permanent loss of less than 0.1 acre of owl habitat per year (3 acres over 30 years), temporary loss of 5 acres, and other disturbance on 42 acres (Jones & Stokes 2006b). The HCP will use preconstruction surveys and work exclusion buffer zones to avoid take. For nonbreeding owls, passive relocation techniques will be used as needed to ensure that owls move out of construction areas prior to ground disturbance. PG&E proposed to develop a burrowing owl conservation program for PG&E facilities, to identify protection, management, and enhancement activities for burrowing owl populations that are adapted to work activities at substations and other facility sites. The program may lead to a separate MOU between PG&E and the agencies for burrowing owl management and may be incorporated adaptively into the HCP. Compensation for owl impacts may entail acquiring existing occupied burrowing owl habitat or enhancing lands near occupied burrowing owl habitat, managed to maintain compatibility with burrowing owl use.

ARCO Western Energy HCP

The ARCO Coles Levee (ARCO Western Energy) HCP covered 120,320 acres slated for oil and gas development in Kern County; it was approved 03/01/1996 for 30 years. It is unclear what impacts this project had on burrowing owls; the permittee surrendered the permit prior to the expiration date (USFWS 2023). The project had set up a Coles Levee Ecosystem Preserve, a 6,059-acre mitigation preserve in Kern County focused on monitoring of San Joaquin kit fox, kangaroo rats, listed plant species, and other federally listed species; in the annual monitoring reports burrowing owls are listed in a table of species known to occur but absolutely no information is provided (SVB 2016-2019).

Kern Water Bank HCP

The Kern Water Bank HCP covers water recharge and recovery activities on 1,900 acres in portions of Kern, Tulare, and Kings Counties; it was approved 10/02/1997 for 75 years (KWBA 1997; USFWS 2023). It includes canals, levees, roads, and other infrastructure where burrowing owls may nest. Project impacts include loss of individual owls from project grading, flooding, facilities construction, maintenance of levees and canals, and project related traffic. The HCP anticipates ground squirrel control efforts, including poisoning. The Kern Water Bank HCP mentions no specific protections or mitigations for the burrowing owl, but claims benefits from habitat preserves (KWBA 1997). It is unclear what has or will be done to benefit burrowing owls, the status of conservation banks, or the status of owls in the plan area.

Metropolitan Bakersfield HCP

The burrowing owl was not a covered species in the Metropolitan Bakersfield HCP (approved 1994, renewed 2014), which covered 262,000 acres of urban development in and around Bakersfield (USFWS 2023). Menzel (2015) noted that the HCP had never done comprehensive surveys for burrowing owls, though the CNDDB listed 39 occurrences in plan area from 1990-2015. The City of Bakersfield opted to not renew the Bakersfield Metropolitan HCP in 2023.

Maricopa Sun Solar Complex HCP

The Maricopa Sun Solar Complex HCP covers development and operation of a 700 MW solar project on 5,784 acres in southwestern Kern County; it was approved 08/12/2022 for 35 years (Quad Knopf 2014; USFWS 2023). The HCP noted 9 records of burrowing owls from 1998-2005 occurring within a five-mile radius of the project area, including on and adjacent to 6 of the solar sites, but presumed that no owls were breeding on site, rather that the site was foraging habitat for owls. Burrowing owls were also observed on and adjacent to 5 conservation sites. The HCP anticipated direct loss of 3,798.2 acres of owl habitat that will be graded, and disturbance from construction activities. Owls would be evicted from the project area if needed through passive relocation, using one-way doors. The HCP tried to claim, without substantiation, that habitat conditions favorable to supporting a greater number of burrowing owls may develop on the sites once the solar facilities are installed, thus potentially providing an increase in the number of owls. See the discussion earlier in the section on solar about the incompatibility of industrial solar facilities with burrowing owls, and the increased risks of mortality at solar facilities. The HCP would provide conservation easements on 1,894.4 acres of land suitable for burrowing owls; it is unclear whether these lands support breeding burrowing owls. Once the solar project has been decommissioned it is claimed that an additional 3,798.2 acres of habitat will be available and managed for western burrowing owls. The likelihood of solar projects being decommissioned instead of repowered is low, and even with decommissioning it could take a significant amount of time to return project sites to a condition that would support burrowing owls.

Nuevo-Torch HCP

The Nuevo-Torch HCP covers 21,800 acres in Bakersfield, Kern County; it was approved 11/18/1999 for 30 years. Burrowing owls were known to occur throughout the entire 21,800 acres covered by the Nuevo-Torch HCP. The plan estimates 13% of this habitat (1,700 acres) will be “disturbed” by oil and gas activities authorized by the plan. Potential threats identified are that owls will be “directly injured or killed by land clearing and compaction, by vehicle strikes resulting from increased project related traffic, through inadvertent entrapment in collapsed dens or burrows, by oil spills, and by wildfires…started during construction activities…may be subject to harassment resulting from increased levels of disturbance, vehicle use, and through the implementation of certain mitigation measures, such as excavation of burrows.” The mitigation measure allowing excavation of burrows, which will be “excavated by hand and refilled to prevent reoccupation,” sanctions destruction of owl habitat. While this mitigation avoids direct “take” of owls, it does not adequately mitigate for the habitat loss. The Nuevo-Torch HCP acknowledges significant impacts to burrowing owls: “oil and gas activities involving ground disturbance may impact the species. Destruction of the burrows may result in a net reduction of burrowing habitat used by these animals for shelter, reproduction, and escape cover. Animals may be displaced into adjacent areas resulting in increased predation, exposure, or stress through disorientation and loss of shelter.”

Bay Area

Santa Clara Valley HCP

The Santa Clara Valley HCP/NCCP covers mostly urban and rural development on 508,669 acres in Santa Clara County as the permit area for the western burrowing owl; it was approved 07/30/2013 for 50 years (ICF 2012; USFWS 2023). The HCP modeled 197,869 acres of burrowing owl habitat in the plan area, 13,586 acres of which were protected in Type 1 open space (ICF 2012). There were 25 known extant burrowing owl occurrences in the permit area, including sightings of several breeding individuals over multiple years. The core population of breeding and overwintering owls was at the San José International Airport, a population which has crashed since 2014. Burrowing owls were known to be declining throughout the permit area. The HCP anticipated permanent impacts to 9,671 acres of modeled overwintering only habitat (7%), 198 acres of modeled occupied nesting habitat, and 4,000 acres of modeled potential nesting habitat. The HCP anticipated temporary impacts to 762 acres of modeled overwintering habitat (<1%), 20 acres of modeled occupied nesting habitat (<1%), and 604 acres of modeled potential nesting habitat (<1%). Compensation for impacts includes land acquisition, easement, or management agreements covering: 17,000 acres of modeled overwintering habitat acquired for a Reserve System and 4,310 acres of modeled overwintering habitat added to the Reserve System from existing open space (i.e. habitat already protected from development); and 5,300 acres of occupied and potential nesting habitat managed with permanent long-term management plans by year 45 of the plan (a minimum of 600 of these 5,300 acres will be occupied nesting habitat acquired in fee title or easement for the Reserve System). Protected nesting habitat would include the following minimums: 3,700 acres in the North San José/Baylands region, 800 acres in the Gilroy region, 530 acres in the Morgan Hill region, and 270 acres in the South San José region. The HCP will also include enhancement, restoration, and creation of burrowing owl habitat, with all acquired, added, or managed habitat enhanced to benefit burrowing owls. The Conservation Strategy specifies using grassland management to enhance habitat quality through vegetation management, creating artificial burrows and increasing extent of ground squirrel colonies, encouraging owl colonization of new areas, and maybe ceasing rodenticide use (but only to the extent possible). Monitoring will: assess habitat quality and document available nesting, foraging, and overwintering habitat within the Reserve System; determine owl movements and identify habitat corridors during breeding and wintering seasons; use multiple approaches (e.g., track nesting pairs, density and distribution of California ground squirrels) to determine owl response (i.e., nesting success, site fidelity) to habitat protection and enhancement; and track owl response to grassland management by monitoring California ground squirrel colonies to determine burrow and prey availability.

As of 2015, the HCP had protected 719 acres of burrowing owl habitat, with a target of eventually protecting 5,300 acres and a goal to recruit 3 adult burrowing owls each year to maintain a viable population (Menzel 2015). As of 2023, the HCP had protected about 2,161 acres of modeled nesting habitat (S. Menzel, pers. comm., 2024). The HCP compiles burrowing owl survey data annually from various monitoring efforts. By 2022, the number of burrowing owls in the HCP area had declined to 17 pairs (Talon Ecological Research Group 2023), and emergency measures were being implemented. Measures being taken by the HCP to attempt to increase the regional burrowing owl population include banding, monitoring, habitat enhancement, non-native predator control, installation of artificial burrows, and reintroduction to currently unoccupied sites. Emergency measures include: reintroductions; supplemental feeding of breeding pairs and their offspring; a juvenile owl overwintering project (head-starting) initiated in 2019 that has retained a total of 110 juveniles, released 30 pairs and 18 single owls, resulting in 128 fledglings; and a captive breeding program initiated in 2021 that had bred 14 fledglings as of 2022 (Talon Ecological Research Group 2023) and 2 pairs in captive breeding in 2023 that produced 9 young (SCVHA 2024). The HCP uses burrowing owl genomic analysis and genealogy to pair overwintered juveniles to ensure genetic diversity. The HCP has recently secured two new owl release sites, cattle ranches in rural Santa Clara County that are protected in perpetuity, and have a fund for habitat management; these POST/OSA and SCCP reintroduction sites received 9 owl pairs in 2023 that were successful in breeding and produced a total of 47 young (SCVHA 2024). From 2014 to 2023, Talon Ecological Research Group conducted in-depth burrowing owl breeding season surveys on behalf of the Santa Clara Valley Habitat Agency throughout Santa Clara County and one location in Alameda County. The three largest historical breeding sites (Moffett Field, San Jose Airport and Warm Springs) experienced extirpation as breeding locations during this time period (SCVHA 2024).

Western Riverside

Western Riverside HCP

The Western Riverside MSHCP covers urban development and associated infrastructure on 1.3 million acres in western Riverside County (one HCP/ITP permit with 22 permittees); it was approved 06/22/2004 for 75 years (USFWS 2023). The burrowing owl is narrowly distributed at relatively few locations within the HCP plan area, and recent observations at the time of approval were clumped in only a few locations. Known nesting locations were at Lake Perris, Mystic Lake/San Jacinto Wildlife area, Lake Skinner area, the area around Diamond Valley Lake, playa west of Hemet, Lakeview Mountains, Lake Mathews/Estelle Mountain Reserve and Sycamore Canyon Regional Park. The HCP identified additional survey needs and procedures for the burrowing owl, with surveys to be conducted as part of the project review process for public and private projects where habitat is present. If burrowing owls are detected on a project site within a “criteria area” then at least 90 percent of the area with long-term conservation value will be included in the MSHCP conservation area. Otherwise, if the site contains, or is part of an area supporting less than 35 acres of habitat or the survey reveals that the site and the surrounding area supports fewer than 3 pairs of burrowing owls, then the on-site burrowing owls will be passively or actively relocated following accepted protocols. If the site (including adjacent areas) supports 3 or more pairs of burrowing owls, supports greater than 35 acres of habitat and is non-contiguous with MSHCP conservation area lands, then at least 90 percent of the area with long-term conservation value and burrowing owl pairs will be conserved onsite. Pre-construction presence/absence surveys within 30 days prior to disturbance will be conducted where habitat is present, for all covered activities through the life of the permit. Smallwood (2022b) noted that the MSHCP survey protocols for burrowing owls are vastly inferior to the CDFW (2012) guidelines. Take of active nests will be avoided, but passive relocation (use of one way doors and collapse of burrows) will occur when owls are present outside the nesting season. Translocation sites for the burrowing owl will be created in conservation areas for the establishment of new colonies, taking into consideration unoccupied habitat areas, presence of burrowing mammals to provide suitable burrow sites, existing colonies and effects to other covered species. Reserve managers will consult with wildlife agencies regarding site selection prior to translocation site development.

The HCP has a target of protecting about 50,000 acres of burrowing owl habitat (27,470 acres of primary conserved habitat and 22,120 acres of secondary conserved habitat) in conservation areas, in at least 5 core areas and interconnecting linkages, which “may” include portions of these 80,000 acres of reserves: Lake Skinner/Diamond Valley Lake area (existing core area C plus proposed extension of existing cores 5, 6, 7; 29,060 acres); playa west of Hemet (proposed noncontiguous habitat block 7; 1,250 acres); San Jacinto Wildlife Area/Mystic Lake area including Lake Perris area (existing core H; 17,470 acres); Lake Mathews (existing core C plus proposed extension of existing cores 2; 23,710 acres); and along the Santa Ana River (9,670 acres). The Core conservation areas are supposed to support a combined total breeding population of approximately 120 burrowing owls with no fewer than 5 pairs in any one core area, with the majority on public land (Menzel 2015; Peterson 2023). Conservation areas are also supposed to include at least 22,120 acres of secondary habitat for the burrowing owl including playas and vernal pools, and agriculture outside of the core areas identified above, including west of the Jurupa Mountains, near Temescal Wash (i.e., vicinity of Alberhill), near Temecula Creek, within the Lakeview Mountains, Banning, the Badlands, Gavilan Hills, and Quail Valley. Conservation areas will encompass known nesting locations of the burrowing owl at Lake Perris, Mystic Lake/San Jacinto Wildlife area, Lake Skinner area, the area around Diamond Valley Lake, playa west of Hemet, Lakeview Mountains, Lake Mathews/Estelle Mountain Reserve and Sycamore Canyon Regional Park.

About 82,490 acres (75%) of the primary potential habitat and 101,400 acres (82%) of the secondary potential habitat for the burrowing owl will be outside of the criteria area or public/quasi-public lands and owls within these areas are subject to incidental take consistent with the plan. A total of 22 point localities recorded will be outside of the MSHCP Conservation Area. Core owl areas not conserved include Valle Vista, Beaumont, Banning, and Murrieta, as well as smaller numbers of clustered locations of burrowing owls west of the Jurupa Mountains, San Jacinto, Rancho California area (Long Canyon and De Portola Road), and March AFB. Historically, there were a number of owl locations concentrated within the Moreno Valley area, however the number of owls within Moreno Valley was unknown, and due to existing development the area receives no conservation. The HCP was problematic from the start, proposing to conserve only 12% of remaining agricultural lands, 28% of remaining grasslands, and 52% of remaining coastal sage scrub habitat (Riverside 2023), an amount which would not adequately protect the owl. Only 50% of the 12 known owl populations in western Riverside County would be protected in the most optimistic circumstances. The HCP intends to conserve only 6 of the 12 core populations of burrowing owls with sufficiently large blocks of habitat to maintain viable populations: at Lake Skinner area, Diamond Valley Lake area, the playa west of Hemet, Mystic Lake, Lake Mathews, and along the Santa Ana River. Only 16 of the 38 precise point locations for burrowing owls (and of 82 overall locations in the region from the previous 10 years) fell within the proposed assembled reserve. Additionally, only 21% of the primary habitat for burrowing owls throughout western Riverside County (agriculture, grassland, playa, and vernal pool habitats) is proposed for inclusion within the assembled reserve, and reserve lands are to be purchased from willing sellers only and thus protection is not assured. The plan also relies heavily on presumed successful translocation of burrowing owls into the reserve areas from development sites.

The strategy of the HCP is to preserve patches of habitat as mitigation for the habitat that will be lost to development, which fails to consider the chronic impacts of the ecological sinks created by the projects' habitat destruction, and consigning wildlife to preserved small, isolated habitat patches. The HCP does not account for chronic impacts such as from road traffic mortality; many of the projects in the HCP area are traffic-generating projects such as warehouse distribution.

The HCP appears to be failing to meet its conservation goals and objectives while at the same time frontloading development. According to the 2018 annual report, additional acreage acquired through 2018 totaled 60,336 acres, or 39% of the goal. Only 38,767 acres were managed under the Regional Conservation Authority, or 25% of the goal. Over the same time period, habitat losses totaled 83,975 acres, of which 16,161 acres (19%) were inside Criteria Cells.

Between 2004 and 2006, Kidd et al. (2007) monitored 160 pairs within the Western Riverside MSHCP area and observed a 25.6% decline in breeding territories, while 41 pairs were extirpated without mitigation. Of the remaining pairs, only 31 were located on reserve lands. Kidd et al. (2007) predicted that most of the remaining 88 unprotected pairs would be eliminated within five to ten years due to habitat loss and lack of protection. As of 2015 there were only 8 known breeding pairs in the HCP area (Menzel 2015). Current management includes installation of artificial burrows, vegetation management, and active relocations, and the HCP has frequent surveys for burrowing owls (Menzel 2015). Peterson (2023) used visual and trail camera surveys annually from 2015-2022 to determine whether the goal of at least 5 breeding pairs has occurred in two of the HCP core owl areas, San Jacinto Wildlife Area and southwest of Lake Skinner. Peterson (2023) documented 5 or more breeding pairs southwest of Lake Skinner during five breeding seasons between 2015 and 2022, but never documented more than 3 pairs near the SJWA. Peterson (2023) reported that productivity (number of fledglings/breeding pair) at these locations was highest in 2020 (5.0) and lowest in 2015 (1.5). The HCP's 2021 annual report acknowledges that the HCP is failing to meet the burrowing owl conservation requirements and failing to establish breeding owl populations in the HCP reserves (Western Riverside 2021).

The Lake Mathews HCP (5,993 acres) and North Peak Development Project HCP (997 acres) were encompassed by the Western Riverside MSHCP. The Lake Matthews HCP protects 710 acres of burrowing owl habitat off-site in Metropolitan mitigation bank lands, in exchange for "taking" 344 of 3,046 acres (11%) of the occupied owl habitat on the site. The North Peak Development Project HCP protects only 31 acres of burrowing owl habitat on-site and 100 acres off-site, in exchange for "taking" 147 acres of potential owl habitat.

<u>San Diego</u>

San Diego HCP
The San Diego MSCP incorporates several subarea plans, and covers urban development on 582,243 acres in San Diego County; it was approved 07/18/1997 for 50 years (San Diego 1998; USFWS 2023). Impacts were anticipated to 5,000+ acres of known owl habitat and 8 known owl locations (Otay Ranch, San Pasqual Valley, and South County at the border); 4,000+ acres of known owl habitat and 12 known owl locations were to be conserved (Spring Canyon, northeast of Brown Field, and Lake Hodges; and 8 known locations within the South County major amendment segment) (San Diego 1998). In total, ~4,000 acres of known grassland habitat and ~5,770 acres of potential owl habitat will be conserved, including portions of Spring Canyon, San Pasqual Valley, Lake Hodges, Otay Mesa northeast of Brown Field, Otay Ranch, Otay River Valley, and the Future Urbanizing Area. 45% of the presumed potential owl habitat would be conserved under the San Diego MSCP. There are 28,373 acres of grasslands in the HCP study area, with 10,926 of those acres in the plan area; 9,770 acres of grasslands (34%) will be preserved; only 11% of disturbed lands and 6% of agricultural lands will be conserved. Under the HCP protocol owl surveys are required to determine species presence and the location of active burrows. Impacts to owls must be avoided within the protected areas. Impacts outside the protected areas must avoided to the maximum extent practicable, with mitigation measures including passive or active relocation, and habitat compensation (at the subarea plan specified ratio) for impacts to occupied habitat through the conservation of other occupied owl habitat or conservation of land appropriate for restoration, management and enhancement of owl nesting and foraging habitat. Management plans for conserved lands must include: enhancement (artificial burrows, and vegetation management to enhance foraging habitat) of known, historical, and potential burrowing owl habitat; management for maintenance of ground

squirrels; predator control; and establishment of 300-foot wide impact avoidance areas within preserves around occupied burrows. Monitoring of nest sites is required to determine use and nesting success. The HCP anticipated site-specific preserve design, special measures and management for burrowing owls, monitoring at 10 grassland locations, and area-specific management directives. The HCP identified habitat enhancement opportunities for owls in Spring Canyon, San Pasqual Valley, Lake Hodges, Otay Mesa northeast of Brown Field, Otay Ranch, Otay River Valley, and the Future Urbanizing Area 4, with public land managers allowing for relocation of burrowing owls elsewhere in the county, particularly in conjunction with owl removal programs where they conflict with nesting of California least terns. The HCP noted that persistence of burrowing owls in San Diego County is dependent upon adequate conservation of known concentrations of owls in the Santa Maria Valley in the vicinity of Ramona.

Unfortunately, at the time the HCP was approved, only one protected region within the San Diego MSCP (at Otay Mesa) was thought to have an owl population with any long-term viability (P. Unitt, pers. comm., 2001). That prediction has largely played out as development has proceeded, and as of 2017 the only significant breeding owl populations left were at Otay Mesa and Rancho Jamul (Lehman et al. 2021); from 2018-2023 as owl habitat was being eliminated at Brown Field, owls were being translocated to Rancho Jamul and Ramona Grasslands (SDZWA 2018, 2022).

Fieldstone/La Costa & Carlsbad HCP
The Fieldstone/La Costa & City of Carlsbad HCP covered 1,955 acres in Carlsbad; it was approved 06/07/1995 for 30 years. This HCP would conserve 55 acres of burrowing owl habitat on-site and "take" 280 acres of potential owl habitat. In 1996 Real Estate Collateral assumed the responsibilities of Fieldstone/La Costa under the HCP. Information on this HCP could not be found, and it is unclear if there are any burrowing owls left in Carlsbad to protect.

<u>Coachella Valley</u>

Coachella Valley HCP
The Coachella Valley Multi-Species HCP covers urban development on 1,206,578 acres and within 8 cities in the Coachella Valley in central Riverside County; it was approved 10/01/2008 for 75 years (CVCC 2007; USFWS 2023). There were 74 known burrowing owl records in the plan area, but the number of burrowing owls that occurred in the HCP plan area was not known and a species habitat distribution model was not developed for the burrowing owl (CVCC 2007). Breeding burrowing owls were known to occur in the Snow Creek/Windy Point Conservation Area, Whitewater Floodplain Conservation Area, the Upper Mission Creek/Big Morongo Canyon Conservation Area, the Willow Hole and Edom Hill Conservation Areas, and the Thousand Palms Conservation Area. Burrowing owls had also been observed in Bear Creek Canyon in La Quinta and Magnesia Canyon in Rancho Mirage, and in agricultural areas around the Salton Sea. Though burrowing owls are notably common in nearby Imperial County along roads and levees in the agricultural areas, and had the potential to occur along roads and levees in agricultural areas at the eastern end of the Coachella Valley within the plan area, efforts to locate reliable records for burrowing owls in these agricultural areas met with limited success (CVCC 2007). Biologists from CDFG and CVWD who routinely visited the agricultural drains and associated levees around the Salton Sea reported only one burrowing owl observation within the plan area. Burrowing owl nesting surveys were conducted in 2009 and 2011, with re-surveys planned every 2-5 years "as needed" (Menzel 2015).

Disturbance (and take of habitat) is authorized under the HCP outside of conservation areas for 33 of the 74 known burrowing owl occurrences (44%). The HCP attempts to rationalize this significant loss of the breeding population by noting that these locations (mostly the area south of Desert Hot Springs and east of Highway 62) are marginal or highly fragmented and surrounded by existing development, thus the potential for these habitat areas to provide for the long-term persistence of burrowing owls is low. The HCP acknowledges that the percentage (44%) of burrowing owl locations that could be lost to development within the next 75 years is substantial, but that it does not represent an actual reduction in habitat value because: conserved habitat areas will be large enough to contain a self-sustaining metapopulation of burrowing owls and incorporate key habitat elements, including burrows and foraging areas; there will be no authorized take within the conservation areas that would eliminate or significantly impact any individual burrowing owls; potential development would not adversely impact the essential ecological processes needed to maintain currently viable habitat; and lands in the MSHCP reserve system would be managed and monitored to address significant edge effect problems, potential loss of habitat from introduction of exotic species, and other stressors to owls.

Of the 41 remaining burrowing owl occurrences (56%), 23 were within existing conservation lands and 18 were in areas yet to be conserved. The HCP provides for multispecies preserve areas, and commits to protect and manage in perpetuity all of those 41 areas within the MSHCP reserve system. It asserts conservation of known burrowing owl breeding areas within the following conservation areas: Stubbe and Cottonwood Canyons Conservation Area; Snow Creek/Windy Point Conservation Area; Whitewater Floodplain Conservation Area; Upper Mission Creek west of Highway 62; Big Morongo Canyon Conservation Area; Willow Hole Conservation Area; Edom Hill Conservation Area; Thousand Palms Conservation Area; Coachella Valley Stormwater Channel and Delta Conservation Area; and Santa Rosa and San Jacinto Mountains Conservation Area. Other potential conservation areas would Dos Palmas and the Desert Tortoise and Linkage Conservation Areas. Though the HCP had not modeled burrowing owl habitat, it presumed that owls will benefit from conservation areas occupied by other covered species (including the Coachella Valley round-tailed ground squirrel, Coachella Valley milkvetch, and Palm Springs pocket mouse), and protections for natural community, essential ecological process area, biological corridor, or linkage areas, such as the Cabazon Conservation Area and Indio Hills Palms Conservation Area.

The HCP claims conserved populations “should” be protected from edge effects, off-road vehicle impacts, and from any activities that may result in disturbance to owl burrows. However, the HCP commits to no specific management actions to benefit or maintain burrowing owl habitat (Menzel 2015). In fact, every one of the management actions for burrowing owls in the HCP are couched in “might” and “should” language, not guaranteeing that any of them will actually occur. For example, if biological monitoring indicates it is warranted owl protection actions "might" include controlling off-road vehicle and human disturbance through fencing and patrolling; the HCP would “consider” whether a restriction on human access to occupied owl habitat during the breeding season is warranted; it would control invasive species “where feasible”; maintenance schedules for levees and dikes "should" avoid the owl breeding season; and “caution” in the use of pesticides “is important.” The HCP also “might” include the installation of artificial nest burrows.

Smallwood (2023d) reviewed the Coachella Valley HCP and its supporting documents to ascertain its performance standards and measurement of progress towards those standards, but could not find biological performance standards such as minimum numbers of individuals to be achieved through conservation actions, or minimum productivity of each species, or even a minimum species richness as a community metric. It is unclear how HCP biological monitoring studies result relate to HCP performance standards, and it is unclear if the HCP is conserving covered species (Smallwood 2023d). The performance standards of the HCP appear focused on acreage conserved specific to the habitat needs of each covered species. Most of the conserved acreage to date has been committed by state and federal agencies, with much less protected by HCP (according to the HCP's 2020 annual report, agencies have achieved 60% of their acreage goals to the reserve system since inception of the HCP in 2008, but permittees have achieved only 13.7% of their acreage goal). Between 1996 and 2020, permittees contributed an average 552 acres per year in exchange for an allowed authorized disturbance to 898 acres/year (22,420 acres total). Outside conservation areas, 7,016 acres of Coachella Valley fringe-toed lizard habitat have been taken through 2020, whereas 2,391 acres of habitat have been conserved. It appeared to Smallwood (2023d) that authorized take is being front-loaded while conserved acreage from permittee fees lags.

Imperial Valley

The Imperial Irrigation District (IID) has been in the planning process for an HCP since at least 2002, when a draft HCP was prepared (CH2M HILL 2002), and signed a planning agreement with the USFWS and CDFG for an HCP/NCCP in 2006. As of 2023, the HCP/NCCP has still not been finalized but is in the process of preparation (IID 2023). permit is anticipated to cover 96 fish, wildlife, and plant species (including the burrowing owl) for a term of up to 75 years. Covered activities include all water conservation projects and mitigation measures, whether undertaken by IID or by farmers, tenants, or landowners, in connection with both the conservation and transfer of up to 300,000 acre-feet/year of Colorado River water pursuant to a water Transfer Project and/or a Quantification Settlement Agreement (QSA) with the state, compliance with a cap on IID's annual diversions of Colorado River water established by the QSA, and adaptive habitat management and monitoring activities. All activities related to IID Water Department operations including water delivery, drainage, and O&M will also be covered by these permits. The IID Water Conservation and Transfer Project would involve IID conserving and transferring the right to use up to 300,000 acre-feet per year of Colorado River water to San Diego County Water Authority, Coachella Valley Water District, and/or the Metropolitan Water District. The IID planned to line a small percentage of their earthen irrigation canals with concrete.[20] The HCP also covers operations and maintenance activities along IID drains and canals. IID cleans 20% of its canals and ditches each year, through chaining, disking, side scraping, and use of Roundup, Rodeo, and Direx. The draft HCP specified avoidance and mitigation measures for burrowing owls, but was criticized for having vague adaptive management provisions and guidelines and for failing to address the potential impacts of pesticides on owls.[21]

---

20 At the time of the 2002 draft HCP (CH2M Hill 2002), there were 1,667 miles of IID canals in the Imperial Valley, about 70% lined, and about 537 miles of earthen channels. While up to 100% of unlined canals would be available to line (537 miles) under the HCP, only 1.74 miles of canal (0.1% of the entire system) were then proposed for lining. The estimated abundance of owls along canals in the Imperial Valley was 4.7 pairs/mile; lining 1.74 miles would likely displace 16 owls. The IID expected to construct about 72 miles of lateral canals that would potentially provide suitable owl habitat. It is estimated that about 4 owls could be displaced per year because of drain and canal rerouting (this is not a permanent habitat loss, as the owls can relocate to the new canals) and maintenance.

21 The Draft HCP proposed to implement a worker and farmer education program; minimize the potential for operations and maintenance activities to injure individual owls by avoidance of burrows that do not compromise the integrity of the channel embankment and lining; filling or impacting burrows from October through February after surveying by a biologist to ensure an owl is not present in the burrow; careful management of grading spoils; and replacement of impacted burrows by a two-to-one ratio in appropriate areas (regardless of whether the burrow was currently in use). The IID would also conduct a 12-15 year demographic study of the Imperial Valley burrowing owl population. According to the Western Environmental Law Center (WELC 2002), the draft HCP failed to adequately identify, evaluate, and provide mitigation for the increased concentrations of toxic chemicals, including pesticides, which will occur in agricultural runoff in the drains and canals within the IID service area. The draft HCP did not address the

Southern Desert Range

Borax HCP
The U.S. Borax HCP covers borax mining on 3,465 acres in Boron, in southeastern Kern County; it was approved 02/05/1999 for 50 years (USFWS 2023). Information on this HCP could not be located. It is unclear if this HCP covers an area that has any burrowing owls.

West Mojave Plan
The U.S. Bureau of Land Management in 2004 completed a draft of the West Mojave Plan, and a proposed Habitat Conservation Plan and California Desert Conservation Area Plan Amendment (USBLM 2004). The HCP was never finalized and it is not an approved HCP under the ESA (USFWS 2023). The target species and focus for management of the West Mojave HCP were the desert tortoise and the Mojave ground squirrel; the burrowing owl was a covered species and would also have benefitted somewhat from tortoise and ground squirrel conservation measures. The plan would have covered a 9,359,070-acre planning area on both public and private lands (3,263,874 acres of BLM-administered public lands, 3,029,230 acres of private lands and 102,168 acres of state lands), and involved 11 cities, 4 counties, and a water district, CDFG, Caltrans, and the USFWS. It proposed integrated natural resource management plans for 2,667,445 acres of military lands and the and expansion of Fort Irwin, as well as urban development. Existing records of burrowing owls in the plan area in 2004 included 53 records within the western Mojave Desert, representing only a small sample of the locations at which burrowing owls had recently been or were currently present (USBLM 2004).[22] The draft plan did not conduct surveys or baseline data to determine how many owls are in the area or how many would be taken through activities allowed under the plan (M. Connor, pers. comm., 2002). Wilkerson and Siegel (2011) subsequently found large aggregations of burrowing owls in the western Mojave Desert region, concentrated in or along edges of scrublands, on the periphery of urban areas, and in active or fallow agricultural fields, with an estimate of up to 560 pairs. Since the Western Mojave HCP was never finalized, take authorization and burrowing owl mitigation for development has continued merely on a project-by-project basis. Consequently, there has been no consistent standard for conducting baseline surveys, implementing avoidance measures, or carrying out mitigation efforts. Such a fragmented approach has led to variability in how burrowing owl populations are managed across different jurisdictions and developments.

Concerns About Conservation Effectiveness of HCPs

An early nationwide study of some of the first HCPs developed was conducted by the National Center for Ecological Analysis & Synthesis and the American Institute of Biological Sciences (Kareiva et al. 1999). Kareiva et al. (1999) found that most HCPs contributed to habitat losses for the targeted species, failed to meet recovery goals, and suffered from poor planning and plan evaluation. Among the failures of HCPs discussed by Kareiva et al. (1999):

- nearly 30% of HCPs allowed “take” of 100% of the focal species’ populations or habitat in the permit area;

---

extent to which herbicides will be sprayed directly on occupied burrows, the potential direct toxicity impacts on owls, or indirect impacts from contact with water or prey with elevated levels of pollutants.

[22] Of the 53 records, 23 (43%) were from within Edwards Air Force Base; all of these had no specific locale or date. Of the other 30 records, only 13 had specific locales and dates. Probable or confirmed breeding was noted at five locales.

- about 50% of HCPs allowed 50% or more of the species' populations or habitat in the plan area to be "taken";
- 43% of the time, HCPs failed to provide sufficient mitigation measures;
- 23% of the time, species and their habitats would be "taken" before mitigation measures had been implemented and found effective;
- most HCPs failed to reduce allowed "take" levels or use other more conservative approaches in the face of inadequate information or uncertainties;
- 33% of HCPs failed to secure up-front funding to ensure that mitigation actually occurs;
- 81% of HCPs studied would have irreversible impacts

Not surprisingly, Kareiva et al. (1999) found that HCPs which fail to adequately conserve species also tend to lack rigorous impact assessments and planning. The Kareiva et al. (1999) study found that:

- 75% of the time, impacts to species were not adequately studied by HCPs;
  42% to 49% of the time, HCPs failed to quantify how much of a species' habitat and population, respectively, would be "taken";
- most HCPs used low quality data to evaluate their mitigation measures;
- 25% of the time, sufficient information did not exist to determine how HCPs would affect the species' viability

Subsequently, Rahn et al. (2006) reviewed the species selected for coverage in 22 multispecies HCPs from USFWS Region 1 that were approved by the end of 2004, including 9 HCPs in California that cover the burrowing owl. HCPs frequently cover multiple species, some federally listed and others not. Rahn et al. (2006) focused their evaluation exclusively on such multiple species HCPs (MSHCPs) because the federal and state wildlife agencies promote the multispecies approach because it both increases certainty for the permittee in case of future listings and increases the "biological value" of the plans by providing for "ecosystem planning" and early consideration of the needs of unlisted species (USFWS and NMFS 1996). Rahn et al. (2006) sought to evaluate the claim that MSHCPs provide special conservation value. While a comprehensive planning approach at the community, habitat, or ecosystem level may seem reasonable and efficient, it carries the risk that the needs of particular species may be over-looked. For example, Smallwood et al. (1998) concluded that many MSHCPs intended to provide comprehensive coverage for multiple species were actually focused on just one species. Similarly, two studies suggested that multiple-species recovery plans may not be as effective as single-species plans; Boersma et al. (2001) and Taylor et al. (2005) found that species covered under multiple-species plans were generally less likely to show improving trends in status than species covered under single-species plans. To gauge the extent to which MSHCPs incorporate science-based conservation planning, Rahn et al. (2006) evaluated whether or not covered species were confirmed in the planning area, and whether or not the plan contained specific conservation measures for the covered species. Rahn et al. (2006) found that the conservation benefits of multispecies plans to individual covered species may be overestimated, that conservation measures were often not clearly defined, and that the presence of the species in the planning area was not even confirmed for 41 percent of covered species. While Rahn et al. (2006) do not question the conservation value of multispecies plans, their study suggested that changes were needed to achieve full conservation potential. Rahn et al. (2006) identified three shortcomings of MSHCPs that can substantially limit their conservation potential. First, many plans were overbroad, covering species for which they provided no localized scientific information. The lack of information makes it difficult to predict the effectiveness of a plan when an incidental take permit is issued, or to evaluate it during the permit term. Second, most unconfirmed species also did not have specific conservation actions.

Finally, taking their results as a whole, Rahn et al. (2006) found high levels of variability across plans in the species they covered, the levels of justification for that coverage, and the extent to which they offered species-specific conservation actions.

Menzel (2015) sent a questionnaire to managers of 18 HCPs in California in the burrowing owl range. Two of the HCPs did not include burrowing owls as a covered species and eight were still in the development phase but would eventually cover the species. For the eight approved HCPs that included burrowing owls, the query included: the HCP targets for acres protected or managed for burrowing owls; the extent currently under protection/management; the years of owl population monitoring and monitoring frequency; current population sizes; target sizes under the HCP; population trends; and adaptive management intervention to meet the HCP targets. Surveys were conducted within only four of the eight Plan areas and active management for the species occurred in only two Plan areas. The conclusion of Menzel (2015) on whether HCPs in California that cover the burrowing owl are actually protecting the species was that there is plenty of room for improvement. Menzel (2015) recommended that in order to better advance burrowing owl protections, HCPs need: annual breeding and wintering surveys; management and protection of habitat at known nesting and wintering sites; initiation of a banding program; and collaboration and information exchange among all HCP jurisdictions.

The vast majority of state’s burrowing owls are on private lands with no coverage under approved or pending HCPs. Almost all HCPs allow for varying levels of development and destruction of occupied or potential burrowing owl habitat, with appropriate “mitigations.” Although some owl habitat is theoretically protected for the 30 to 75-year life of these plans (assuming there are no problems with monitoring, funding, etc.), the result is always a net loss of occupied burrowing owl breeding habitat. Further, many HCPs take different approaches to burrowing owl conservation, which may confound the ability to make sense of monitoring data and to adapt management activities so that they more effectively conserve burrowing owls across regions. Conservation strategies employed in most HCPs rely on existing mitigation measures delineated in the CDFW guidance (CDFW 2012) and California Burrowing Owl Consortium Guidelines, the limitations of which are discussed in this petition.

Department of Defense Lands

Burrowing owls occur on several Department of Defense (DOD) lands and are usually covered in an Integrated Natural Resource Management Plan (INRMP) as a California Species of Special Concern. Several INRMPs have been updated, with input from USFWS and CDFW biologists. Passive relocation of owls following CDFW guidelines (CDFG 1995, 2012) has been used on DOD lands as a way to relocate owls away from burrows on active military runways, in order to protect owls, aircraft, and pilots.

Naval Air Station Lemoore had an adaptive management plan for the burrowing owl (Rosenberg et al. 1998; Rosenberg and Gervais 2009), but subsequently ceased vegetation management, failed to maintain owl nest boxes, evicted owls from runway areas, and attempted to eradicate ground squirrels, leading to a 50% decline in breeding burrowing owls from 1999 through 2008 (S. Smallwood, pers. comm., 2019). NAS Lemoore changed its management plan for owls in 2013, at which point the INRMP was under renewal.

The ongoing closure of military bases and their conversion to commercial and residential development is a major threat that could reduce or extirpate significant owl populations. A formerly large breeding burrowing owl colony has been and continues to be rapidly eliminated at Camp Parks Reserve Forces Training Area in Alameda County. Large owl populations once resided at Lemoore Naval Air Station in Kings County and Moffett Airfield in Santa Clara County; populations also occur at other bases such as Alameda Naval Air Station, and southern San Diego County Naval Bases. If these sites are closed and their grasslands developed, their owl populations could be lost. At Sharpe Depot in Lathrop, no breeding burrowing owls remain, and as of 2023 the property is considered excess and the land is in the process of being sold. For example, NASA planned to develop 500 acres of land (1,930 housing units) at Moffett Field in Mountain View, Santa Clara County, with only 81 acres protected as a burrowing owl preserve. The potential closure and development of the Sacramento Army Depot and Norton Air Force Base in western San Bernardino County threatens burrowing owl colonies.

Conservation Banks

The U. S. Fish and Wildlife Service (USFWS) approves conservation banks where land can be purchased by developers, as "mitigation" credits for projects that involve destruction of ESA listed or special status species habitat elsewhere. The idea is to allow for larger habitat areas protected in banks that are more efficient and cost effective to manage instead of small, isolated properties. As of 2023, the USFWS has approved 14 mitigation banks in California that accept credits for the burrowing owl (USACE 2023). The relatively large Coles Levee in Kern County (6,059 acres) is sold out, and was used as mitigation for the ARCO Western Energy HCP. The only other large mitigation bank is in the desert in San Bernardino County, the Mojave Desert Tortoise Umbrella Bank Sites 1-8, totaling 5,997 acres. Twelve of these banks are in the Central Valley, totaling 12,326 acres; only four of them have more than 1,000 acres.[23] It is untracked and unknown how many burrowing owl breeding pairs these lands support, or whether management is continued to benefit burrowing owls, so it is impossible to claim these banks are a net benefit for maintaining burrowing owls in California. The conservation bank approach for burrowing owls implicitly endorses extirpation of owls from areas of high development by not requiring on-site conservation measures, ensuring that owls will eventually be eradicated from urbanizing areas. Additionally, the small number of conservation banks with owl habitat, their small size, and the rising cost of purchasing suitable land for habitat make this approach incapable of protecting significant populations of owls.

State Regulatory Mechanisms

Species of Special Concern

The burrowing owl was designated as a state Species of Special Concern ("SSC") by the California Department of Fish and Game in 1979. SSC status applies to animals not listed under the federal ESA which are declining at a rate that could result in listing, or historically occurred in low numbers and known threats to their persistence currently exist. The SSC designation is intended to result in special consideration by CDFW, land managers, and others, to focus research and management attention on the species. SSC are supposed to get this special consideration during preparation of CEQA documents, and in CDFW comments on CEQA documents with proposed conservation and mitigation measures. But as discussed in the

[23] Agua Fria Conservation Bank in Merced County (3,233 acres); Bryte Ranch Conservation Bank in Sacramento County (573 acres); Burke Ranch Conservation Bank in Solano County (964 acres); Cayetano Creek Mitigation Bank in Alameda/Contra Costa counties (101 acres); Dolan Ranch Conservation Bank in Colusa County (252 acres); Dutchman Creek Conservation Bank in Merced County (510 acres); Elsie Gridley Mitigation Bank in Solano County (1,815 acres); Haera Wildlife Conservation Bank in Alameda County (299 acres); Mountain House Conservation Bank in Alameda County (147 acres); Muzzy Ranch Conservation Bank in Solano County (1,391 acres); Piedra Azul Conservation Bank in Merced County (2,418 acres); and Wildlands Mitigation Bank in Placer/Sutter counties (623 acres).

section on CEQA below, the CEQA process has proven completely inadequate to protect burrowing owls or reverse their precipitous declines in California. The practical benefit of the SSC designation for the burrowing owl has been minimal. Such status may call attention to the species and prompt more information to be collected about the loss of its habitat in Environmental Impact Reports and other documents, but it has not halted the habitat loss or other factors causing the decline of the species. SSC species do not benefit from the ESA prohibitions against "take" that a federally or state listed species would get. The inadequacy of the SSC designation to protect burrowing owls is vividly demonstrated by the current dismal status of the species throughout California.

Natural Community Conservation Plans

As of 2023, there are 22 approved state NCCPs covering burrowing owls: 10 in the Central Valley, 1 in the Bay Area, 7 in southwestern California, 1 in Imperial Valley, 1 in Coachella Valley, and 2 in the southern desert region (CDFW 2023c). All 22 of these NCCPs appear to be joint HCP/NCCP plans, and the conservation measures, effectiveness, and status of burrowing owls covered by these plans are discussed above in the section on HCPs.

In the northern Central Valley region, the Placer County Conservation Plan Phase I, Butte Regional Conservation Plan, and Yuba/Sutter NCCPs all overlap with their respective HCPs. In the middle Central Valley region, the Yolo Natural Heritage Program and East Contra Costa County NCCPs overlap with their respective HCPs; the Natomas Basin HCP appears to also include an NCCP but this is not stated clearly; the South Sacramento HCP appears to have been amended to include and NCCP; and the PG&E San Joaquin Valley Operations & Maintenance HCP is listed on the CDFW website as an NCCP and had a CEQA review, but it is unclear. In the southern Central Valley region, the Kern Water Bank and Bakersfield Regional Habitat Conservation Plan overlap with their respective HCPs; the Bakersfield plan expired and was not renewed in 2023. In the Bay Area region, the Santa Clara Valley Habitat Plan NCXCP overlaps with the HCP (this NCCP does not cover most of the primary burrowing owl locations in the county). In the Southwestern California region, the Orange County Southern Subregion, Western Riverside County Multiple Species Habitat Conservation Plan, San Diego Gas & Electric Subregional, San Diego North County Multiple Species Conservation Plan, San Diego County Multiple Species Conservation Program, San Diego East County Multiple Species Conservation Plan, and San Diego County Water Authority NCCPs overlap with their respective HCPs. In the Imperial and Coachella Valleys, the Coachella Valley Multiple Species Habitat Conservation Plan NCCP overlaps with the HCP, and the Imperial Irrigation District NCCP appears to be in process and would overlap with the HCP. In the Southern Desert Region, the Desert Renewable Energy Conservation Plan and Town of Apple Valley Multi-Species Habitat Conservation Plan NCCPs overlap with their respective HCPs.

The state Natural Communities Conservation Planning Act (California Fish and Game Code §2800) was enacted in 1991, to provide for comprehensive, regional multi-species planning. The entirely voluntary Natural Communities Conservation Planning (NCCP) program is intended to preserve blocks of contiguous habitat large enough to sustain viable populations of listed species and to prevent the need for additional listings, while still allowing for "compatible and appropriate" economic growth and development.

When first implemented, the NCCP program was experimental in nature and could not be relied upon to protect or recover burrowing owl populations in California, with significant unanswered questions about the biological integrity and long-term viability of the plans. Some of the problems identified with the NCCP process were that it was heavily weighted in favor of economic development, rather than species recovery goals; was politically driven rather than science driven; had insufficient monitoring mechanisms; the voluntary nature of the program limited its effectiveness; landowner and industry representatives and their consultants dominated the planning process; and the program did not ensure adequate funding to carry out NCCP acquisition programs (Jasny 1997; Mueller 2001). The NCCP process was used to undermine other state protections (such as CESA listing) and to weakens citizens' and local governments' ability to obtain and/or enforce species protections through other legal mechanisms, which may provide stronger protection than the NCCP process (Mueller 2001). In 2003, Fish and Game Code §2800 was replaced with a new NCCP statute approved that required independent scientific input, higher standards for plan approval and public participation, and mandates that funding must be secured for NCCP implementation, including monitoring and adaptive management programs. However, the revised NCCP Act still emphasizes "appropriate" development and growth.

CDFG (2003, 2012) considered the NCCP program to be one of its top priorities based on the potential to create collaborative, science-based land use plans that could protect biodiversity in rapidly urbanizing areas. CDFG (2003) asserted that burrowing owl conservation "should be readily accomplished through the NCCP process" and "may be the most effective mechanism to stabilize and recover local populations." The past two decades have not borne this promise out, given the widespread continuing burrowing owl declines documented in this petition, despite the 22 NCCPs in place in California as of 2023. CDFG (2003) acknowledged that federal or state listing of the burrowing owl may be needed as an impetus for protecting grassland habitats under NCCPs, and allowing NCCPs to ensure conservation.

California Environmental Quality Act

The California Environmental Quality Act ("CEQA") requires public agencies in California to analyze and disclose potential environmental impacts associated with a project. The environmental review process under CEQA should theoretically provide some protection to burrowing owls. CEQA declares that it is the policy of the state to "[p]revent the elimination of fish or wildlife species due to man's activities, ensure that fish and wildlife populations do not drop below self-perpetuating levels, and preserve for future generations representations of all plant and animal communities." (California Public Resources Code, Section 21001(c)). When the CEQA process is triggered, it requires full disclosure of the potential impacts of proposed projects. The operative document for major projects is usually the Environmental Impact Report (EIR).

Theoretically, besides ensuring environmental protection through procedural and informational means, CEQA also has substantive mandates for environmental protection. The most important of these is the provision requiring public agencies to deny approval of a project with significant impacts when feasible alternatives or feasible mitigation measures can substantially lessen such effects. In practice, this mandate is rarely implemented by lead agencies, especially with regard to the burrowing owl. Project proponents and approving agencies frequently dismiss alternatives that would protect burrowing owls and other wildlife as "infeasible".

CEQA requires a full public disclosure of the potential environmental impacts of proposed projects. The public agency with primary authority or jurisdiction over the project is designated as the lead agency and is responsible for conducting a review of the project and consulting with other agencies concerned with resources affected by the project. Section 15065 of the CEQA guidelines require a finding of significance if a project has the potential to "reduce the number or restrict the range of a rare or endangered plant or animal."

Once significant impacts are identified, the lead agency has the option to require mitigation for effects through changes in the project, claim a categorical exemption, or to decide that overriding considerations make mitigation infeasible. In the latter case, projects may be approved that cause significant environmental damage, such as destruction of sensitive species. Though state and federal wildlife agencies can weigh in, protection of non-listed species through CEQA is at the discretion of the lead agency involved. CEQA provides that when overriding social and economic considerations can be demonstrated, project proposals may go forward, even in cases where the continued existence of the species may be threatened, or where adverse impacts are not mitigated to the point of insignificance.

Burrowing owls are frequently overlooked during the CEQA review process and often preconstruction surveys are performed just prior to ground-disturbance, too late in the CEQA process to allow for adequate mitigation planning. This results in last-minute efforts to mitigate impacts to burrowing owls, such as relocation out of development areas. Trulio (1998a) noted that in her experience, when owl habitat is identified during the CEQA process, mitigation other than avoidance is nearly always proposed, meaning that owl habitat is nearly always destroyed or reduced. Most California counties consider practices such as tilling, disking, or grading on private lands to be “minor alterations” that do not require biological review under CEQA. The result is that numerous private land parcels have had habitat for burrowing owls altered without any environmental review or surveys for burrowing owls.

CEQA was never intended to be, nor does it function as, a habitat protection mechanism. When owl habitat is identified during the CEQA process, mitigation other than avoidance is nearly always proposed, meaning that owl habitat is nearly always destroyed, reduced, or degraded. Standard procedure for lead agencies is to declare that significant impacts can be avoided by moving owls out of the way of development, thereby avoiding direct take. Despite little data supporting the premise that owls moved long distances or evicted from their burrows can survive or reproduce successfully, CDFW has allowed and encouraged this approach. Eviction continues to be the most common “mitigation” for development projects which result in the destruction or alteration of owl habitat. Relocation can avoid immediate owl mortality, but usually results in disguised or delayed take, and does not mitigate for habitat loss.

The utter failure of the CEQA process to protect burrowing owl habitat has been well documented in Santa Clara County. Surveys by Trulio (1998a) of 123 of 215 known owl occupancy sites in Santa Clara County (H. T. Harvey and Associates 1994) showed a steady decline in remaining owl habitat. In 10 years, 70 of 123 sites (57%) were lost to development, an average of almost 6% per year. Another 12 sites (10%) were reduced in size or habitat quality.[24] Trulio (1998a) noted that the following factors likely explain the failure of CEQA to protect owl habitat: lack of CEQA review, failure to identify owl habitat during CEQA review, use of Categorical Exemptions, use of Overriding Considerations, and ineffective mitigation measures. Many lead agencies declare significant impacts to owls, then approve the project despite those impacts pursuant to a Statement of Overriding Considerations which concludes that the benefits of the project outweigh the harm to the owls. This was the case when the City of Alviso, in Santa Clara County, approved its General Plan in 1998, with 18 significant, unavoidable impacts, including loss of habitat for burrowing owls.

[24] Trulio listed sites completely developed as “lost,” those diminished in size or habitat quality as “reduced,” and those which could still support a pair of owls as “extant”.

The Santa Clara Valley Audubon Society (Breon 2009) reported on failure to follow through on CEQA mitigation promises, failure to adequately monitor projects, and failure of lead agencies to track or document CEQA mitigation measures. Breon (2009) looked at mitigation monitoring under CEQA, investigating 41 past public and private development project approvals in Santa Clara County and the Southern Bay Area, including 10 having to do with promised mitigations for burrowing owls. Breon (2009) tried to ascertain what mitigation measures or conditions were placed on those projects in order to protect the environment, and then tried to find out whether those conditions had in fact been met by the developers and lead agencies. Breon (2009) found numerous problems regarding compliance mitigation measures, the most common being lost or missing compliance documents, and documents relevant to mitigation monitoring not being housed by the lead agency. He found projects with ambiguous mitigation measures, or required mitigation measures that did not make it into the Mitigation Monitoring and Reporting Plan, and failure to conduct required pre-construction surveys. Breon (2009) also found frequent violations and failure to comply with mitigation measures, or mitigations not meeting success criteria, with no lead agency enforcement.

Abuses of CEQA with regard to burrowing owls seems to be widespread, including inadequate environmental review, shoddy biological surveys, use of incorrect or misleading information, underestimates of impacts, lead agencies ignoring CDFW comments or recommendations, and insufficient mitigation. A few examples:

S. Smallwood (pers. comm., 2023) has accumulated many examples of abuse of the CEQA process with regard to burrowing owls. For example Smallwood (2013b) commented on the improper use of a Mitigated Negative Declaration for a development project in Davis, in Yolo County; the project would have significant impacts to burrowing owls through heavy construction next to and on top of known nesting burrowing owls, but the lead agency used inadequate surveys for presence of owls to produce inadequate mitigations, that were not consistent with CDFW staff recommendations.

CDFW (2022) commented on the proposed Greentree development project DEIR in Vacaville, Solano County. The EIR indicated that only two pairs of burrowing owls were nesting on the project site, based on consultant surveys conducted in 2021. But subsequent breeding surveys found 7 breeding pairs of owls and 9 territories, with 192 burrows mapped showing owl use. CDFW commented on the obviously flawed preconstruction survey methodology. The lead agency proposed a 1:1 nest mitigation, based on this flawed baseline of nesting owls in the EIR, despite CDFW request for a 2:1 mitigation ratio. CDFW also noted inadequate buffer zones around nests.

In just one of many examples of flawed CEQA analysis for wind turbine repowering projects in Altamont Pass Wind Resource Area (APWRA), Smallwood (2021) commented on the inadequate environmental review for the Mulqueeney Ranch Wind Repowering Project. The project was characterized as repowering of existing energy capacity, but was in fact installing 48% additional capacity over what operated on the project site until 2014. The DSEIR was silent on the ongoing substantial decline of burrowing owls in the APWRA, and erroneously attributed most of the recorded burrowing owl fatalities to predation rather than to wind turbines. The DSEIR based conclusions of potential cumulative impacts to burrowing owls on flawed analyses, underestimating burrowing owl numbers by two orders of magnitude. The DSEIR presented a flawed analysis of potential wind turbine-caused collision mortality, made wrong conclusions about which wind projects pose more or less risk to particular avian species because of ignorance about where burrowing owls were more or less abundant, and drew inaccurate conclusions about burrowing owl abundance from surveys that were not designed nor suitable for measuring burrowing owl abundance and spatial distribution. The DSEIR miscalculated the blade-sweep of wind turbine rotors and their distance above the ground, which is significant for collision hazards to burrowing owls and other raptors.

At least a few of the rapidly approved industrial scale solar projects in the Imperil Valley have relied on inadequate environmental review under CEQA to underestimate impacts to burrowing owls and provide insufficient mitigations. Smallwood (2011) commented on the DEIR for the Mount Signal and Calexico Solar Farm Projects, finding that the review lacked basic knowledge of burrowing owl ecology and used a misleading portrayal of burrowing owl behaviors to attempt to minimize the importance of the project site to burrowing owls. Smallwood (2012) commented on the DEIR for the Solar Gen 2 Array Project, which would adversely affect at least 56 nesting pairs of burrowing owls. The DEIR relied on cursory biological resources surveys that were grossly insufficient for characterizing the distribution and abundance of burrowing owls on the project sites. This led to under-estimates of the project's impacts and inadequate mitigation for burrowing owls. The EIR discounted the need to protect foraging habitat for owls, failed to identify potential significant project hazards to birds from collisions, and improperly deferred mitigation measures. Smallwood (2013c) commented on an inadequate 2012 DEIR for the Solar Company 2 Project. The DEIR mischaracterized and under-estimated the breeding population of burrowing owls on the project site, and did not meet the 2012 CDFG protocol for burrowing owl surveys. The DEIR also failed to assess cumulative impacts and deferred mitigation, falsely claiming there were no impacts to special status species on the site.

California Fish and Game Codes Preventing Take

The California Fish and Game Code contains strict prohibitions on the take of burrowing owls without a permit (Fish & G. Code, §§ 86, 2000, 3503, 3503.5, 3513). For all birds, the Fish and Game Code prohibits any action to take, possess, or needlessly destroy its nest or eggs (Fish & G. Code, § 3503). But for owls (the order Strigiformes) specifically, the law without qualification forbids any taking or destruction of the nests and eggs: "[i]t is unlawful to … take, possess, or destroy any birds in the orders Falconiformes or Strigiformes (birds-of-prey) or the nest or eggs of any such bird" (Fish & G. Code, § 3503.5). While section 3503 targets only needless acts, the Legislature expanded the protections for owls, making it unlawful to take a burrowing owl or possess/destroy its nest or egg, even incidentally or unintentionally. (*Adoption of A.B.* (2016) 2 Cal.App.5th 912, 919 [when a particular word is used in a statutory scheme, the omission of similar language from a related provision is evidence of a different legislative intent]; see also *Department of Fish & Game v. Anderson-Cottonwood Irrig. Dist.* (1992) 8 Cal.App.4th 1554, 1561 [prohibitions against "take" or "possess[ion]" of any endangered or threatened species apply to killings of endangered species in the course of lawful activity.])

These protections originated over a century ago when, in 1909, the Legislature criminalized any action to "take or needlessly destroy, or attempt to take or destroy the nests or eggs of any bird protected by this code, or have such nests or eggs in his possession." (Former Penal Code, 637, subd. (f).) By 1957 the Legislature incorporated this language into Fish and Game Code section 3503, and in 1985 the Legislature expanded the prohibition to forbid any destruction of nests or eggs for falcons and owls, as codified in Fish and Game Code section 3503.5. The take prohibition enshrined in sections 3503, 3503.5, 2000, and 2080 is unambiguous. Neither the code nor any regulations allow for the destruction of a burrowing owl nest or eggs.

These Fish and Game Code provisions should provide strong protections from take for burrowing owls and their eggs and nests, as the Legislature intended. Unfortunately, CDFW has failed to consistently enforce them. From 1994 to 2003, CDFW issued only 86 citations for all species under sections 3503 and 3503.5 combined (CDFW 2003). In 2001, CDFW issued 53 protected species violations (again without specifying for which species) (CDFW 2003). Smallwood (2015b) reported on numerous reports to CDFG/CDFW of illegal take of burrowing owls, with evidence provided to CDFG/CDFW and requests for action under 3503, with no action ever taken.

To justify its inaction, CDFW has cited purported ambiguity in the statute, specifically the meaning of terms such as "take", "possess", "destroy", and "nest", among others. (Initial Statement of Reasons, p. 3.) But CDFW to date has failed to resolve these ambiguities. For example, in 2015, CDFW proposed regulations to clarify these terms, but the agency with little explanation subsequently withdrew them.

Since 2015, it is unclear whether CDFW has enforced these provisions at all. The Petitioners sent a Public Records Act request to CDFW specifically requesting information about any enforcement of California Fish and Game Codes 3503 and 3503.5 for take of burrowing owl from 2015-2023, and there were no responsive documents. There were only two warning letters sent by CDFW for documented direct take of burrowing owls: one in January 2103 to Topaz Solar Farm for placing an exclusion device and blocking an occupied burrowing owl nest, killing an adult owl and causing nest failure in the spring of 2012; and one in March 2016 to a property owner in Elk Grove, where 3 burrowing owls had been trapped in open vertical pipes and died. There is no indication in CDFW's records that the agency has ever issued a citation or any other enforcement action for illegal take of burrowing owls. Yet since 2015, the documented illegal take of burrowing owls in California was frequent, with well-documented instances of bulldozing of burrows, shooting, vandalism, strikes at wind turbines, and other activities, and repeated requests for enforcement, as discussed in this petition.

The plain language, if properly implemented, could provide significant protections to the burrowing owl. CDFW could resolve any perceived ambiguities based on the best available science and within its enforcement discretion, as biologists and other experts recommend. (Smallwood 2015b). The lack of enforcement means that take has gone unmitigated, and the burrowing owl continues to suffer. This failure of existing regulatory mechanisms reinforces the need for CESA protections.

While CDFW has developed protocol guidelines on how to displace burrowing owls from nests prior to destroying their burrows (Staff Report on Burrowing Owl Mitigation 2012), it has not enforced those in any meaningful way either. These guidelines are not regulations and cannot authorize take. Any benefit these guidelines have provided has been insufficient to avoid the continued loss of habitat and drastic decline of the species, which further reinforces the need for CESA protections.

The guidelines focus on preventing direct take; they do not address the destruction of unoccupied burrows or previously occupied burrows outside of the nesting season, which often serve as future owl nesting habitat. Burrowing owls, because of their subterranean habitats, also often go undetected. The guidelines' narrow focus has resulted in the inadvertent killing of burrowing owls and the destruction of their nests and habitat by ground-disturbing activities, such as permitted bulldozing and unregulated activities such as plowing, disking, or grading. Similarly, the guidelines also encourage active and passive relocation, which subject burrowing owls to "serial evictions" (Hennessy et al. 2022). Such actions force the subject owls to relocate with no assurances that alternative burrows or suitable habitat exist nearby (Hennessy et al. 2022). Consequently, relocation, though state-sanctioned, often results in the disguised or delayed take of owls. CDFW's implementation of the guidelines thus fails to address the clear "take" of owls and their nests and eggs, which the Fish and Game Code prohibits but regularly occurs.

State Policy on Burrowing Owl Mitigation

In the absence of endangered species laws or state agency guidelines to protect an obviously declining species, and in an attempt to develop a consistent, logical means for avoiding direct owl mortality, defining impacts, and suggesting reasonable mitigation, the biological community formed the California Burrowing Owl Consortium (CBOC) in 1989. The CBOC prepared a document entitled "Burrowing Owl Survey Protocol and Mitigation Guidelines" in 1993, intended to standardize determinations of owl presence and impact assessment (CBOC 1997). After submission of this document, CDFG subsequently prepared a "Draft Staff Report on Burrowing Owl Mitigation," which borrowed extensively from the CBOC's document (CDFG 1995). The CDFG (1995) report was intended to assist CDFG staff in reviewing CEQA for projects which may impact owls and their habitat.

The CBOC guidelines were intended to assist individuals (in the private or agency sectors) faced with mitigating direct impacts to burrowing owls; this document was not intended to address region-wide, long-term conservation planning for the species. The guidelines were widely used by agency and private biologists from 1994 to the early 2000s, and were badly misused and misinterpreted. In trying to determine a number that represented an impact threshold, CBOC took into account the fact that owls move, sometimes long distances (e.g., Haug and Oliphant 1990), and also nest in areas that might appear to have only a small proportion of suitable habitat. The threshold question hinged on how close development could come to a burrow without a significant impact and whether projects with a modest footprint (e.g., pipelines and transmission lines) could be declared to have significant impacts to an owl home range encompassing scores, if not hundreds of acres. Using a combination of intuited disturbance distances (a few dozen meters) and territorial considerations, biologists with the CBOC selected a 300-foot radius around an occupied burrow (6.5 acres) as the amount of habitat estimated to be a threshold where significant impacts should be considered. This area was not purported to be the amount of habitat needed to support a pair of burrowing owls, nor was it meant to be used as a way to manage for a sustainable population of owls.

CDFG subsequently used the 6.5 acre figure as acceptable mitigation for impacts to breeding owl pairs. The replacement acreage did not have to be in the vicinity of the project and it did not have to be in place for 2 years. Unofficial "owl banks" and then later approved conservation banks in eastern Contra Costa County were used for mitigation for South Bay development projects, re-enforcing the perception that CDFG had abandoned efforts to protect owls in the urban Bay Area. CDFG applied this mitigation requirement of conservation and long-term management of 6.5 acres of existing burrowing owl habitat to at least 84 owl pairs directly impacted by development activities from 2000-2003, within the southern and eastern portions of the Bay Area (Contra Costa, Alameda, and Santa Clara Counties) (CDFG 2002a, 2003). Use of these conservation banks as acceptable mitigation preserved only a very small amount of burrowing owl habitat in exchange for the likely eventual extirpation of owl populations from the eastern and southern Bay Area. And use of the 1995 guidelines facilitated local extirpations without requiring any evidence of survivorship or successful breeding of relocated owls. CDFG (2003) felt that the staff report helped conserve burrowing owls and their habitat and that offsite mitigation may be more biologically viable for burrowing owls by permanently securing larger blocks of contiguous, less fragmented habitat. CDFG (2003) acknowledged the limitations of the 1995 staff report and concurred that offsite mitigation may lead to local onsite burrowing owl extirpation, but maintained that offsite mitigation was a valuable alternative tool which could provide an incentive to lead agencies that determine that onsite conservation efforts are too costly. Which underscores the need for CESA listing of Burrowing owl populations, so that the profit margins of development projects are not driving burrowing owl conservation approaches.

In 2012, CDFG updated and replaced the 1995 staff report to better protect burrowing owls. CDFG (2012) recommended revised avoidance, minimization and mitigation approaches for burrowing owls. One of the main changes in the guidelines from 1995 to 2012, was that the amount of mitigation acreage for impacts to breeding owl pairs was changed from a fixed 6.5 acres to a flexible, un-predetermined amount, with guidance from CDFG based on local observation and site-specific conditions. There is no longer any 6.5 acre requirement for impacts to owl foraging habitat, but the mitigation acreage is based on local natural history. CDFG eliminated the 2:1 requirement for burrow replacement with artificial burrows, with the updated mitigation based on site-specific conditions. The new guidance requires more rigorous burrowing owl survey methods, improved impacts assessments, developing clear and effective avoidance and minimization measures, and developing mitigation measures to ensure impacts to burrowing owls are effectively addressed at the project, local, and/or regional level.

The 2012 report gives examples of activities that have the potential to take burrowing owls, their nests or eggs, or destroy or degrade burrowing owl habitat. It outlines steps for project impact evaluations: habitat assessment; surveys, and impact assessment. CDFG is available to assist in the development of site-specific avoidance and mitigation measures. Methods for avoidance of impacts include take avoidance, pre-construction surveys, site surveillance, minimizing impacts, buffers, and burrow exclusion and closure.

Project proponents are supposed to provide CDFW with more detailed information to assist in development of mitigation measures, such as information about: foraging (link between field irrigation methods and owl foraging); buffer strips; how much land is required to sustain the necessary amount of food (invertebrates and mammals) for owls; prey surveys on cropland (crop type and irrigation); diet analysis; and determining foraging distances on a project site.

The 2012 guidelines still allow owl eviction and burrow closure, with replacement by artificial burrows. The 2012 guidelines acknowledge (italics added):

> The long-term demographic consequences of active and passive eviction techniques have not been thoroughly evaluated, and the fate of evicted or excluded burrowing owls has not been systematically studied. Because burrowing owls are dependent on burrows at all times of the year for survival and/or reproduction, evicting them from nesting, roosting, and satellite burrows may lead to indirect impacts or take. Temporary or permanent closure of burrows may result in significant loss of burrows and habitat for reproduction and other life history requirements. Depending on the proximity and availability of alternate habitat, loss of access to burrows will likely result in varying levels of increased stress on burrowing owls and could depress reproduction, increase predation, increase energetic costs, and introduce risks posed by having to find and compete for available burrows. Therefore, exclusion and burrow closure are not recommended *where they can be avoided*. The current scientific literature indicates consideration of all possible avoidance and minimization measures before temporary or permanent exclusion and closure of burrows is implemented, in order to avoid take.

Passive relocation requires monitoring to determine the fate of evicted owls and site fidelity after relocation; and artificial burrows require better success evaluation (with banded individuals) and information about configuration. The 2012 guidelines state that CDFG can not authorize translocation (active relocation offsite >100 meters) at that time due to little published information regarding the efficacy of translocating burrowing owls. Currently, active relocation or translocation is not approved by CDFW unless part of permitted scientific research or in an approved NCCP conservation strategy.

The 2012 guidelines detail methods for mitigating permanent impacts to burrowing owls, including permanent conservation of similar vegetation communities with fossorial mammals, and permanently protecting (ideally adjacent or proximate) mitigation land through a conservation easement. A mitigation land management plan is required to be developed and implemented, with long-term funding mechanism. Mitigation may include artificial burrows, with semi-annual to annual cleaning and maintenance and/or replacement (though this is not always being done or enforced). Mitigation for temporary impacts is restoring temporary disturbed areas to the pre-project condition.

Monitoring and reporting on mitigation measures is supposed to be done through the CEQA process. See the discussion above regarding the inadequacies and failures of monitoring and reporting under CEQA. Mitigation projects are supposed to provide CDFG with breeding and non-breeding season surveys and reports. The 2012 guidelines have example components for burrowing owl artificial burrow and exclusion plans, Mitigation Management Plans and Vegetation Management Goals, and Mitigation Site Success Criteria.

A 2014 CDFW report on implementation of the 2012 guidelines (Riesz and Rodriguez 2014) stated that CDFW is developing further information about resident vs. migrant owls, disturbance studies, appropriate buffers, and minimization measures. Studies as part of HCP/NCCPs are evaluating farming/drain maintenance impacts, active relocation, and appropriate distances between project site and mitigation lands. CDFW was working with applicants for energy projects to establish conservation easements for burrowing owls, to ensure the land will be retained in agricultural use compatible with burrowing owl forage and to prevent use that will impair or interfere with those values. Energy projects applicants are providing artificial burrows to compensate for directly impacted burrows.

The 2012 guidelines anticipated meaningful protection for burrowing owls will mostly be accomplished by incorporating burrowing owl conservation strategies into landscape-based planning efforts through NCCPs and HCPs. See the discussion above on the limited success of HCPs and NCCPs in protecting significant burrowing owl populations.

The 2012 guidelines have lofty and laudable conservation goals: maintaining the size and distribution of extant burrowing owl populations; increasing the geographic distribution of burrowing owls into formerly occupied historical range; increasing the size of existing populations where possible and appropriate; protecting and restoring self-sustaining ecosystems or natural communities which can support burrowing owls at a landscape scale, and which will require minimal long-term management; minimizing or preventing unnatural causes of burrowing owl population declines; and augmenting/restoring natural dynamics of burrowing owl populations including movement and genetic exchange among populations. Unfortunately, none of these goals have been accomplished since 2012.

The new guidelines are not resulting in widespread protection of California's burrowing owls. Nothing in the guidelines is binding on lead agencies that make the decisions about project impacts and mitigations. It is used as guidance by CDFW during reviewing and commenting on environmental documents and making recommendations to avoid, minimize, and mitigate potential negative impacts, but success depends entirely on CEQA lead agencies to adopt and enforce the guidelines, unless a permit is required that CDFW can influence. Since CDFW does not enforce take under Fish and Game Codes or the MBTA, and the burrowing owl is not a state listed species, there is little incentive for CEQA lead agencies to adhere to the 2012 guidelines.

State Conservation Strategy

The need for a range-wide conservation strategy for the burrowing owl was recognized in 1995 (CDFG 1995). After the 2003 listing petition, CDFG announced at the 2003 state burrowing owl symposium in Sacramento that it was preparing a statewide conservation strategy. In 2007, CDFG (Burkett and Johnson 2007) stated it would be completed in 2008. CDFW reportedly started developing a Burrowing Owl Comprehensive Conservation Strategy, based on the approach in the 2012 staff report. This strategy was going to be a guidance document, not a regulatory mechanism, relying heavily on voluntary adoption of conservation measures. No strategy has been put in place for the past 28 years, other than what is implied in CDFW (2012).

State Conservation Banks and Preserves

Starting in the 1990s, the California Department of Fish and Game unofficially sanctioned the use of small mitigation banks in eastern Alameda and Contra Costa Counties to “mitigate” for the loss of burrowing owl habitat to urban development in eastern and southern San Francisco Bay Area. These included the Byron Conservation Bank, Brushy Creek Conservation Bank, and the Haera Conservation Bank. Credits are purchased in exchange for permits allowing destruction of known owl breeding habitat, and usually passive eviction of owls from a project site. CDFG viewed conservation banks as a valuable conservation tool when impacts to burrowing owls from projects were “unavoidable” (CDFG 2003). CDFG moved to formally approve conservation banks that consisted of sites with occupied habitat and/or suitable unoccupied habitat, protected in perpetuity by a conservation easement, and with each bank operator providing endowment funding to manage the lands in perpetuity. The idea of these mitigation banks is to consolidate the acquisition of mitigation land, and credits for mitigation, into large and biologically meaningful parcels (CDFG 2002b).

There are a number of problems with the conservation bank approach. Due to territorial spacing, only so many burrowing owls can exist in one conservation bank; and sufficient space is also needed for seasonal shifts in activity areas. Use of these banks implicitly endorses extirpation of owls from areas of high development by not requiring on-site conservation measures, ensuring that owls will eventually be eradicated from urbanizing areas. The small number of mitigation banks with burrowing owl habitat, their small overall size (less than 25,000 acres statewide), and the rising cost of purchasing suitable land for habitat make this approach incapable of protecting significant populations of owls. A few conservation banks are co-managed by non-profit organizations with a mission to protect wildlife, but the vast majority are business ventures. Allowing for-profit ventures to assume responsibility for managing habitat in perpetuity to benefit burrowing owls is a losing proposition. There seems to be little financial incentive for management companies doing more than the primary method of "managing" for burrowing owls by keeping grass short through cattle grazing, without much else done to actively manage for owls (Breon 2015). Many sites initially managed for burrowing owls may no longer support breeding owls if vegetation management is not appropriate, artificial burrows are not maintained, predators and disturbances are not controlled, if funding (or profit margin) is short, or if other focal species take precedence over non-listed burrowing owls. The data gathering at conservation banks is weak and there are no standardized protocols, making it difficult to judge the success of any one conservation bank (Breon 2015).

Burrowing owls occur in relatively higher densities and numbers in habitat that is maintained by some sort of disturbance, be it livestock grazing, agricultural irrigation infrastructure operation and maintenance, or mowing (e.g., at airports). Because of their affinity for disclimax grasslands that are maintained by some sort of vegetation disturbance the conservation practice of "setting aside" habitat often fails through time to provide the short, sparse vegetation that these owls use. It is vitally important that any designated owl habitat conservation areas have rigorous management plans that ensure appropriate habitat conditions are maintained through time.

An example of problems with conservation banks is the Haera Wildlife Conservation Bank (HWCB), which was one of the first conservation banks used as supposed mitigation for eviction of breeding owls and destruction of owl habitat in Santa Clara County. Since 2001, the HWCB in eastern Alameda County and an adjacent PG&E San Joaquin Kit Fox Mitigation Site in western San Joaquin County have sold mitigation credits and purportedly been managed to protect habitat for a breeding population of burrowing owls, as well as two federally listed species (California tiger salamander and San Joaquin kit fox). In 2000, before the site was active as a conservation bank, HWCB had 10 owls and 6 active burrows, and the PG&E site had 6 owls and 3 active burrows. The Santa Clara Valley Audubon Society secured CDFG documents and the management plan for the conservation bank, which is managed by Wildlands, Inc., and published a report about the failures of the conservation bank (SCVAS 2010). Between 2001 and 2008, Wildlands, Inc. Haera Wildlife Conservation Bank sold close to 200 of its 299 acre-credits, which were used to justify multiple evictions from multiple developments in multiple counties, and representing at least 9 pairs of evicted burrowing owls (SCVAS 2010). Taking the most liberal accounting approach, both conservation sites maintained fewer than 5 owl breeding pairs as of 2010, while selling credits for at least twice that number. The management plan fails to establish population goals for any of the target species or their prey populations, does not incorporate any metrics for ecological analysis or triggers for adaptive management processes for any target species (SCVAS 2010). The plan implied that maintaining short grass habitat suffices to protect and sustain a breeding population of burrowing owls. After eight years of monitoring, there was no evidence that a viable breeding population of burrowing owls existed in HWCB. During monitoring, Wildlands Inc. often counted individual owls more than once per sampling event or per sampling year, producing data only on presence/absence of owls on the site. There was no information on breeding or fledging of burrowing owls on the site and no evaluation of the success of the conservation bank in conserving burrowing owls. Population estimates and trends could not be discerned from the data provided to CDFG. The conservation bank has sold all of its credits as of 2022 (CDFW 2023b).

Santa Clara Valley Audubon Society (SCVAS 2010) concluded that the use of off-site mitigation for burrowing owls in the manner that it was being implemented, cannot be defended as a viable conservation alternative, and petitioned CDFG to stop offering Haera or any other conservation bank as an option for mitigation for loss of burrowing owls and their habitat in Santa Clara County. Santa Clara Valley Audubon Society noted that "without a rigorous scientific approach at the implementation, monitoring, and adaptive management stages, the use of conservation banks as a conservation tool appears to be a waste of resources."

As of 2023, CDFW has 21 conservation banks in California where credits can be purchased by developers or project proponents as mitigation credits for impacts to burrowing owls (CDFW 2023a,b). There is one conservation bank for burrowing owls in the Northern Central Valley region, the 615-acre Wildlands Mitigation Bank in Placer, where 466 credits are sold out. Most (16) of the state approved conservation banks for burrowing owls are in the Middle Central Valley region, covering 10,873 acres. These include: 252-acre Dolan Ranch Conservation Bank in Colusa County (297 credits of 309 sold); 1,288.5-acre Muzzy Ranch Conservation Bank (796 credits of 1209 sold) and 405-acre Jenny Farms Conservation Bank (406 credits sold out) in Solano County; 120-acre Brushy Creek Conservation Bank (118 credits sold out) in Contra Costa County; 140-acre Byron Conservation Bank (139 credits sold out), 74-acre Springtown Natural Community Reserve (73 credits sold out), 147-acre Mountain House Conservation Bank (145 credits sold out), 299-acre Haera Wildlife Conservation Bank (299 credits sold out), and the Cayetano Creek Mitigation Bank (75 acres of grasslands as of 2023) in Alameda County; 501-acre Dutchman Creek Conservation Bank (490 of 497 credits sold), 281-acre Grassland Mitigation Bank (181 of 232 credits sold), 4,131-acre Piedra Azul Conservation Bank (pending), and 3,234-acre Agua Fria Conservation Bank (3,220 credits sold out) in Merced County. There are two state conservation banks in the Southern Central Valley region, covering about 7,000 acres: the 6,059-acre Coles Levee Ecosystem Preserve (5,580 of 6,059 credits sold for energy development impacts; not for sale to the public), and 946-acre Alkali Sink Conservation Bank in Fresno County (830 of 943 credits sold). San Diego has one conservation bank, the 210-acre Ramona Grasslands Conservation Bank (74 of 199 credits sold). In the southern desert region, the 4,678-acre Mojave Desert Tortoise Conservation Bank in San Bernardino County accepts burrowing owl mitigation credits (3,081 of 4,658 credits sold). A few banks only cover overwintering or foraging habitat: 573-acre Bryte Ranch Conservation Bank in Sacramento County (235 of 264 credits sold); and 964-acre Burke Ranch Conservation Bank (668 of 920 credits sold) and 1,815-acre Elsie Gridley Mitigation Bank in Solano County (1,398 of 1,735 credits sold). Through 2022, these 19 existing banks had collectively sold 19,894 credits (CDFW 2023b).

These conservation banks are a bit of a black box, since there is minimal readily available public information about how many breeding pairs of owls are actually protected on these conservation banks, and what exactly the management plans are doing to ensure owls can persist in perpetuity, despite them being used to “mitigate” for take of known breeding pairs of owls elsewhere. The petitioners submitted a public records request to CDFW asking for information on the status of burrowing owls on all state approved mitigation and conservation banks. CDFW was only able to provide annual reports with any information for 9 of these 21 banks (Alkalai Sink, Bryte Ranch, Burke Ranch, Cayateno, Dolan, Dutchman Creek, Elsie Gridley, Grasslands, and Muzzy Ranch).

The Alkali Sink Conservation Bank in Fresno County has sold 830 credits, but only had two wintering burrowing owls documented in January of 2018; there is no evidence of breeding burrowing owls on the site (CDFW 2018). The Bryte Ranch Conservation Bank in Sacramento has sold 235 credits, and detected small numbers of wintering owls in 2005 (May & Associates 2005); 4 wintering owls observed during 2009-2014 surveys (MHB 2014); no owls and no evidence of owl usage during surveys from 2018-2022 (ECorp 2018-2022); and an unspecified number of owls flushing from five burrows on the bank on February 23, 2023, with evidence of burrowing owl usage (e.g., whitewash, owl pellets, feathers) (ECorp 2023); these were presumably wintering owls and there did not seem to be follow up later in the breeding season. Burke Ranch Conservation Bank in Solano County has sold 668 credits; and during focused owl surveys from 2008-2022 documented no breeding owls, and only single wintering owls in 2012, 2013, 2020, and 2021 (Westervelt 2009-2023). The first year of operation of the Cayetano Creek Mitigation Bank in Alameda County, 2 burrowing owls were observed within the bank but reporting did not specify what time of year, presumably not during breeding season (Olberding 2023a). Dolan Ranch Conservation Bank in Colusa County has sold 297 credits, but despite installing artificial burrows in 2004 has not had any use at all by burrowing owls for 20 years (RES 2022). Dutchman Creek Conservation Bank in Merced County has sold 490 credits; CDFW had only one informal wildlife report stating that the burrowing owl has also been observed utilizing the property as breeding habitat (Westervelt 2013), but no documentation or annual survey reports. Elsie Gridley Mitigation Bank in Solano County has sold 1,398 credits; artificial burrows have been installed and maintained; focused owl surveys since 2007 have documented no breeding owls on the bank; with 3-6 wintering owls present most years from 2007-2023 (LSA 2009-2011; WRA 2013-2020; RES 2021-2023). Grassland Mitigation Bank in Merced County has sold 181 credits; only a single wintering burrowing owl was documented on the site in November 2013, but no breeding burrowing owl observations during 2010-2014 surveys (Westervelt 2014), with no other annual reports provided. Muzzy Ranch Conservation Bank (in Solano County has sold 796 credits; despite 5+ years of focused owl surveys, there has been no evidence of successful breeding on the bank, with up to 5-6 wintering owls (LSA 2018-2022).

Thus, despite sale of nearly 20,000 credits at these 21 mitigation banks, CDFW has documentation of exactly zero pairs of breeding burrowing owls at all of these conservation banks. From the limited information CDFW seems to keep on the status of burrowing owls at these banks, it is clear that the use of these banks as mitigation results in a massive net loss of breeding owl pairs.

CDFW provided additional monitoring reports for proposed mitigation banks not yet on the list of banks accepting credits for burrowing owls, none with large breeding owl populations. These included: 1,948 acre Black Mountain Conservation Bank in San Bernardino County; 220-acre Eagle Ridge Preserve East Mitigation Site on the Contra Costa/Alameda county line; and the 2,615-acre Gabrych Study Area in San Bernardino County. During focused transect surveys for burrowing owls at Black Mountain in April 2017 no burrowing owls were observed but 6 burrows with whitewash and/or pellets were noted (Corvus 2017). Eagle Ridge Preserve East had two pairs of burrowing owls observed on the bank in 2009 and again in 2011, and one pair and four nestlings observed in summer of 2021 (Olberding 2023b). Focused surveys at Gabrych Study Area in 2015 found no evidence of breeding burrowing owls, and 2 locations with whitewash/pellets (Corvus 2015).

CDFW provided additional monitoring reports for mitigation banks that do not cover the burrowing owl, but may incidentally provide habitat. The 4,526-acre Palo Prieto Conservation Bank in northeast San Luis Obispo County and western Kern County sells credits for San Joaquin kit fox but apparently also supports burrowing owls, which are not a focal species. The Palo Prieto Conservation Bank became operational in March 2007 and had sold 3,814 kit fox credits as of 2018. Unspecified numbers of wintering burrowing owls were observed on two parcels 2009-2010; high abundance of wintering owls were reported 2010-2015; apparently "high abundance" of burrowing owls were also present during breeding season surveys (May, July and August) from 2012-2015, but no numbers, evidence or additional documentation is provided (Althouse & Meade 2009-2015); and the 2018 Palo Prieto report states that no burrowing owls were observed during 2018 (Althouse & Meade 2018). The 3,284-acre Sparling Ranch Conservation Bank in southeastern Santa Clara County and northeastern San Benito County sells credits for California tiger salamander and California red-legged frog, and supports a small number of wintering burrowing owls, which are not a focal species. There is no documentation of breeding burrowing owls; winter surveys in 2013 found signs of burrowing owl presence and one presumed transient burrowing owl was seen September 2017 (H.T. Harvey & Associates 2015-2016; Biosearch 2018-2019).

CDFW provided monitoring reports for some additional conservation areas established to mitigate for energy development project impacts:

The 52-acre Alpaugh Conservation Easement in Tulare County was established to mitigate for destruction of burrowing owl habitat as a result of the development of the Alpaugh 50, LLC and Alpaugh North, LLC Solar Projects in Tulare County. As of the recording of the conservation easement in 2014, no breeding or wintering protocol-level surveys had been conducted on the conservation easement area, and recent observations did not yield any burrowing owls on the site, despite burrowing owl observations on adjacent sites (Sequoia Riverlands Trust 2014); CDFW provided an undated map showing 8 "active BUOW burrows" on the Alpaugh site, but no additional information.

The 634-acre Alta Oak Creek Mojave Mitigation Conservation Areas in Kern County were established to compensate for impacts to threatened and endangered species resulting from the Alta Oak Creek Mojave Wind Energy Project, the construction and operation of 100 wind turbine generators and ancillary facilities on 606 acres within the West Mojave Desert Planning Area, permitted by Kern County. The preserve surveys and supporting documents did not provide any evidence of breeding burrowing owls on these preserve sites. (Wildlands 2011, 2012). As of 2017, there were no burrowing owls detected during surveys of the Alta Oak Creek conservation areas (Corvus 2018).

California Valley Solar Ranch Project (CVSR) is a 250-megawatt solar photovoltaic energy facility in eastern San Luis Obispo County that went into operation 2012-2013, and has set aside 8,082 acres of conservation lands. Based on focused owl surveys, within the California Valley onsite conservation lands there were 6-12 documented breeding pairs of burrowing owls in 2011; 5 pairs in 2012 (that produced 18 juveniles); 7 pairs in 2013 (that produced 6 juveniles), and biologists declared the breeding population stable; there was only 1 breeding pair in 2014 and 2 breeding pairs in 2015 (that produced 15 juveniles); there were no surveys in 2016 or 2017 (H.T. Harvey and Associates 2013-2018).

A 50.2-acre mitigation parcel for the Manzana Wind Energy Project in Kern County was evaluated for burrowing owl presence in December 2012 surveys, with no burrowing owls sighted, and several kit fox burrows just offsite with signs of use by burrowing owls (Sapphos Environmental 2013).

The 407-acre Vasco Winds Ecological Preserve in eastern Contra Costa County was protected with a conservation easement to mitigate for impacts of the Vasco Winds Repowering Project, which decommissioned approximately 438 obsolete wind turbines and associated infrastructure and replacing them with 34 larger wind turbine generators in 2011. The burrowing owl is a covered species for Vasco Winds; 3 owl pairs nested on the preserve in 2013; 2 pairs nested onsite in 2014; at least 6 owls overwintered 2014-2015; but there was no evidence of nesting in 2015 or 2016, with former nesting sites overtaken by the spread of invasive black mustard (Biosearch Associates 2014-2016).

The Topaz Solar Farm Project is a 3,510 acre photovoltaic installation constructed in eastern San Luis Obispo County between 2011 and 2013. To mitigate primarily for impacts to San Joaquin kit fox, the project provided permanent protection and management of 12,168 acres of mitigation lands at North Carrizo Ecological Reserve (NCER). Based on 2010 survey data, the Topaz Solar Project would displace 2 pairs of nesting burrowing owls. During opportunistic and ineffective burrowing owl surveys from 2011-2018, large numbers of wintering burrowing owls were noted, burrowing owl locations were recorded on the preserve, nesting activity was noted but no successful reproduction was documented from 2011-2017, and no nesting activity was documented in 2018 (Althouse and Meade 2011-2013; CDFW 2015-2020). Survey techniques to better detect burrowing owl nesting and breeding on the NCER are supposed to be developed and evaluated during the coming years. In 2012, Topaz Solar 2012 illegally and inappropriately installed a burrow exclusion device on an occupied nesting burrow during the nesting season, resulting in one dead adult owl and nest failure. CDFW sent a warning letter to Topaz Solar but no enforcement action was taken.

CDFW provided a proposed burrowing owl relocation, mitigation and monitoring plan for the 180-acre Corcoran Solar Generation Facility in Kings County (HEC 2013). The Conditional Use Permit and Mitigation and Monitoring Plan for Corcoran Solar required the project to conduct a pre-construction burrowing owl survey and passively relocate any owls found on the site. CDFW requested that owls be evicted outside of the breeding and nesting season (preferably before they are pairing up or after fledging; the project provide a nearby location with suitable burrows so that there is at least the opportunity for owls to relocate to adjacent habitat; the project protect that nearby location in perpetuity via conservation easement or fee title transfer to a public agency; the amount of protected habitat should be based on the amount of habitat displaced and applicable home range requirements for the number of owls displaced; and the project provide funding for initial habitat enhancement and perpetual management. The project apparently failed to meet many of these requirements. The project relied on flawed preconstruction surveys, conducted in December 2012, outside of breeding season and not according to CDFG (2012) protocols, locating 11 adult owls using 15 burrow complexes; and 9 active owl burrows in January 2013. The project would impact all of these burrows. The project proposed compensatory mitigation acreage of 109 acres; and the burrowing owl plan proposed possibly protecting 43 adjacent acres with 23 suitable burrow complexes, as well as creating berms (similar to what ground squirrels and owls were utilizing on the project site) and artificial burrows at a 2:1 ratio, if needed. The project proposed to lease the lease the 43-acre mitigation property for 60 years. Mitigation lands were supposed to be monitored with breeding season and winter surveys for a period of 5 years to determine if owls are using them, with annual monitoring reports submitted to CDFW. It is unclear if any of the monitoring or mitigation was ever done, as CDFW did not provide any further information or monitoring or mitigation reports.

The Center for Natural Lands Management (CNLM) manages numerous private mitigation preserves in California that offer mitigation credits, 10 of which are specifically managed for burrowing owls as a non-listed species; and 9 of these preserves cover only 3,038 acres (CNLM 2023). In the northern Central Valley, these include Alkali Grasslands in Yolo County, Michael Remy in Solano County, Arroyo Seco and Mehrten Ranch in Sacramento County, and Dublin Ranch in eastern Alameda and Contra Costa counties. CNLM mitigation preserves in Kings, Kern and Tulare counties include Cholame Ranch, Lost Hills, Petit, and Pixley Vernal Pools. Lost Hills Preserve is 441 acres, with no evidence of burrowing owl breeding; 2 owl burrows were located off-site during 2012 surveys and owl foraging habitat is present on the site (CNLM 2016). In Southern California, CNLM manages the Skunk Hollow Vernal Pool (aka Barry Jones Wetland Mitigation Bank) in Riverside County. As of 2007 no breeding burrowing owls occurred on the Barry Jones/Skunk Hollow preserve, though owls breeding on adjacent lands likely forage and roost there (Stanton and Teresa 2007). The success of these preserves requires an adequate funding endowment, and adequate maintenance and monitoring criteria; and inclusion of burrowing owls in a preserve management plan must be compatible with other preserve objectives, which can focus more on listed species (Stanton and Teresa 2007). The long-term viability of owl populations on these small preserves depends in part on the future status of surrounding lands which may be developed or conserved (Stanton and Teresa 2007). The Cholame Ranch Preserve in Kings and Kern County is the only large CNLM protected area of owl habitat, with about 10,000 acres of low-elevation foothills. Other CNLM preserves where burrowing owls are not a mandated conservation target may support and benefit owls through grazing, mowing or fire programs intended to benefit other grassland species, and through management strategies such as fencing and signage, trapping feral cats and dogs, removal of artificial perching sites for predators, enhancing habitat for ground squirrels, and installation of artificial nesting burrows (Stanton and Teresa 2007). But at preserves where the primary management effort is to increase habitat for listed species that require different habitats, such as shrub enhancement for the California gnatcatcher in Southern California, burrowing owls do not benefit. Preserves are also not necessarily protected in perpetuity - the former CNLM 1,008-acre March Stephen's Kangaroo Rat Preserve for the endangered Stephens' kangaroo rat in western Riverside County supported a small wintering population of burrowing owls, but this preserve was closed down to allow industrial development, in exchange for other preserve land of unknown value for burrowing owls. CNLM is proposing to manage conservation lands being used as mitigation for the Panoche Valley Solar Project, a 247 MW solar photovoltaic energy facility on 1,688 acres in eastern San Benito County; the burrowing owl is not a covered species and the draft Habitat Management Plan for approximately 25,618 acres of conservation lands does not discuss the status of burrowing owls on the conservation lands, nor contain any management efforts to support burrowing owls (McCormick Biological 2016).

Regional and Local Management Efforts

Failed conservation efforts in the San Francisco Bay Area in the 1990s and 2000s are indicative of the limitations and challenges of attempted owl conservation planning at the county and city level for non-listed species. Some jurisdictions have subsequently opted to join regional planning efforts through NCCPs and HCPs that cover the burrowing owl.

Regional Plans

Members of the CBOC met with the California Secretary of the Resources Agency in 1995 and the Director of the Department of Fish and Game in 1998 to discuss ways to enhance burrowing owl conservation in the San Francisco Bay Area other than listing the species (there was a perception that listing might lead to intentional eradication of burrows from private lands through disking). An approach involving regional conservation planning by the Department of Fish and Game and local/municipal habitat conservation was agreed upon, and the California Audubon Society introduced a bill to the California legislature in 1999. This bill would have provided funds for the Department of Fish and Game to prepare a Burrowing Owl Conservation Strategy for the Bay Area, however during legislative review this bill was amended to apply to other species and eventually was not funded. It is worth noting that every city in the southern San Francisco Bay that was approached with the concept of cooperating on a multi-city (i.e., regional) plan opted instead for its own separate plan. The result was a different approach to similar problems of habitat loss in the same locality, and the need to reinvent the process multiple times as a result of these decisions.

County Plans

The General Plans for the 37 California counties that still had breeding burrowing owls (excluding the counties in the desert range of the species) were reviewed in 2003, and none of these plans mentioned or required any mitigation for loss of burrowing owl habitat. The Fresno County General Plan typified the treatment of special status species under county level planning efforts. Protection policies were couched in qualifiers, such as "where possible," and there is no guaranteed protection of sensitive habitat if it is "not practicable." For example, the plan commits to "*support efforts* to avoid the "net" loss of important wildlife habitat *where practicable*" and "ensure the conservation of large, continuous expanses of native vegetation to provide suitable habitat for maintaining abundant and diverse wildlife populations, *as long as this preservation* *does not threaten the economic well-being of the county*" [italics added]. The plan did not specifically mention the burrowing owl, but discussed protecting the San Joaquin kit fox in the context of mandating that the County "shall promote effective methods of pest (e. g. ground squirrel) control on croplands bordering sensitive habitat that do not place special-status species at risk, such as the San Joaquin kit fox." Of course, effective ground squirrel control puts the long-term survival of burrowing owl populations at risk. Under the Fresno County General Plan, if protecting wildlife habitat is deemed unfeasible, "mitigation" is required. However, compliance with existing environmental laws, such as CDFG codes, U.S. Fish and Wildlife Service regulations, and the MBTA are considered part of the mitigations. The County acknowledged that development under the plan would destroy specific habitat types that support special-status animals, and that although implementation of its mitigation policies would somewhat reduce impacts for development within the County's jurisdiction, they would not be reduced to a less-than-significant level. The impacts of future development under the plan are deemed to be significant and unavoidable for development within the County and other city jurisdictions.

City Plans

Repeated conflicts between burrowing owls and development projects, especially in southern San Francisco Bay, have led some municipalities to consider preparing city-wide burrowing owl conservation programs for their respective jurisdictions.

The City of San Jose, in Santa Clara County, attempted the most ambitious such project in 1998 and spent two years developing a Burrowing Owl Habitat Conservation Strategy and Implementation Plan ("Plan"), which was fashioned after the Habitat Conservation Plan model for federally-listed species. The Plan would have provided a consistent way to evaluate impacts to burrowing owls and burrowing owl habitat from development according to their General Plan through 2020. The Plan proposed a development fee for every acre of open space land developed (although the fee was the most obvious way to fund the Plan, the Plan also contained other funding mechanisms) to create an endowment fund to maintain and monitor owl habitat. This funding mechanism would have resulted in the management of several hundred acres of burrowing owl habitat on dual-purpose land in San Jose, without the need to purchase prohibitively costly land (in the range of $1 million/acre). Development was expected to consume over 2,000 acres of owl habitat over 20 years, which would be mitigated by 1,250 managed acres of owl habitat within the City's urban service area. Unfortunately, the City Council denied the Plan in May 2000 without even bothering to read it, due to objections by the building industry over the proposed development fee, concerns by the City that it would cause undue restraint of commercial development in San Jose, and the perception that they were being held to a higher standard of mitigation than neighboring entities (as in the 6.5 acres/pair mitigation for owl habitat in Byron allowed for development in Santa Clara). Shortly after the rejection of the Plan, the City, in a self-serving interpretation of the CBOC guidelines, offered a "less than significant" free pass to a development project at Lake Cunningham Park, because it impacted less than 6.5 acres of owl habitat.

The City of Morgan Hill, in Santa Clara County, began preparing a city-wide burrowing owl habitat conservation program in 2000. The City committed in 1999 to prepare such a plan as part of the approval of a development project that affected burrowing owl habitat. Unfortunately, breeding burrowing owls may have been extirpated from Morgan Hill during the time the plan was being prepared (J. Barclay, pers. comm., 2002).

In San Bernardino County, the City of Chino General Plan authorizes low to high-density housing development on much of the agricultural land around the Chino Airport, including the majority of occupied owl locations in the vicinity of Chino (J. Bath, pers. comm., 2001). The City of Ontario General Plan proposed to convert 8,200 acres of existing agricultural grasslands, and develop 31,000 homes in an area that supports a large burrowing owl population in the Inland Empire with only a mere 50 acres of raptor habitat provided as "mitigation" (G. Stewart, D. Guthrie, pers. comm., 1997). Litigation over this plan resulted in a settlement offering some burrow owl protection measures, which were likely inadequate to protect the owls (J. Bath, pers. comm., 2003).

A local management plan emphasizing on-site relocation and off-site habitat replacement (outside of the Santa Clara Valley) was developed for the Mission College owl population in Santa Clara County, where owl numbers have fallen from 30 pairs to 8 pairs in 5 years (Trulio 2002). This type of offsite habitat replacement is detrimental to local owl populations in the Santa Clara Valley region and the affected owls will lose most of their foraging habitat to development under this plan. The inevitable loss of the Mission College population is a perfect example of the simple relationship between habitat loss and species extirpation. (Delevoryas 1997; Trulio 1998a, 2002).

Because private lands in the City of Davis were frequently being tilled, disked or graded without environmental review under CEQA or even adequate surveys to determine owl presence, and due to the precipitously declining breeding burrowing owl population in Davis, in 2003 Davis enacted a disking ordinance (McNerny and Sears 2007). Prior to 2000, the City had no policies or programs to protect burrowing owls within city limits, and the Davis owl population had declined from more than 40 pairs in 1985 to 16 pairs in 2001 and 14 pairs in 2003 (McNerny and Sears 2007). A temporary disking ordinance enacted in 2000 was replaced with a permanent Disking Ordinance (Davis Municipal Code 8.18.0), which prohibits disking, tilling or grading without City approval and a biological survey, with mitigation and conditions to protect special-status plants and wildlife. As of 2007 the ordinance was successful in preventing direct impacts to burrowing owls on private lands from disking, but was acknowledged as not being an optimal conservation tool, since it does not address direct impacts of loss of foraging habitat, nor does it require off-site mitigation for the loss of owl breeding and foraging habitat (McNerny and Sears 2007). After the implementation of the disking ordinance, the City of Davis had 21 known breeding pairs of owls as of 2007 (YHC 2017), but breeding burrowing owls were completely extirpated from Davis by 2020 (S. Smallwood, pers. comm., 2023), and the ordinance seems to be disregarded.

Recommended Management and Recovery Actions

This petition has documented significant local and regional extirpations and ongoing dramatic population declines of burrowing owls throughout the majority of their range in California, as well as the failure of current management efforts to reverse this trend. The factors causing burrowing owl declines and the threats to the majority of remaining owl populations can only be addressed by providing elevated legal protection to the species. Without endangered or threatened status, future management policy will continue to emphasize protecting individual owls without fully addressing cumulative habitat loss or other factors reducing survivorship. Ultimately, the protection of the burrowing owl in California hinges on strong habitat protection regulations.

Recommended management and recovery actions for the burrowing owl:

1. **List imperiled regional burrowing owl populations or the statewide population under CESA.** Listing will allow CDFW to apply effective and meaningful protection measures for breeding owls and for essential owl habitat during the CEQA process. Listing will also likely result in wider scale coverage of burrowing owls under regional conservation plans such as HCPs and NCCPs.

2. **Make CDFW (2012) survey and mitigation guidelines required instead of voluntary.** This will ensure that appropriate breeding-season surveys are completed and strengthen CDFW's warning that eviction can be interpreted as take.

3. **Update CDFW (2012) to require stronger survey methods based on what has been learned from research over the past decade.** Require that CDFW's survey guidelines are implemented rather than other guidelines that appear in HCPs. Update CDFW (2012) to require implementation of mitigation ratios that are incentivized to protect habitat closer to the site of authorized take. Vary mitigation ratios so that they are smaller for habitat protected closer to the site of take, and larger for habitat protected farther from the site of take.

4. **Curtail the use of evictions through passive relocation.** Passive relocation (eviction) of burrowing owls to allow permanent impacts to burrowing owl breeding pairs or habitat should be considered "take" and not be allowed except in special circumstances; and then only when owls are moved short distances and to permanently protected and managed lands. Appropriate uses of passive relocation would be on public lands such as large military reservations, when used to discourage nesting in proximity to airport runways, or when used to avoid take for temporary disturbances (such as pipelines). Any relocation of owls should require marking, monitoring, and meeting success criteria.

5. **Continue CDFW translocation policy.** Translocation, or active relocation of owls should only be allowed for scientific research or under a NCCP conservation strategy. Any relocation of owls should require marking, monitoring, and meeting success criteria. Require performance bonds to fund additional measures should translocation not meet success criteria.

6. **Accelerated regional conservation planning.** CDFW should immediately develop emergency burrowing owl protection and recovery plans for regions where breeding owls are nearing extirpation. This would include the Bay Area, Central Valley, Central Coast, and Southwestern California regions.

7. **Focus on large stable populations on private lands and on grasslands.** Permanent protection of large, stable breeding groups or colonies of owls on unprotected private lands should be the highest priority for acquisition or conservation easements. Most burrowing owls now live at an artificially high population density in a narrow niche on the margins of agricultural lands, and if management practices change slightly, these populations cannot be depended upon to buffer environmental perturbations. Burrowing owls should be reintroduced and their native grassland habitat retained and experimentally restored wherever possible. Restoration using experimental designs is needed to convincingly answer questions about efficacy and which factors contributed most to restoration success.

8. **Strengthen mitigation requirements.** Robust mitigation should be required for any permanent impacts to breeding owl pairs or habitat. Loss of breeding pairs must be mitigated with equal or greater conservation of breeding pairs or occupied habitat, through permanent acquisition or conservation easement. Mitigation lands must include long-term management, monitoring, and demonstration of breeding colony success. If artificial burrows are used for mitigation, there should be a requirement for maintenance of the burrows and funding for such maintenance in perpetuity.

9. **Keep mitigation local or regional.** Mitigation requirements and ratios should incentivize offsetting impacts to burrowing owls or habitat by protecting local or regional owl colonies or habitat, to prevent eventual extirpations. The further away from project impacts mitigation lands are located, the higher the mitigation ratio should be.

10. **Enforce state fish and game codes.** CDFW should bring enforcement actions under Section 681, Title 14 and Fish and Game Code sections 3503 and 3503.5 for documented take of burrowing owls by developers, industrial energy facilities, or counties or cities that authorize illegal take. Enforcement should be a priority for projects or actions that cause massive ongoing take of burrowing owls (such as at Altamont Pass).

11. **Prioritize public ownership/conservation management.** CDFW should scale back use of for-profit mitigation and conservation banks, and instead prioritize owl conservation banks on public lands or by nonprofit organizations with an interest in maintaining owls in perpetuity.

12. **Conduct another statewide breeding owl survey.** It has been 16 years since the Institute for Bird Populations resurvey of the entire burrowing owl breeding range in the state from 2006-2007. The state should fund another comprehensive IBP statewide breeding survey, to better evaluate population trends, identify where emergency measures are needed, and inform state policy and recovery planning. Listing the species should NOT be contingent on completing such a survey, since it could take many years, and there is ample information demonstrating population declines and the threatened and endangered status of populations.

13. **Statewide recovery plan.** CDFW should turn the draft conservation plan into a statewide recovery plan, with a roadmap for curtailing extirpations and declining population trends, and moving regional populations toward recovery.

14. **Amend management and land use plans to ensure recovery.** County and city general plans should be revised to address the protection and restoration of owl habitat

appropriate for their areas, and to be consistent with the CDFW recovery plan. Environmental impact documents for projects which impact owls must then comply with local planning documents and CDFW requirements. Municipalities must be required to implement statewide burrowing owl recovery guidelines as part of the CEQA and planning process.

15. **HCPs and NCCPs.** HCPs and NCCPs that cover the burrowing owl should be reviewed to ensure they are not promoting extirpation of burrowing owls and ensure they are assisting recovery. New HCPs and NCCPs should be consistent with a statewide recovery plan. If the burrowing owl is a covered species under an HCP or NCCP, monitoring and active management should be automatically required.

Burrowing Owl Management Impacts on Other Species

Several other wildlife species may benefit from increased protection for burrowing owls in different parts of the burrowing owl's range in California. Increased grassland habitat protection for burrowing owls in Altamont Pass would complement California red-legged frog (*Rana draytonii*), California tiger salamander (*Ambystoma californiense*), loggerhead shrike (*Lanius ludovicianus*), prairie falcon (*Falco mexicanus*), northern harrier (*Circus hudsonius*), and white-tailed kite (*Elanus leucurus*). Increased protection in in the southern San Joaquin Valley would complement conservation efforts for the San Joaquin kit fox (*Vulpes macrotis mutica*), blunt-nosed leopard lizard (*Gambelia sila*), various listed and special-status kangaroo rats (*Dipodomys ingens, D. nitratoides nitratoides, D. n. exilis, D. n. brevinasus*), San Joaquin antelope squirrel (*Ammospermophilus nelsoni*), San Joaquin pocket mouse (*Perognathus inornatus inornatus*), and Tulare grasshopper mouse (*Onychomys torridus tularensis*).

Increased protection of burrowing owls would also benefit golden eagle (*Aquila chrysaetos*), American kestrel (*Falco sparverius*), grasshopper sparrow (*Ammodramus savannarum*), Swainson's hawk (*Buteo swainsoni*), California horned lark (*Otocoris alpestris actia*), American badger (*Taxidea taxus*), and Salinas pocket mouse (*Perognathus inornatus psammophilus*) in the overlapping portions of their respective ranges. In the Mojave Desert, increased protection of burrowing owls would complement protection of desert tortoise (*Xerobates agassizi*) and Mohave ground squirrel (*Spermophilus mohavensis*). The habitat of the endangered Delhi Sands Flower Loving Fly (*Rhaphiomidas terminatus abdominalis*) in Colton, Fontana and Mira Loma overlaps with probable burrowing owl habitat.

Management and recovery of burrowing owls is not expected to have significantly negative impacts on other wildlife species. Increased owl numbers could impact local populations or concentrations of some prey species. Burrowing owls have been known to prey on California least terns (*Sterna antillarum brownii*), a federally endangered species, at colonies on North Island and Ream Field (Imperial Beach) in San Diego County. Owls are hazed away from tern nests at Ocean Beach and also discouraged in the vicinity of snowy plover (*Charadrius alexandrinus nivosus*) nesting areas in the region.

Individuals with Burrowing Owl Expertise Supporting Petitioned Action

Chris Alford
Principal, Alford Environmental

Scott Artis, MA
Founder and Executive Director, Urban Bird Foundation and Burrowing Owl Conservation Network

John H. Barclay
Albion Environmental (retired)

Daniel S. Cooper, Ph.D.
Resource Conservation District of the Santa Monica Mountains

Jim Estep
Wildlife Biologist,

Lisa Henderson
Director of Biological Services, Olberding Environmental, Inc., San Ramon, CA

Dr. Geoffrey L. Holroyd
Research Scientist (retired), Canadian Wildlife Service, Environment and Climate Change Canada
Adjunct Professor (retired), University of Alberta
Chair, Beaverhill Bird Observatory

Robin D. Ikeda
Biology Professor Emerita, Chaffey College

David H. Johnson
Director, Global Owl Project

Jeff W. Kidd, Raptor Biologist
Vice President, Kidd Biological, Inc.

Sandra Menzel
Senior Wildlife Biologist

Anthony Metcalf, Ph.D.
Professor of Biology, California State University, San Bernardino

Catherine Portman
CEO & Co-founder, Burrowing Owl Preservation Society, Woodland, CA

K. Shawn Smallwood, Ph.D.
Ecologist

Carl Thelander
President/CEO BioResource Consultants, Inc.

Dr. Lynne Trulio
Professor, Department of Environmental Studies, San Jose State University

Dr. J.H. Widdicombe
Professor of Physiology, U.C. Davis

Bob Wilkerson
Staff Biologist, Institute for Bird Populations

Bibliography of Literature Cited

Abbott, C.G. 1930a. Urban Burrowing Owls. Auk. Vol. XLVII, No. 4, October 1930, pp. 564-565.

Abbott, C.G. 1930b. Owl Voices. Condor. Volume XXXII, Number 5, September-October 1930, p. 258.

AECOM. 2012. IID Burrowing Owl Monitoring Results 2012. Presentation, September 21, 2012.

Ahmed, Q. 2022. Use of a Utility-Scale Solar Energy Facility by Avian Populations in Central California. Master's Thesis, San Jose State University.

Albion Environmental, Inc. 2008. Camp Parks Reserve Forces Training Area Burrowing Owl Management Plan. Prepared For: U.S. Army Combat Support Training Center, Environmental Division. Fort Hunter Liggett, CA. Prepared by J. Barclay.

Albion Environmental, Inc. 2010. Camp Parks Reserve Forces Training Area 2009 Burrowing Owl Survey Report.

Albion Environmental, Inc. 2011. Camp Parks Reserve Forces Training Area 2010 Burrowing Owl Survey Report.

Albion Environmental, Inc. 2012. Camp Parks Reserve Forces Training Area 2011 Burrowing Owl Survey Report.

Albion Environmental, Inc. 2022. 2022 Annual Burrowing Owl Breeding Season Census at Sharpe Depot. Unpublished report, December 2022. 26 pp.

Althouse & Meade Biological And Environmental Services, Inc. 2009-2018. Palo Prieto Conservation Bank 2009-2018 Annual Reports.

Althouse & Meade Biological And Environmental Services, Inc. 2011. Habitat Mitigation and Monitoring Plan Resource Management Plan for the Topaz Solar Farm Conservation Lands, San Luis Obispo County, California. Prepared for Topaz Solar Farms, LLC.

Althouse & Meade Biological And Environmental Services, Inc. 2012-2013. Topaz Solar Farm Conservation Lands Habitat Mitigation and Monitoring Plan, 2012-2013 Annual Report.

American Museum of Natural History (AMNH). 2001. Collection data provided by Paul Sweet, Collections Manager, Department of Ornithology, American Museum of Natural History, New York.

American Ornithologists' Union (AOU). 1983. Check-List of North American Birds. 6th edition. Washington, D.C.

American Ornithologists' Union (AOU). 1991. Thirty-Eighth Supplement to the American Ornithologists' Union Check-List of North American Birds. Auk 108: 750-754.

American Ornithologists' Union (AOU). 1997. Forty-First Supplement to the Check-List of North American Birds. Auk 114(3): 542-552.

Anderson, J.W. 1979. The Burrowing Owl in Sacramento. Bulletin, Sacramento Zoological. Society. Vol. 16, No. 1 (from a scientific paper presented at the 1977 annual meeting of the American Ornithologists' Union, Berkeley, CA).

Anderson, S.H., L.W. Ayers, J.A. Dechant, M.T. Green, W.H. Howe, S.L. Jones, D.S. Klute, D.K. Rosenberg, S.R. Sheffield, and T.S. Zimmermann. 2001. Draft Status Assessment and Conservation Plan for the Western Burrowing Owl in the United States. Administrative Report. U.S. Department of the Interior, Fish and Wildlife Service, Denver, Colorado.

Animal Damage Control (ADC). 1993. National Annual Report for Fiscal Year 1993. U.S. Department of Agriculture.

Animal Damage Control (ADC). 1994. National Annual Report for Fiscal Year 1994. U.S. Department of Agriculture.

Animal Damage Control (ADC). 1995. National Annual Report for Fiscal Year 1995. U.S. Department of Agriculture.

Arbib, R. 1976. Blue List for 1977. American Birds. Volume 30, No. 6, pp. 1031-1039.

Arizona Game and Fish Department (AGFD). 1995. Status Designations Notebook. Heritage Data Management System. Phoenix, Arizona.

Association of Bay Area Governments (ABAG). 1999. Projections 2000. Forecasts for the San Francisco Bay Area to 2020 and Beyond.

Audubon California. 2015. An Interactive Mapping Tool for Burrowing Owl Conservation in Imperial Valley, California. Prepared for: Imperial Valley Community Foundation.

Audubon Society. 2019. Survival by Degrees: 389 Bird Species on the Brink.

Bailey, F.M. 1917. Red Letter Days in Southern California. Condor. Volume XIX, Number 5, September-October 1917, p. 158.

Baird, S.F. 1870. Ornithology. Volume I. Land Birds. Geological Survey of California. Edited by S. F. Baird, from the manuscript and notes of J. G. Cooper.

Barclay, J. 2007. Burrowing Owl Management at Mineta San Jose International Airport. Pages 146-154 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

Barclay, J. and R. Cull. 1999. Northeastern California Burrowing Owl Population Estimate. Unpublished report, 15 pp.

Barclay, J.H. and S. Menzel. 2011. Apparent Polygynous Nesting by Burrowing Owls. Journal of Raptor Research 45(1), pp.98-100.

Barclay, J., C. Bean, D. Plumpton, B. Walton, and the California Burrowing Owl Consortium. 1998. Burrowing Owl Conservation in California: Issues and Challenges. Page 7 *in* Abstracts of the Second International Burrowing Owl Symposium, Ogden, Utah.

Barclay, J.H., N.M. Korfanta and M. Kauffman. 2011. Long-Term Population Dynamics of a Managed Burrowing Owl Colony. Journal of Wildlife Management 75(6):1295-1306.

Baril, A. 1993. Pesticides and Wildlife in the Prairies: Current Regulatory Issues. Pages 44-48 *in* G.L. Holyrod, H.L. Dickson, M. Regnier, and H.C. Smith (editors). Proceedings of the Third Endangered Species and Prairie Conservation Workshop. Natural History Occasional Paper 19. Provincial Museum of Alberta, Edmonton, Alberta.

Barlow, C. 1901. A List of the Land Birds of the Placerville - Lake Tahoe Stage Road. Condor. Volume 3, Number 6, November-December 1901, p. 162.

Barr, K.R. 2021. Expanding Genomics Toolkits to Facilitate the Conservation and Recovery of Two Protected Species, the Tricolored Blackbird and Burrowing Owl. Ph.D. dissertation, University of California, Los Angeles.

Barr, K., C. Bossu, R. Bay, E. Anderson, J. Belthoff, L. Trulio, D. Chromczak, C. Wisinski, T. Smith and K. Ruegg. 2023. Genetic and Environmental Drivers of Migratory Behavior in Western Burrowing Owls and Implications for Conservation and Management. Evolutionary Applications 00:1–12.

Barrentine, C.D. and K.D. Ewing. 1988. A Capture Technique for Burrowing Owls. North American Bird Bander, Oct.-Dec. 1988, p. 107.

Bartholomew, P.S. 1940. Bird Life in the Gibraltar Study Area. U.S. Forest Service Publication, Los Padres National Forest, California.

Bartok, N.D. and C.J. Conway. 2010. Factors Affecting the Presence of Nesting Burrowing Owls in an Agricultural Landscape. Journal of Raptor Research, 44(4): 286-293.

Beedy, E.C. and S.L. Granholm. 1985. Discovering Sierra Birds. Western Slope. Yosemite Natural History Association and Sequoia Natural History Association.

Bell, C., W. Acevedo, and J.T. Buchanan. 1994. Dynamic Mapping of Urban Regions: Growth of the San Francisco Sacramento Region. *In* Proceedings, 3rd annual urban and regional information systems association conference; 1995 July 16-20; San Antonio, Texas: 723-734.

Bellocq, M.I. 1997. Ecology of the Burrowing Owl in Agroecosystems of Central Argentina. Pages 52-57 *in* J.L. Lincer and K. Steenhof [eds.] The Burrowing Owl, its Biology and Management: Including the Proceedings of the First International Symposium. Raptor Research Report No. 9.

Belthoff, J.R. and R.A. King. 2002. Nest-Site Characteristics of Burrowing Owls in the Snake River Birds of Prey National Conservation Area, Idaho, and Applications to Artificial Burrow Installation. Western North American Naturalist 62:112-119.

Belthoff, J.R. and B.W. Smith. 2003. Patterns of Artificial Burrow Occupancy and Reuse by Burrowing Owls in Idaho. Wildlife Society Bulletin 31:138–144.

Bendix, J.A. 2007. Passive Relocation of Burrowing Owls on a 57-Hecatre Site in Eastern Alameda County. Pages 141-145 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

Bent, A.C. 1938. Life Histories of North American Birds of Prey. Part 2. Smithsonian Institution, U.S. National Museum Bulletin 170. Washington, D.C.

Berner, M. 2015. Solano County Breeding Bird Atlas.

Berry, K.H. 1973. Birds of the Desert Tortoise Preserve. Unpublished list prepared for the Desert Tortoise Preserve Committee.

Biosearch Associates. 2014-2016. Biological Monitoring Reports (2013-2016), Vasco Winds Ecological Preserve, Contra Costa County, California. Prepared for California Rangeland Trust
.

Biosearch Environmental Consulting. 2018-2019. Annual Monitoring and Management Reports (2017-2018), Sparling Ranch Conservation Bank, San Benito and Santa Clara Counties, California.

Biosearch Wildlife Surveys (BWS). 1991. Mohave Ground Squirrel study at El Mirage Cooperative Management Area. Report prepared for the U.S. Bureau of Land Management, California Desert District Office, Riverside, CA. Contract #B950C10026.

BioSystems Analysis, Inc. 1993a. Biological Resource Surveys for the Proposed Tuscarora Natural Gas Pipeline Project. Prepared for Tuscarora Gas Transmission Company, Reno, NV. BioSystems Analysis Inc., Santa Cruz, CA. Unpublished Report.

BioSystems Analysis, Inc. 1993b. Reno-Alturas Transmission Project, 1993 Resource Reconnaissance Surveys. Prepared for Sierra Pacific Power Company, Reno, NV. BioSystems Analysis Inc., Santa Cruz, CA. Unpublished Report.

BioSystems Analysis, Inc. 1994. Special Status Terrestrial Wildlife Surveys, Tuscarora Pipeline Project. Prepared for Tuscarora Gas Transmission Company, Reno, NV. BioSystems Analysis Inc., Santa Cruz, CA. Unpublished Report.

BioSystems Analysis, Inc. 1995. Tuscarora Gas Transmission Project: Botanical and Wildlife Resource Survey. Prepared for Tuscarora Gas Transmission Company, Reno, NV. BioSystems Analysis Inc., Santa Cruz, CA. Unpublished Report.

Bird Banding Laboratory (BBL). 2023. Longevity Records of North American Birds. Version 2023.1. Eastern Ecological Science Center. US Geological Survey. Laurel, MD. From BBL Banding Portal, accessed 2/27/24.

Bloom Biological, Inc. 2009. Burrowing Owl Population Size in the Imperial Valley, California: Surveys and Sampling Methodologies for Estimation. Final report to the Imperial Irrigation District, Imperial, California, April 15, 2009.

Bloom, P.H. 2023. Extirpation of Orange County, California, Breeding Burrowing Owl Population: The Convergence of Philopatry, Habitat Fragmentation, and Allee Effects. Journal of Raptor Research 57 (3): 475–484.

Boatman, N.D., Brickle, N.W., Hart, J.D., Milsom, T.P., Morris, A.J., Murray, A.W.A., Murray, K.A., and Robertson, P.A. 2004. Evidence for the Indirect Effects of Pesticides on Farmland Birds. Ibis (London, England), 146(s2), 131–143. https://doi.org/10.1111/j.1474-919X.2004.00347.x

Bock, C.E., V.A. Saab, T.D. Rich, and D.S. Dobkin. 1992. Effects of Livestock Grazing on Neotropical Migratory Landbirds in Western North America. *In* status and management of neotropical migratory birds. USDA, USFS - General Technical Report RM-229.

Boersma, P.D., P. Kareiva, W.F. Fagan, J.A. Clark and J.M. Hoekstra. 2001. How Good are Endangered Species Recovery Plans? BioScience 51: 643–649.

Bolander, G.L. and B.D. Parmeter. 1978. Birds of Sonoma County, California: An Annotated Checklist and Birding Gazetteer. Grape Press Printing, Napa, California.

Bond, R.M. 1939. Observations on Raptorial Birds in the Lava Beds-Tule Lake Region of Northern California. Condor. Volume XLI, Number 2, March-April 1939, p. 55.

Bond, R.M. 1942. Food of the Burrowing Owl in Western Nevada. Condor 44: 183.

Botelho, E.S. 1996. Behavioral Ecology and Parental Care of Breeding Western Burrowing Owls (*Speotyto cunicularia hypugaea*) in Southern New Mexico, USA. Dissertation, New Mexico State University, Las Cruces, New Mexico.

Botelho, E.S. and P.C. Arrowood. 1996. Nesting Success of Western Burrowing Owls in Natural and Human-Altered Environments. Pages 61-68 *in* Raptors in Human Landscapes. Academic Press Inc.

Botelho, E.S. and P.C. Arrowood. 1998. The Effect of Burrow Site Use on the Reproductive Success of a Partially Migratory Population of Western Burrowing Owls (*Speotyto cunicularia hypugaea*). Journal of Raptor Research 32:233-240.

Bowman, R.I. 1961. Late Spring Observations on Birds of South Farallon Island, California. Condor. Volume 63, Number 5, September-October 1961, p. 414.

Brattstrom, B.H. 1995. Wildlife Mortalities in PVC Claim Posts. Wildlife Society Bulletin 23(4): 765-766.

Breninger, G.F. 1904. San Clemente Island and Its Birds. Auk. Vol. XXI, No. 2, April 1904, p. 222.

Brenkle, J.F. 1936. The Migration of the Western Burrowing Owl. Bird Banding 7: 66-68.

Breon, C. 2009. Losing What We Thought We Gained: An Investigation into Mitigation Monitoring. Prepared for the Santa Clara Valley Audubon Society.

Breon, C. 2015. Issues with Mitigation Banks – How to Make Them Work for Burrowing Owls. California Burrowing Owl Consortium Conference, 2015.

Brown, N.L. and R.W. Mannan. 2002. Status of Burrowing Owls in Arizona. Final Report. Prepared for the Arizona Game and Fish Department.

Bryant, W.E. 1888. Proceedings of the California Academy of Sciences, 2nd Series, Volume I, 1888, p. 45.

Buchanan, J.T. 1996. A Spatial Analysis of the Burrowing Owl (*Speotyto cunicularia hypugaea*) Population in Santa Clara County, California Using A Geographic Information System. M.S. Thesis. Department of Environmental Studies, San Jose State University.

Buchanan, J.T. 1997. A Spatial Analysis of the Burrowing Owl (*Speotyto cunicularia*) Population in Santa Clara County, California Using A Geographic Information System. Pages 90-96 *in* J.R. Duncan, D.H. Johnson, and T.H. Nichols (editors). Biology and Conservation of Owls of the Northern Hemisphere. USDA Forest Service, General Technical Report NC-190. North Central Forest Experiment Station, St. Paul, Minnesota.

Burkett, E.E. and B.S. Johnson. 2007. Development of A Conservation Strategy for Burrowing Owls in California. Pages 165-168 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

Burridge, B. 1995. Sonoma County Breeding Bird Atlas. Madrone Audubon Society.

Burrowing Owl Preservation Society (BOPS). 2015. California Burrowing Owl Consortium Conference Presentation Summaries. October 24, 2015.

Burrowing Owl Preservation Society (BOPS). 2023. Yolo County Burrowing Owl Survey 2023.

Butts, K.O. 1973.Observations on the Ecology of Burrowing Owls in Western Oklahoma. A Preliminary Report. Proceedings of the Oklahoma Academy of Science 51: 66-74.

California Academy of Sciences (CAS). 2002a. California Academy of Sciences Ornithology Holdings.

California Academy of Sciences (CAS). 2002b. California Academy of Sciences Photo Collection. www.calacademy.org

California Burrowing Owl Consortium (CBOC). 1997. Burrowing Owl Survey Protocol and Mitigation Guidelines. Appendix B. Pages 171-177 *in* Lincer, J.L. and K. Steenhof (editors). 1997. The Burrowing Owl, its Biology and Management; Including the Proceedings of the First International Burrowing Owl Symposium. Raptor Research Report Number 9.

California Climate and Agriculture Network (CCAN). 2023. Farmland Conservation. https://calclimateag.org/solutions/farmlandconservation/

California Department of Conservation (CDOC). 1994. California Farmland Conversion Report 1990-1992. Farmland Mapping and Monitoring Program, Division of Land Resource Protection.

California Department of Conservation (CDOC). 2000. California Farmland Conversion Report 1996-1998. Farmland Mapping and Monitoring Program, Division of Land Resource Protection.

California Department of Corrections (CDC). 1999. Statewide Electrified Fence Project Habitat Conservation Plan. Prepared by EDAW.

California Department of Finance (CDF). 2020a. Historical Census Populations of Counties and Incorporated Cities in California, 1850–2020. https://dof.ca.gov/reports/demographic-reports/

California Department of Finance (CDF). 2020b. County Population Projections (2020-2060). https://dof.ca.gov/forecasting/demographics/projections/

California Department of Fish and Game (CDFG). 1975. Arroyo de las Coches and Silver Creek Stream Surveys. From CDFG files, Yountville, California.

California Department of Fish and Game (CDFG). 1990. Wildlife Habitat Relationships System Database.

California Department of Fish and Game (CDFG). 1994. Burrowing Owl Draft Mitigation Guidelines. Unpublished report.

California Department of Fish and Game (CDFG). 1995. Staff Report on Burrowing Owl Mitigation. Unpublished report. 8 pp.

California Department of Fish and Game (CDFG). 2002a. Information from CDFG files on the burrowing owl provided by David Kiene, Office of the General Counsel, CDFG.

California Department of Fish and Game (CDFG). 2002b. Conservation and Mitigation Banking. Habitat Conservation Planning Branch.

California Department of Fish and Game (CDFG). 2003a. Petition Evaluation for Western Burrowing Owl (*Athene cunicularia hypugaea*). October 2003

California Department of Fish and Game (CDFG). 2003b. Petition Evaluation for Western Burrowing Owl (*Athene cunicularia hypugaea*). August 2003

California Department of Fish and Game (CDFG). 2008. Monitoring Burrowing Owl Populations at Yolo Bypass Wildlife Area and Wildhorse Golfcourse, Yolo County, California, 2008. Report by Zach Smith and Chris Stermer, CDFG Sacramento Office.

California Department of Fish and Game (CDFG). 2012. Staff Report on Burrowing Owl Mitigation. State of California, Natural Resources Agency, Department of Fish and Game. Replaced the 1995 Staff Report on Burrowing Owl Mitigation.

California Department of Fish and Wildlife (CDFW). 2015-2020. Topaz Solar Farm Conservation Lands Habitat Mitigation and Monitoring Plan, 2014-2019 Annual Reports, North Carrizo Ecological Reserve.

California Department of Fish and Wildlife (CDFW). 2018. Alkali Sink Conservation Bank Annual Report 2017-2018.

California Department of Fish and Wildlife (CDFW). 2019. Public Draft Land Management Plan for the Carrizo Plains Ecological Reserve. Prepared by Jodi McGraw Consulting for California Department of Fish and Wildlife.

California Department of Fish and Wildlife (CDFW). 2022a. May 20, 2022 comment letter on The Greentree Project (File No. 16-289), Draft Environmental Impact Report, SCH No. 2019049003, City of Vacaville, Solano County.

California Department of Fish and Wildlife (CDFW). 2022b. March 2022 Status Review of Western Joshua Tree (*Yucca brevifolia*).

California Department of Fish and Wildlife (CDFW). 2023a. Conservation and Mitigation Banks Established in California by CDFW. https://wildlife.ca.gov/Conservation/Planning/Banking/Approved-Banks

California Department of Fish and Wildlife (CDFW). 2023b. California Conservation and Mitigation Banking. Report to the Legislature.

California Department of Fish and Wildlife (CDFW). 2023c. Conservation Plans by Species. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=108719&inline

California Department of Fish and Wildlife (CDFW). 2024. Status Review for Mojave Desert Tortoise (*Gopherus agassizii*). Report to the California Fish and Game Commission.

California Department of Pesticide Regulation (CDPR). 2001. 1990-1999 Pesticide Use Reporting. www.cdpr.ca.gov

California Department of Pesticide Regulation (CDPR). 2023a. Pesticide Use Reporting 2019-2021 Summary Data. ww.cdpr.ca.gov

California Department of Pesticide Regulation (CDPR). 2023b. Chlorpyrifos, Active Ingredients database output. https://apps.cdpr.ca.gov/cgi-bin/label/labq.pl?p_chem=253&activeonly=on (last visited December 2023)

California Energy Commission (CEC), California Department of Fish and Wildlife, U.S. Bureau of Land Management, and U.S. Fish and Wildlife Service. 2016. California Desert Biological Conservation Framework.

California Environmental Resources Evaluation System (CERES). 2002. The Catalogue of Conservation Banks in California. ceres.ca.gov/topic/banking/catalogue_index.html

California Natural Diversity Database (CNDDB). 2001. CNDDB Burrowing Owl Records as of 2001. California Department of Fish and Game.

California State University, Chico (CSUC). 2001. Collection data provided by Jay Bogiatto, Department of Biology, California State University, Chico.

California State University, Long Beach (CSULB). 2001. Ornithology collection data provided by Charlie Collins, California State University, Long Beach.

Campbell, K. 1999. Burrowing Owl, *Athene cunicularia*. *In* West Mojave Habitat Conservation Plan Species Accounts: Birds. U.S. Bureau of Land Management, California Desert District.

Canfield, C.S. 1869. Habits of the Burrowing Owl of California. American Naturalist, Volume 2, Issue 11: 583-586.

Captanian, N., M.G. Hawkins, C. Fiorello, M. Thurber and W. K. Reisen. 2017. Low Prevalence of West Nile Virus Antibodies in Select Northern California Owl Species (2007–2014). Journal of Zoo and Wildlife Medicine 48(4).

Carnegie Museum of Natural History (CMNH). 2002. Collection data provided by Robin Panza, Section of Birds, Carnegie Museum of Natural History, Pittsburgh, Pennsylvania.

Carter, F. 1937. Minutes of Cooper Club Meetings. Condor. Volume XXXIX, Number 3, May-June 1937, p. 136.

Catalina Island Conservancy (CIC). 2002. Island Ecology. www.catalinaconservancy.org

Catlin, D.H. 2004. Factors Affecting Within Season and Between Season Breeding Dispersal of Burrowing Owls in California. M.S. Thesis, Oregon State University, Corvallis, Oregon, USA.

Catlin, D.H. and D.K. Rosenberg. 2006. Nest Destruction Associated with Mortality and Dispersal of Burrowing Owls in the Imperial Valley, California. The Southwestern Naturalist 51(3): 406-409.

Catlin, D.H. and D.K. Rosenberg. 2014. Association of Sex, Fledging Date, and Sibling Relationships with Post-Fledging Movements of Burrowing Owls in a Nonmigratory Population in the Imperial Valley, California. Journal of Raptor Research 48(2):106–117.

Center for Biological Diversity (CBD), Santa Clara Valley Audubon Society, Defenders of Wildlife, San Bernardino Valley Audubon Society, California State Park Rangers Association, and Tri-County Conservation League. 2003. Petition to List the California Population of the Western Burrowing Owl (*Athene cunicularia hypugaea*) as an Endangered or Threatened Species Under the California Endangered Species Act. Submitted to State of California Fish and Game Commission.

Center for Environmental Management of Military Lands (CEMML). 2018. Parks Reserve Forces Training Area 2017 Annual Burrowing Owl Survey Report, Alameda and Contra Costa Counties, California. March 2018.

Center for Natural Lands Management (CNLM). 2016. Revised Property Analysis Record for Perpetual Stewardship Responsibilities on the ~ 441-acre Lost Hills Preserve, Kern County, California (PN280).

Center for Natural Lands Management (CNLM). 2023. Our Preserves. www.cnlm.org

Centers for Disease Control and Prevention (CDC). 2002. West Nile Virus; West Nile Virus and Birds. U.S. Dept. of Health and Human Services, Division of Vector-Borne Infectious Diseases. www.cdc.gov/ncidod/dvbid/westnile/qa/wnv_birds.htm

CH2MHILL. 2001. Draft Habitat Conservation Plan, Imperial Irrigation District Water Conservation and Transfer Project.

Chan, F. 2001. Vegetation Management Plan for the Wildhorse Ag Buffer. Unpublished consultant report for the City of Davis Open Space Program.

Chandler, S., Tietz, J., Bradley, R. and L. Trulio. 2016. Burrowing Owl Diet at a Migratory Stopover Site and Wintering Ground on Southeast Farallon Island, California. Journal of Raptor Research. 50. 391-403. 10.3356/JRR-16-00006.1.

Chicago Academy of Sciences (CHAS). 2001. Collection data provided by Steven Sullivan, Collections Manager, Chicago Academy of Sciences, Chicago. Illinois.

Chromczak, D. 2002. South San Francisco Bay Burrowing Owl Demography Study: Annual Progress Reports, 1998-2001. Unpublished data provided by personal communication, 2002.

City of Sacramento, Sutter County, and Natomas Basin Conservancy. 2003. Final Natomas Basin Habitat Conservation Plan.

Clark, R.J., J.L. Lincer, and J.S. Clark. 1994. A Bibliography on the Burrowing Owl (*Athene cunicularia*). Department of Biology, York College of Pennsylvania, York, PA. 51 pp.

Clark, R.J., D.G. Smith, and L.H. Kelso. 1978. Working Bibliography of Owls of the World. National Wildlife Federation Scientific Technical Series, No. 1. Washington, D.C.

Clayton, K.M. and J.K. Schmutz. 1997. Burrowing Owl (*Speotyto cunicularia*) Survival in Prairie Canada. Pages 107-110 *in* Duncan, J.R., D.H. Johnson and T.H. Nicholls (editors). Biology and Conservation of Owls of the Northern Hemisphere: 2nd International Symposium, Winnipeg, Manitoba, Canada. General Technical Report NC-190. USDA Forest Service, North Central Forest Experimental Station, St. Paul, Minnesota.

Clemings, R. 1996. Mirage: The False Promise of Desert Agriculture. Sierra Club Books, San Francisco, California.

Coachella Valley Association of Governments (CVAG). 2001. Coachella Valley Multiple Species Habitat Conservation Plan.

Coachella Valley Conservation Commission (CVCC). 2007. Final Recirculated Coachella Valley Multiple Species Habitat Conservation Plan and Natural Community Conservation Plan, September 2007. https://cvmshcp.org/plan-documents/

Collins, C.T. 1979. The Ecology and Conservation of Burrowing Owls. Pages 6-17 *in* Scheaffer, P.P. and S.M. Ehlers (editors), Proceedings of the National Audubon Society Symposium of Owls of the West, Their Ecology and Conservation. National Audubon Society Western Education Center, Tiburon, CA.

Collins, C.T. and R.E. Landry. 1977. Artificial Nest Burrows for Burrowing Owls. North American Bird Bander 2:151-154.

Conard, C. 2023. Burrowing Owls Over the Last 25 Years in Sacramento County: An Unsteady Decline. Sacramento Wastewater Treatment Plant Bufferlands. 2023 Burrowing Owl Symposium, February 6-7, 2023, Riverside, CA. The Wildlife Society. https://sites.google.com/tws-west.org/2023buowsymposium/abstracts?authuser=0

Conard, C. 2024. Precipitous Decline of Burrowing Owls in the Sacramento Area. Central Valley Birds. In prep. for Vol 27 (2024).

Conroy, R.M. and D.L. Chesemore. 1987. Food Habits of the Burrowing Owl (*Athene cunicularia*) in Fresno County, California. Pp. 105-110 *in* D.F. Williams, S. Byrne, and T.A. Rado (editors). Endangered and Sensitive Species of the San Joaquin Valley, California: Their Biology, Management, and Conservation. California Energy Commission, Sacramento, California.

Conway, C.J. 2018. Spatial and Temporal Patterns in Population Trends and Burrow Usage of Burrowing Owls in North America. Journal of Raptor Research 52:129–142.

Corvus Ecological Consulting. 2015. Gabrych (BRP) Study Area Survey Results, General Habitat and Sensitive Species Suitability Assessment.

Corvus Ecological Consulting. 2017. Black Mountain Conservation Bank Internal Summary/Survey Results: General Habitat and Sensitive Species Suitability Assessment.

Corvus Ecological Consulting. 2018. Alta Oak Creek Mojave Mitigation Conservation Areas (AOCMCA) 2017 Annual Report.

Coulombe, H.N. 1971. Behavior and Population Ecology of the Burrowing Owl, *Speotyto cunicularia*, in the Imperial Valley of California. Condor. Volume 73, Number 2, Summer 1971, pp. 162-176.

County of Sacramento, City of Rancho Cordova, City of Galt, Sacramento County Water Agency, Sacramento Regional County Sanitation District, and the Southeast Connector Joint Powers Authority. 2018. Final South Sacramento Habitat Conservation Plan. January 2018. Sacramento, CA.

Cribbs and Associates. 2011-2023. Metro Air Park Habitat Conservation Plan Implementation 2010-2022 Annual Reports. Prepared for Metro Air Park Property Owners Association.

Crowe, D.E. and K.M. Longshore. 2010. Estimates of Density, Detection Probability, and Factors Influencing Detection of Burrowing Owls in the Mojave Desert. Journal of Raptor Research 44(1) : 1-11.

Cull, R.I. and F. Hall. 2007. Status of Burrowing Owls in Northeastern California. Pages 42-51 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

Daggett, F.S. 1904. Annual Outing Meeting of the Southern Division, 1903. Condor. Volume VI, Number 1, January-February 1904, p. 22.

Davies, K. 2015. Burrowing Owl Habitat Management at San Jose-Santa Clara Regional Wastewater Facility. California Burrowing Owl Consortium Conference, October, 2015.

Dawson, W.L. 1911. Another Fortnight on the Farallones. Condor. Volume XIII, November 1911, p. 180.

Dawson, W.L. 1923. The Birds of California. Volume Two. South Moulton Company, San Diego, Los Angeles, San Francisco.

Dechant, J.A., M.L. Sondreal, D.H. Johnson, L.D. Igl, C.M. Goldade, P.A. Rabie, and B.R. Euliss. 1999 (revised 2001). Effects of Management Practices on Grassland Birds: Burrowing Owl. Northern Prairie Wildlife Research Center, Jamestown, North Dakota.

Delaware Museum of Natural History (DMNH). 2001. Collection data provided by Gene Hess, Collection Manager – Birds. Delaware Museum of Natural History, Wilmington, Delaware.

Delevoryas, P. 1997. Relocation of Burrowing Owls During Courtship Period. Pages 138-144 *in* Lincer, J.L. and K. Steenhof (editors). 1997. The Burrowing Owl, Its Biology and Management; Including the Proceedings of the First International Burrowing Owl Symposium. Raptor Research Report Number 9.

DeMay, I. 1942. An Avifauna from Indian Kitchen Middens at Buena Vista Lake, California. Condor. Volume 44, Number 5, September-October 1942, pp. 228-230.

DeSante, D.F. and D.G. Ainley. 1980. The Avifauna of the South Farallon Islands, California. Studies in Avian Biology No. 4. Cooper Ornithological Society.

DeSante, D.F. and E. Ruhlen. 1995. A Census of Burrowing Owls in California, 1991-1993. Institute for Bird Populations. Point Reyes Station, CA.

DeSante, D.F., E.D. Ruhlen, S.L. Adamany, K.M. Burton, and S. Amin. 1997. A Census of Burrowing Owls in Central California in 1991. Pages 38-48 *in* Lincer, J.L. and K. Steenhof (editors). 1997. The Burrowing Owl, Its Biology and Management; Including the Proceedings of the First International Burrowing Owl Symposium. Raptor Research Report Number 9.

DeSante, D.F., E. Ruhlen, and D.K. Rosenberg. 1996. The Distribution and Relative Abundance of Burrowing Owls in California: Evidence for A Declining Population. Institute for Bird Populations. Point Reyes Station, California.

DeSante, D.F., E.D. Ruhlen, and D.K. Rosenberg. 2004. Density and Abundance of Burrowing Owls in the Agricultural Matrix of the Imperial Valley, California. Studies in Avian Biology No. 27, pp. 116-119.

DeSante, D.F., E.D. Ruhlen, and D.K. Rosenberg. 2007a. Density and Abundance of Burrowing Owls in the Agricultural Matrix of the Imperial Valley, California. Pages 103-108 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

DeSante, D.F., E.D. Ruhlen, and R. Scalf. 2007b. The Distribution and Relative Abundance of Burrowing Owls in California During 1991-1993: Evidence for a Declining Population and Thoughts on its Conservation. Pages 1-41 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

DeSmet, K. 1997. Return Rates and Movements of Burrowing Owls in Southwestern Manitoba (abstract). *In* Second International Symposium: Biology and Conservation of Owls of the Northern Hemisphere. February 5-9 1997; Winnipeg, Manitoba.

Desmond, M.J. 1991. Ecological Aspects of Burrowing Owl Nesting Strategies in the Nebraska Panhandle. M.S. thesis. University of Nebraska, Lincoln, NB. 114 pp.

Desmond, M.J., J.A. Savidge and K M. Eskridge. 2000. Correlations Between Burrowing Owl and Prairie Dog Declines: A 7-Year Analysis. Journal of Wildlife Management 64: 1067-1075.

Desmond, M.J., T.J. Parsons, T.O. Powers and J.A. Savidge. 2001. An Initial Examination Of Mitochondrial DNA Structure in Burrowing Owl Populations. Journal of Raptor Research, 35(4), 274–281.

Desmond, M.J., D. Doublet, D.H. Johnson and F.A. Gebreselassie. 2023. Effects of Group Translocation on Burrowing Owl Survival, Fidelity and Nesting in Arizona. Department of Fish, Wildlife & Conservation Ecology, New Mexico State University and Global Owl Project. 2023 Burrowing Owl Symposium, February 6-7, 2023, Riverside, CA. The Wildlife Society. https://sites.google.com/tws-west.org/2023buowsymposium/abstracts?authuser=0

Diamond, J. 1969. Avifauna Equilibria and Species Turnover Rates on the Channel Islands of California. Proceedings of the National Academy of Sciences 64: 57-63.

Dixon, J. 1906. Land Birds of San Onofre, California. Condor. Volume VII, Number 4, July-August 1906, p. 96.

Dixon, J.S. 1933. Field Notes. Manuscript. Cited in USNPS, Check-List of the Birds of the National Parks. Department of the Interior, Washington, D.C. 1937.

Doublet, D. 2020. Effects of Mitigation Translocation on Burrowing Owl Survival, Fidelity, and Reproduction in Arizona. M.S., New Mexico State University.

Doublet, D.D., F. Abadi, D.H. Johnson, and M.J. Desmond. 2022. Survival and Fidelity of Translocated and Resident Burrowing Owls in Arizona. Journal of Wildlife Management.

Drost, C.A. and R.C. McCluskey. 1992. Extirpation of Alternative Prey During A Small Rodent Crash. Oecologia 92: 301-304.

Drury, A. 1953. Point Lobos Reserve State Park, California. Interpretation of a Primitive Landscape. State of California, Division of Beaches and Parks, Department of Natural Resources. Sacramento, California.

Dudek and Associates. 2002. Draft Multi-Species Habitat Conservation Plan, Volume IV, Draft EIR/EIS. Western Riverside County MSHCP. Prepared for the County of Riverside and U.S. Fish and Wildlife Service.

Dusek, R.J., W.M. Iko and E.K. Hofmeister. 2010. Occurrence of West Nile Virus Infection in Raptors at the Salton Sea, California. Journal of Wildlife Diseases, 46(3), pp. 889–895.

Dyer, O. 1988. Reintroductions of Burrowing Owls (*Athene cunicularia*) to the South Okanagan Valley, British Columbia (1983-1988). Report to the Ministry of Environment, British Columbia. 7 pp.

Earhart, C.M. and N.K. Johnson. 1970. Size Dimorphism and Food Habits of North American Owls. Condor 72: 251-264.

East Bay Municipal Utility District (EBMUD). 2001. Raptor Surveys.

East Contra Costa County Habitat Conservancy (ECCCHC). 2022. East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan Annual Report 2022. https://www.cocohcp.org/ArchiveCenter/ViewFile/Item/71

ECORP Consulting. 2017. Winters Highland Survey Report. May 24, 2017

ECorp Consulting. 2018-2022. 2018-2022 Annual Reports. Bryte Ranch Conservation Bank, Sacramento, California.

ECorp Consulting. 2023. 2023 Annual Report. Bryte Ranch Conservation Bank, Sacramento, California.

Edwards Air Force Base (EAFB). 2001. Integrated Natural Resources Management Plan for Edwards Air Force Base, California. Environmental Management Office.

Emerson, W.O. 1884. Californian Notes. Ornithologist and Oologist. Vol. IX, No. 12, December 1884, pp. 143-144.

Emlen, J.M. and E.K. Pilkitch. 1989. Animal Population Dynamics: Identification of Critical Components. Ecol. Model. 44: 253-273.

England, A.S., M.K. Sogge, and C. Van Riper III. 1988. Avian Species of Management Concern: Mill and Deer Creek Drainages, Tehama County, California. Cooperative National Park Resources Study Unit. Technical Report No. 33. Final Report to National Park Service, October 1988.

Errington, P.L. and L.J. Bennett. 1935. Food Habits of Burrowing Owls in Northwestern Iowa. Wilson Bulletin 47: 125-128.

Estep, J.A. 1989. Avian Mortality At Large Wind Energy Facilities in California: Identification of A Problem. California Energy Commission staff report.

Evans, D.L. 1982. Status Report on Twelve Raptors. U.S. Department of the Interior, Fish and Wildlife Service. Scientific Report No. 238. pp. 13-17.

Evermann, B.W. 1886. A List of the Birds Observed in Ventura County, California. Auk. Vol. III, No. 1, January 1886, p. 93.

Faanes, C.A. and G.R. Lingle. 1995. Breeding Birds of the Platte River Valley of Nebraska. Northern Prairie Wildlife Research Center, Jamestown, ND.

Feeney, L.R. 1997. Burrowing Owl Site Tenacity Associated with Relocation Efforts. Pages 132-137 *in* Lincer, J. L. and K. Steenhof (editors). 1997. The Burrowing Owl, Its Biology and Management; Including the Proceedings of the First International Burrowing Owl Symposium. Raptor Research Report Number 9.

Field Museum of Natural History (FMNH). 2001. Collection data provided by David Willard, Collections Manager – Birds. Field Museum of Natural History, Chicago, Illinois.

Fisher, A.K. 1893. Report on the Ornithology of the Death Valley Expedition of 1891, Comprising Notes of the Birds Observed in Southern California, Southern Nevada, and Parts of Utah. North American Fauna No. 7: 7-158.

Fisher, W.K. 1900. A list of Birds Observed on Mt. St. Helena, California. Condor. Volume 2, Number 6, November-December 1900, p. 136.

Fisher, W.K.1904. List of Birds of Santa Clara County and Santa Cruz Mountains, Exclusive of Water Birds. Handbook of Birds of the Western United States, pp. 1i-1iv. (F.M. Bailey, editor). Houghton, Mifflin and Company.

Fowler, F.H. 1931. Studies of Food and Growth of the Prairie Falcon. Condor. Volume XXXIII, Number 5, September-October 1931, pp. 193-201.

Fund for Animals (FFA). 2002. Comments on Draft Environmental Assessment for Renewal of a Migratory Bird Treaty Act Permit to Take Migratory Birds on Anacapa Island, California.

Garcelon, D.K. and G.W. Roemer. 1990. The Reintroduction of Bald Eagles on Santa Catalina Island, California. *In* Bryant, P.B. and J. Remington (editors). Endangered Wildlife and Habitats in Southern California. Memoirs of the Natural History Foundation of Orange County. A collection of occasional papers published by the Natural History Foundation of Orange County. Volume 3.

Garrett, K. and J. Dunn. 1981. Birds of Southern California. Status and Distribution. Los Angeles Audubon Society.

Gervais, J.A. 2002. Evaluating Space Use and Pesticide Exposure Risk for Burrowing Owls in an Agricultural Environment. Ph.D. Dissertation, Oregon State University, Corvallis, Oregon.

Gervais, J.A. and R.G. Anthony. 2003. Interactions of Chronic Organochlorine Contaminants and Environmental Variability in the Demographics of a Population of Burrowing Owls. Ecological Applications 13(5): 1250-1262.

Gervais, J.A. and D.H. Catlin. 2004. Temporal Patterns of DDE in Burrowing Owl Eggs from the Imperial Valley, California. The Southwestern Naturalist 49(4): 509-512.

Gervais, J.A. and D.K. Rosenberg. 1999. Western Burrowing Owls in California Produce Second Brood of Chicks. Wilson Bulletin 111(4): 569-571.

Gervais, J.A. and D.K. Rosenberg. 2003. Draft Bird Species of Special Concern Species Account. Prepared for California Department of Fish and Game under contract with Point Reyes Bird Observatory.

Gervais, J.A., D.K. Rosenberg, D.M. Fry and L.A. Trulio. 1997. Evaluation of Contaminant Residues in Burrowing Owl Populations from Central and Southern California. Institute for Bird Populations. Point Reyes Station, California. Publication No. 79.

Gervais, J.A., D.K. Rosenberg, D.M. Fry, L.A. Trulio and K.K. Strum. 2000. Burrowing Owls and Agricultural Pesticides: Evaluation of Residues and Risks for Three Populations in California, USA. Environmental Toxicology and Chemistry 19: 337-343.

Gervais, J.A., D.K. Rosenberg and R.G. Anthony. 2003. Space Use and Pesticide Exposure Risk of Male Burrowing Owls in an Agricultural Landscape. Journal of Wildlife Management 67(1): 156-165.

Gervais, J.A., C.M. Hunter and R.G. Anthony. 2006. Interactive Effects of Prey and p,p'-DDE on Burrowing Owl Population Dynamics. Ecological Applications 16(2): 666–677.

Gervais, J.A., D.K. Rosenberg and L.A. Comrack. 2008. Species Accounts: Burrowing Owl (*Athene cunicularia*). Pages 218-226 *in* Shuford, W.D. and T. Gardali (editors). 2008. California Bird Species of Special Concern: A Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Immediate Conservation Concern in California. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento.

Gilman, M.F. 1934. Notes on Birds in Death Valley. Condor. Volume XXXVII, Number 5, September-October 1934, p. 241.

Gilmer, D.S., M.R. Miller, R.D. Bauer, and J.R. LeDonne. 1982. California's Central Valley Wintering Waterfowl: Concerns and Challenges. Transactions of the North American Wildlife Natural Resources Conference 47: 441-452.

Gleason, R.L. and T.H. Craig. 1979. Food Habits of Burrowing Owls in Southeastern Idaho. Great Basin Naturalist 39: 274-276.

Gleason, R.S. and D R. Johnson. 1985. Factors Influencing Nesting Success of Burrowing Owls in Southeastern Idaho. Great Basin Naturalist 45: 81-84.

Glover, F.A. 1953. Summer Foods of the Burrowing Owl. Condor 55: 275.

Glover, S. 2009. Breeding Bird Atlas of Contra Costa County. Mount Diablo Audubon Society, Walnut Creek, CA.

Goldman, E.A. 1908. Summer Birds of the Tulare Lake Region. Condor. Volume X, Number 5, September-October 1908, p. 263.

Gomez, E.A., H.L. Prestridge and J.A. Smith. 2023. Anthropogenic Threats to Owls: Insights from Rehabilitation Admittance Data and Rodenticide Screening in Texas. Plos One 18.8 e0289228. https://doi.org/10.1371/journal.pone.0289228

Gordon, B.L. 1974. Monterey Bay Area: Natural History and Cultural Imprints. Department of Geography, San Francisco State University. Boxwood Press, Pacific Grove, California.

Gordon, B.L. 1996. Monterey Bay Area: Natural History and Cultural Imprints. 3rd edition. Department of Geography, San Francisco State University. Boxwood Press, Pacific Grove, California.

Gorman, L.R., D.K. Rosenberg, N.A. Ronan, K.L. Haley, J.A. Gervais and V. Franke. 2003. Estimation of Reproductive Rates of Burrowing Owls. Journal of Wildlife Management 67(3):493–500.

Grant, R.A. 1965. The Burrowing Owl in Minnesota. Loon 37: 2-17. https://moumn.org/loon/view_frame.php?page=2&year=1965

Green, G.A. 1983. Ecology of Breeding Burrowing Owls in the Columbia Basin, Oregon. M.S. Thesis. Oregon State University, Corvallis, Oregon.

Green, G.A. and R.G. Anthony. 1989. Nesting Success and Habitat Relationships of Burrowing Owls in the Columbia Basin, Oregon. Condor 91: 347-354.

Greenbelt Alliance. 2023. HomeGrown: Tools for Local Farms and Ranches. https://www.greenbelt.org/homegrown/

Griggs, F.T. 1992. The Remaining Biological Diversity of the San Joaquin Valley, California. Pp. 11-16 *in* Williams, D., F.S. Byrne, and T.A. Rado (editors). Endangered and Sensitive Species of the San Joaquin Valley, California: Their Biology, Management, and Conservation. California Energy Commission, Sacramento, California.

Grinnell, H.W. 1936. Minutes of Cooper Club Meeting. Condor. Volume XXXVIII, Number 1, January-February 1936, p. 48.

Grinnell, J. 1898. Land Birds Observed in Mid-Winter on Santa Catalina Island, California. Auk. Vol. XV, No. 3, July 1898, p. 234.

Grinnell, J. 1914. An Account of the Mammals and Birds of the Lower Colorado River Valley. University of California Publications in Zoology; v. 12, no. 4, p. 51-294.

Grinnell, J. 1915. A Distributional List of the Birds of California. Pacific Coast Avifauna Number 11. Cooper Ornithological Club.

Grinnell, J. 1923. Observations Upon the Bird Life of Death Valley. Proceedings of the California Academy of Sciences; v. 13, no. 5.

Grinnell, J. and A.H. Miller. 1944. The Distribution of the Birds of California. Pacific Coast Avifauna, no.27. Cooper Ornithological Club, Berkeley, California.

Grinnell, J. and H.S. Swarth. 1913. An Account of the Birds and Mammals of the San Jacinto Area of Southern California with Remarks Upon the Behavior of Geographic Races on the Margins of their Habitats. University of California Publications in Zoology; v. 10, no. 10. University of California Press, Berkeley, California.

Grinnell, J. and M.W. Wythe. 1927.Directory to the Bird-Life of the San Francisco Bay Region. Pacific Coast Avifauna Number 18. Cooper Ornithological Club.

Gross, L. 2019. Water Savings May Hurt Burrowing Owls. High Country News. January 21, 2019.

Haley, K.A. 2002. The Role of Food Limitation and Predation on Reproductive Success of Burrowing Owls in Southern California. M.S. Thesis, Oregon State University, Corvallis, Oregon.

Hall, D.B and C.J. Conway. 2021. Western Burrowing Owl Satellite-Tracking Study. DOE Mission Support and Test Services, USGS, and University of Idaho. DOE/NV/03624—0931

Hallmann, C.A., Foppen, R.P.B., van Turnhout, C.A.M., de Kroon, H., and Jongejans, E. 2004. Declines in Insectivorous Birds are Associated with High Neonicotinoid Concentrations. Nature, 511(7509), 341–343. https://doi.org/10.1038/nature13531

Hamilton, W.J. 1941. A Note on the Food of the Western Burrowing Owl. Condor 3: 74.

Hansen, H.E. and W.A. Squires. 1917. A List of the Birds Breeding in San Francisco County, California. Condor. Volume XIX, Number 2, March-April 1917, p. 60.

Harman, L.M. and J.H. Barclay. 2007. A Summary of California Burrowing Owl Banding Records. Pages 123-131 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

Harris, R.D. 1987. Burrowing Owl Relocation, Harbor Bay, Alameda, California. Larry Seeman Associates, Inc., Berkeley, California.

Hartzell, L.B. 1888. Nesting of the Burrowing Owl. Ornithologist and Oologist. Vol. XIII, No. 6, June 1888, pp. 85-86.

Haug, E.A. 1985. Observations on the Breeding Ecology of Burrowing Owls in Saskatchewan. M.S. Thesis, University of Saskatchewan, Saskatoon.

Haug, E.A., B.A. Millsap, and M.S. Martell. 1993. The Burrowing Owl (*Speotyto cunicularia*). *In* Poole, A. and F. Gill (editors). The Birds of North America, No. 61. Philadelphia: The Academy of Natural Sciences; Washington, D.C. The American Ornithologists' Union.

Haug, E.A. and L.W. Oliphant. 1987. Breeding Biology of Burrowing Owls in Saskatchewan. Pp. 269-271 *in* Holroyd, G.L., W.B. McGillivray, P.H.R. Stepney, D.M. Ealey, G.C. Trottier, and K.E. Eberhart (editors). Endangered Species in the Prairie Provinces. Provincial Museum of Alberta Occasional Paper, No. 9.

Haug, E.A. and L.W. Oliphant. 1990. Movements, Activity Patterns, and Habitat Use of Burrowing Owls in Saskatchewan. Journal of Wildlife Management 54: 27-35.

Henderson Ecology & Planning (HEP). 2004. Western Burrowing Owl Species Account and Conservation Strategy. Prepared for Sacramento County. Third Draft South Sacramento HCP.

Henderson, L.A. and L.A. Trulio. 2019. Can California Ground Squirrels Reduce Predation Risk to Burrowing Owls? Journal of Raptor Research 53(2):172–179.

Hennessy, S.M., C. Wisinski, J.P. Montagne, K. Marshall, D.M. Shier, R.R. Swaisgood, and L.A. Nordstrom. 2015. Project Report 2015: An Adaptive Management Approach to Recovering Burrowing Owl Populations and Restoring a Grassland Ecosystem in San Diego County. San Diego Zoo Institute for Conservation Research, Escondido, CA.

Hennessy, S.M., S.A. Marczak, L.A. Nordstrom and R.R. Swaisgood. 2018. Reconsidering Habitat Associations in the Anthropocene. Global Ecology and Conservation 14:e00397.

Hennessy, S., C. Wisinski, N. Ronan, C. Gregory, R. Swaisgood, and L. Nordstrom. 2020. Assessing California's Relocation Guidelines for Burrowing Owls Impacted by Renewable Energy Development. California Energy Commission. Publication Number: CEC-500-2020-051. https://ww2.energy.ca.gov/2020publications/CEC-500-2020-051/CEC-500-2020-051.pdf

Hennessy, S.M., C.L. Wisinski, N.A. Ronan, C.J. Gregory, R.R. Swaisgood and L.A. Nordstrom. 2022. Release Strategies and Ecological Factors Influence Mitigation Translocation Outcomes for Burrowing Owls: A Comparative Evaluation. Animal Conservation 25: 614–626.

Henny, C.J., L.J. Blus, and T.E. Kaiser. 1984. Heptachlor Seed Treatment Contaminates Hawks, Owls, and Eagles of Columbia Basin, Oregon. Raptor Research 18: 41-48.

Heritage Environmental Consultants (HEC). 2013. Burrowing Owl Relocation, Mitigation and Monitoring Plan Corcoran Solar Generation Project. Prepared for California Department of Fish and Wildlife.

Hjertaas, D.G. 1997. Recovery Plan for the Burrowing Owl in Canada. Pages 107-111 *in* J.L. Lincer and K. Steenhoff (editors). The Burrowing Owl: Its Biology and Management. Raptor Research Report Number 9.

Higgins, P. 2015. Issues with Burrowing Owl Mitigation Procedures & the Status of Burrowing Owls in Santa Clara County 2015. California Burrowing Owl Consortium Conference, October 2015.

Hobbs, R.J., E. Higgs and J.A. Harris. 2009. Novel Ecosystems: Implications for Conservation and Restoration. Trends in Ecology and Evolution 24:599–605.

Hoetker, G.M. and K.W. Gobalet. 1999. Predation on Mexican Free-Tailed Bats by Burrowing Owls in California. Journal of Raptor Research 33(4): 333-335.

Holmes, C. and K. Novick. 1993. Draft Honey Lake Wildlife Area Management Plan. State of California, Department of Fish and Game. Sacramento, California.

Holmgren, M.A. and P.W. Collins. 1999. Final Report on the Distribution and Habitat Associations of Six Bird Species of Special Concern at Vandenberg Air Force Base, Santa Barbara County, California. Prepared for Vandenberg Air Force Base. Museum of Systematics and Ecology, U.C. Santa Barbara, and Santa Barbara Museum of Natural History.

Holroyd, G.L., C.J. Conway and H.E. Trefry. 2011. Breeding Dispersal of a Burrowing Owl from Arizona to Saskatchewan. The Wilson Journal of Ornithology, 123(2), pp.378-381.

Hooper, M.J., et al. 1989. Organophosphorus Insecticide Exposure in Hawks Inhabiting Orchards During Winter Dormant-Spraying. Bulletin of Environmental Contamination and Toxicology 42: 651-659.

Hooper, M.J., P. Mineau, M.E. Zaccagnini, G.W. Winegrad, and B. Woodbridge. 1999. Monocrotophos and the Swainson's Hawk: A Unique International Partnership Is Helping to Combat Pesticide Threats to Migratory Birds. Pesticide Outlook 10 (3): 97-102.

Hothem, R.L., D.L. Roster, K.A. King, T.J. Keldson, K.C. Marois, and S.E. Wainwright. 1995. Spatial and Temporal Trends of Contaminants in Eggs of Wading Birds from San Francisco Bay, CA. Environmental Toxicology and Chemistry 14: 1319-1331.

Howell, A.B. 1917. Birds of the Islands Off the Coast of Southern California. Pacific Coast Avifauna Number 12. Cooper Ornithological Club, Hollywood, California, 1912. pp. 59-60.

Howell, A.B. and A. Van Rossem. 1915. Additional Observations on the Birds of the Lower Colorado Valley in California. Condor. Volume XVII, Number 6, November-December 1915, p. 233.

Howell, J.A. 1997. Bird Mortality at Rotor Swept Area Equivalents, Altamont Pass and Montezuma Hills, California. Transactions of the Western Section of the Wildlife Society 33: 24-29.

Howell, T.R. 1964. Notes on Incubation and Nestling Temperatures and Behavior of Captive Owls. Wilson Bulletin Vol. 76, No. 1, March 1964, pp. 28-36.

H.T. Harvey and Associates. 1993. Manteca Burrowing Owl Relocation. Project No. 712-05. Alviso, California.

H.T. Harvey and Associates. 1994. Environmental Impact Report on the Burrowing Owl: Interland-Mission College Development. Prepared for Mindigo and Associates.

H. T. Harvey and Associates. 2013-2018. CVSR Conservation Lands Habitat Mitigation and Monitoring Plan Annual Reports. Prepared for SunPower Corporation.

H.T. Harvey and Associates. 2015-2016. Sparling Ranch Conservation Bank Biological Resources Survey. BEI Exhibit H.

Humann-Guilleminot, S., Laurent, S., Bize, P., Roulin, A., Glauser, G., and Helfenstein, F. 2021. Contamination by Neonicotinoid Insecticides in Barn Owls (*Tyto alba*) and Alpine Swifts (*Tachymarptis melba*). Sci. Total Environ. 785:147403. https://doi.org/10.1016/j.scitotenv.2021.147403.

Hunt, G.L., Jr. and M.W. Hunt. 1974. Trophic Levels and Turnover Rates: The Avifauna of Santa Barbara Island, California. Condor. Volume 76, Number 4, Winter 1974, pp. 363-368.

ICF International. 2012. Final Santa Clara Valley Habitat Plan. Prepared for: City of Gilroy, City of Morgan Hill, City of San José, County of Santa Clara, Santa Clara Valley Transportation Authority, Santa Clara Valley Water District.

ICF International. 2018. Yolo Habitat Conservation Plan/Natural Community Conservation Plan. Volume 1. Final. Prepared by ICF for Yolo Habitat Conservancy. Woodland, CA. https://ecos.fws.gov/docs/plan_documents/thcp/thcp_2894.pdf

ICF International. 2023. Biological Effectiveness Monitoring for the Natomas Basin Habitat Conservation Plan Area 2022 Annual Survey Results. April. Agency Version—Final. (ICF 104332.) Sacramento, CA. Prepared for the Natomas Basin Conservancy, Sacramento, CA.

Imperial Irrigation District (IID). 2006. Planning Agreement by and among Imperial Irrigation District, the California Department of Fish and Game, and the United States Fish and Wildlife Service Regarding the Imperial Valley Natural Community Conservation Plan and Habitat Conservation Plan. Planning Agreement No. 2810 - 2004 - 01 - 06. February 2006.

Imperial Irrigation District (IID). 2010. 2010 Annual Report of Imperial Irrigation District Pursuant to SWRCB Revised Order WRO 2002-013.

Imperial Irrigation District (IID). 2012. 2012 Burrowing Owl Monitoring Results, Imperial Irrigation District Rights-Of-Way, Imperial County, California. Prepared by AECOM for Imperial Irrigation District.

Imperial Irrigation District (IID). 2023. HCP/NCCP Process. https://www.iid.com/water/library/qsa-water-transfer/environmental-assessments-permits/hcp-nccp-process

Insignia Environmental. 2009. 2008/2009 Annual Report for the Buena Vista Avian and Bat Monitoring Project (and update of 3rd August 2009). County of Contra Costa: Martinez, CA.

James, P.C. and R.H.M. Espie. 1997. Current Status of the Burrowing Owl in North America: An Agency Survey. Pp. 3-5 *in* J. L. Lincer and K. Steenhoff (editors). The Burrowing Owl: Its Biology and Management. Raptor Research Foundation, Inc., Boise, Idaho.

James, P.C. and T.J. Ethier. 1989. Trends in the Winter Distribution and Abundance of Burrowing Owls in North America. American Birds 43: 1224-1225.

James, P.C., T.J. Ethier, and M.K. Toutloff. 1997. Parameters of a Declining Burrowing Owl Population in Saskatchewan. Pages 34-37 *in* J. L. Lincer and K. Steenhoff (editors). The Burrowing Owl, Its Biology and Management: Including the Proceedings of the First International Symposium. Raptor Research Report Number 9.

James P.C. and G.A. Fox. 1987. Effects of Some Insecticides on Productivity of Burrowing Owls. Blue Jay 45: 65-71.

James P.C., G.A. Fox, and T.J. Ethier. 1990. Is the Operational Use of Strychnine to Control Ground Squirrels Detrimental to Burrowing Owls? Journal of Raptor Research 24(4): 120-123.

Jarman, W.M., S.A. Burns, C.E. Bacon, J. Rechtin, S. DeBenedetti, J.L. Linthcum, and B.J. Walton. 1996. High Levels of HCB and DDE Associated with Reproductive Failure in Prairie Falcons (*Falco mexicanus*) in California. Bulletin of Environmental Contamination and Toxicology 57: 8-15.

Jasny, M. 1997. Leap of Faith: Southern California's Experiment in Natural Community Conservation Planning. Natural Resources Defense Council.

Johnsgard, P.A. 1988. North American Owls: Biology and Natural History. Smithsonian Institution Press, Washington, D. C.

Johnson, B.S. 1992. Effects of Demography, Mating Patterns, and Sociality on the population Genetics and Dynamics of Burrowing Owl *Athene cunicularia*. Dissertation, University of California, Davis.

Johnson, B.S. 1997a. Demography and Population Dynamics of the Burrowing Owl. Pages 28-33 *in* Lincer, J. L. and K. Steenhof (editors). 1997. The Burrowing Owl, Its Biology and Management: Including the Proceedings of the First International Symposium. Raptor Research Report Number 9.

Johnson, B.S. 1997b. Characterization of Population and Family Genetics of the Burrowing Owl by DNA Fingerprinting with pV47-2. Pages 58-63 *in* Lincer, J. L. and K. Steenhof (editors). 1997. The Burrowing Owl, Its Biology and Management: Including the Proceedings of the First International Symposium. Raptor Research Report Number 9.

Johnson, B.S. 1997c. Reproductive Success, Relatedness, and Mating Patterns of Colonial Burrowing Owls. Pages 64-67 *in* Lincer, J.L. and K. Steenhof (editors). 1997. The Burrowing Owl, its Biology and Management. Raptor Research Report Number 9.

Johnson, B.S. and T.A. Schulz. 1985. Biology and Status of the Burrowing Owl on the Campus of the University of California, Davis. Raptor Res. Found. Symp. Biol. Status, and Management of Owls, Sacramento [Abstract].

Johnson, J.W. 1990. The Flora and Fauna of Upper Newport Bay, 1940-55. *In* Bryant, P.B. and J. Remington (editors), Endangered Wildlife and Habitats in Southern California. Memoirs of the Natural History Foundation of Orange County. A collection of occasional papers published by the Natural History Foundation of Orange County. Volume 3.

Johnson, R.G., J.A. Juskevice, S. Obrebski, J.A. Blake, and E.H. Smith. 1971. Biological Characteristics of Tomales Bay. Environmental Study of Tomales Bay, Volume 4. Pacific Marine Station, Research Report Number 11.

Jones, H.L. and P.W. Collins. 2003. Birds of California's Channel Islands: Their Distribution and Status. Santa Barbara Museum of Natural History, Santa Barbara, California.

Jones, H.L. and J.M. Diamond. 1976. Short-Time-Base Studies of Turnover in Breeding Bird Populations on the California Channel Islands. Condor. Volume 78, Number 4, Winter 1976, pp. 526-548.

Jones & Stokes. 2000. Draft Carnegie State Vehicle Recreation Area General Plan Amendment Environmental Impact Report. Prepared for California Department of Parks and Recreation, Off-Highway Motor Vehicle Recreation Division.

Jones & Stokes. 2006a. East Contra Costa County HCP and NCCP. Prepared for East Contra Costa County Habitat Conservation Plan Association by Jones & Stokes. https://ecos.fws.gov/docs/plan_documents/thcp/thcp_2908.pdf

Jones & Stokes. 2006b. Final PG&E San Joaquin Valley Operation & Maintenance Habitat Conservation Plan. Prepared for Pacific Gas and Electric Company

Justice-Allen, A. and Loyd, K.A. 2017. Mortality of Western Burrowing Owls (*Athene cunicularia hypugaea*) Associated with Brodifacoum Exposure. Journal of Wildlife Diseases 53:165-169.

Kareiva, P., S. Andelman, D. Doak, B. Elderd, M. Groom, J. Hoekstra, L. Hood, F. James, J. Lamoreux, G. LeBuhn, C. McCulloch, J. Regetz, L. Savage, M. Ruckelshaus, D. Skelly, H.

Wilbur, K. Zamudio, and NCEAS HCP Working Group. 1999. Using Science in Habitat Conservation Plans. National Center for Ecological Analysis & Synthesis, Santa Barbara, CA, and the American Institute of Biological Sciences, Washington, DC.

KEA Environmental. 1997. Final 1996 Botany and Wildlife Pre-Construction Survey Report for the Alturas Intertie Project. Prepared for Sierra Pacific Power Company, Reno, NV. KEA Environmental, Inc, Sacramento CA

KEA Environmental. 1998. Draft 1998 Special Status Wildlife Pre-Construction Survey Report for the Alturas Intertie Project. Prepared for Sierra Pacific Power Company, Reno, NV. KEA Environmental, Inc, Sacramento CA

Keeler, C.A. 1891. Geographical Distribution of Land Birds in California. IV. The Island Fauna. Zoe. Volume I, January 1891, pp. 337-343.

Keeler, C.A. 1907. Bird Notes Afield; Essays on the Birds of the Pacific Coast with a Field Check List. P. Elder and Company, San Francisco and New York.

Kemper, J. 1996. Discovering Yolo County Wildlife. Yolo Audubon Society and Yolo Basin Foundation, 1996.

Kennard, J.H. 1975. Longevity Records of North American Birds. Bird-Banding 46: 55-73.

Kern Water Bank Authority (KWBA). 1997. Kern Water Bank Habitat Conservation Plan/Natural Community Conservation Plan.

Kidd, J.W. 2023a. Augmented Eviction Resulting in Pair Fidelity and Successful Nesting in Riverside County, California. Kidd Biological Inc. 2023 Burrowing Owl Symposium, February 6-7, 2023, Riverside, CA. The Wildlife Society. https://sites.google.com/tws-west.org/2023buowsymposium/abstracts?authuser=0

Kidd, J.W. 2023b. 30 Year Review of Experimental Burrowing Owl Relocations Throughout California. Kidd Biological Inc. 2023 Burrowing Owl Symposium, February 6-7, 2023, Riverside, CA. The Wildlife Society. https://sites.google.com/tws-west.org/2023buowsymposium/abstracts?authuser=0

Kidd, J.W., P.H. Bloom, C.W. Barrows and C.T. Collins. 2007. Status of Burrowing Owls in Southwestern California. Pages 76-89 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

Kirsher, W. 1951. Check List of the Birds of Sacramento and Vicinity. Sacramento State College Publications, Natural History Series No. 2.

Klute, D.S., Ayers, L., Green, M.T. Howe, W.H., Jones, S.L., Shaffer, J.A., and Zimmerman, T.S. 2003. Status Assessment and Conservation Plan for the Western Burrowing Owl in the United States. USDI, Fish and Wildlife Service Biological Technical Publication ; FWS/BTP-R6001-2003, Washington, DC, USA.

Klute, D.S., Ayers, L., Green, M.T. Howe, W.H., Jones, S.L., Shaffer, J.A., and Zimmerman, T.S. 2007. Status Assessment and Conservation Plan for the Western Burrowing Owl in the

United States – California Summary. Pages 109-114 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

Konrad, P M. and D.S. Gilmer. 1984. Observations on the Nesting Ecology of Burrowing Owls in Central North Dakota. Prairie Naturalist 16: 129-130.

Korfanta, M.N. 2001. Population Genetics of Migratory and Resident Burrowing Owls (*Athene cunicularia*) Elucidated by Microsatellite DNA Markers. M.S. Thesis, University of Wyoming, Laramie, Wyoming.

Korfanta, N.M., D.B. McDonald, T.C. Glenn and C.M. Handel. 2005. Burrowing Owl (*Athene cunicularia*) Population Genetics: A Comparison of North American Forms and Migratory Habits. Auk 122:464–478.

Kosciuch, K., D. Riser-Espinoza, M. Gerringer and W. Erickson. 2020. A Summary of Bird Mortality at Photovoltaic Utility Scale Solar Facilities in the Southwestern U.S. PLOS One, 15(4), Article e0232034. https://doi.org/10.1371/journal.pone.0232034

Koshear, J., C. Shafer, E.F. Van Mantgem and R.V. Olsen. 2007. Burrowing Owl Management at Colonel Allensworth State Historic Park. Pages 155-164 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

Kuenzi, A.J. and M.L. Morrison. 1998. Avian Habitat Use and Flight Behavior in Relation to Bird-Aircraft Strikes in Western U.S. Agricultural Lands. *In* Transactions of the Western Section of the Wildlife Society 34:1-8, pp. 1-7.

La Claire, J. 2000. Lake Perris SRA and San Jacinto Wildlife Area Burrowing Owl Survey May-July 2002. Unpublished report. California State Parks, Inland Empire District, Resource Management Program.

Lamb, C.C. 1929. Land Birds of a Pacific Coast Sea Voyage. Condor. Volume XXXI, Number 1, January-February 1929, p. 36.

Landry, R.E. 1979. Growth and Development of the Burrowing Owl, (*Athene cunicularia*). Unpublished M.A. Thesis. California State University, Long Beach. 66pp.

Lantz, S.J. and C.J. Conway. 2009. Factors Affecting Daily Nest Survival of Burrowing Owls Within Black-Tailed Prairie Dog Colonies. The Journal of Wildlife Management, 73(2), pp.232-241.

Lawrence Livermore National Laboratory (LLNL). 1998. Site 300 Ecology.

Lehman, P.E. 1994. The birds of Santa Barbara County, California. Vertebrate Museum, University of California, Santa Barbara, 1994. pp. 175-176.

Lehman, P., G. McCaskie and P. Unitt. 2021. San Diego County Avian Records Database, 2002-2020.

Lenihan, C. 2007. The Ecological Role of the California Ground Squirrel (*Spermophilus beecheyi*). PhD, University of California, Davis, Davis, CA.

Li, Y., Miao, R. and Khanna, M. 2020. Neonicotinoids and Decline in Bird Biodiversity in the United States. Nat Sustain 3, 1027–1035. https://doi.org/10.1038/s41893-020-0582-x

Ligon, J.S. 1961. New Mexico Birds. University of New Mexico Press, Albuquerque, New Mexico.

Lincer, J.I. and P.H. Bloom. 2007. The Status of the Burrowing Owl in San Diego County, California. Pages 90-102 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

Linton, C.B. 1908a. Notes from Santa Cruz Island. Condor. Volume X, Number 3, May-June 1908, p. 127.

Linton, C B. 1908b. Notes from Buena Vista Lake, May 20 to June 16, 1907. Condor. Volume X, Number 5, September-October 1908, p. 197.

Linton, C.B. 1908c. Notes from San Clemente Island. Condor. Volume X, Number 2, March-April 1908, p. 84.

Lohoefener, R. and C.A. Ely. 1978. The Nesting Birds of LaCreek National Wildlife Refuge. South Dakota Bird Notes (June): 24-30.

Los Angeles County Museum (LACM). 2001. Collection data provided by Christina Couroux, Ornithology Curatorial Assistant. Natural History Museum of Los Angeles County.

Louise M. Darling Biomedical Library (LMDBL). 2001. On-line database of History and Special Collections. California Digital Library. www.cdlib.org

Lovich, J.E. and J.R. Ennen. 2011. Wildlife Conservation and Solar Energy Development in the Desert Southwest, United States. BioScience, Volume 61, Issue 12, December 2011, pp. 982–992.

LSA. 2009-2018. 2007-2017 Annual Reports Elsie Gridley Mitigation Bank, Solano County, California. Prepared for Wetland Resources LLC.

LSA. 2014. Fifth Annual Monitoring Report (2013) for the Prewett Family Park Burrowing Owl Preserve, Antioch, California.

LSA. 2018-2022. Muzzy Ranch Conservation Bank 2017-2022 Monitoring Reports. Muzzy Ranch Conservation Bank Project, County of Solano, California. Submitted Canon Station, LLC.

Lutz, R.S. and D.L. Plumpton. 1999. Philopatry and Nest Site Reuse by Burrowing Owls: Implications for Productivity. Journal of Raptor Research 33:149–153.

Lynch, J.F. and N.K. Johnson. 1974. Turnover and Equilibria in Insular Avifaunas with Special Reference to the California Channel Islands. Condor. Volume 76, Number 4, Winter 1974, pp. 370-380.

Macıas-Duarte, A. and C.J. Conway. 2015. Distributional Changes in the Western Burrowing Owl (*Athene cunicularia hypugaea*) in North America from 1967 to 2008. Journal of Raptor Research 49(1): 75–83.

Macıas-Duarte, A., C.J. Conway, G.L. Holroyd, H.E. Valdez-Gomez and M. Culver. 2019. Genetic Variation Among Island and Continental Populations of Burrowing Owl (*Athene cunicularia*) Subspecies In North America. Journal of Raptor Research 53(2):127–133.

Macıas-Duarte, A., C.J. Conway, A. Munguia-Vega and M. Culver. 2020a. Novel Microsatellite Loci for the Burrowing Owl *Athene cunicularia*. Conservation Genetics Resources.

Macías-Duarte, A., C.J. Conway and M. Culver. 2020b. Agriculture Creates Subtle Genetic Structure Among Migratory and Nonmigratory Populations of Burrowing Owls Throughout North America. Ecology and Evolution 10:10697–10708.

Madden, J. An Analysis of the Burrowing Owls on the Central Coast Region of California. Unpublished report. Environmental Studies Department, San Jose State University.

Mailliard, J. 1900. Land Birds of Marin County, Cal. Condor. Volume 2, Number 3, May-June 1900, p. 63.

Mailliard, J. 1930. Handbook of the Birds of Golden Gate Park. California Academy of Sciences, San Francisco. p. 54.

Mailliard, J. and J.W. Mailliard. 1901. Birds Recorded at Paicines, San Benito Co., California. Condor. Volume 3, Number 5, September-October 1901, p. 122.

Manning, J.A. 2009. Burrowing Owl Population Size in the Imperial Valley, California: Survey and Sampling Methodologies for Estimation. Final report to the Imperial Irrigation District, Imperial, CA.

Marcus H. Bole & Associates. 2014. Bryte Ranch Conservation Bank, Sacramento County, California. 2014 Biological Monitoring Report.

Marczak, S., C.L. Wisinski, S.M. Hennessy, J.P. Montagne, M. Stevens, J. Hargis, D.M. Shier, R.R. Swaisgood and L.A. Nordstrom. 2017. Project Report 2017: An Adaptive Management Approach to Recovering Burrowing Owl Populations and Restoring a Grassland Ecosystem in San Diego County. San Diego Zoo Institute for Conservation Research, Escondido, CA.

Marczak, S., C. L. Wisinski, S. M. Hennessy, M. Stevens, S. Perez, D. Angel, R. R. Swaisgood, and L. A. Nordstrom. 2018. Project Report 2018: Advancing Burrowing Owl Conservation in San Diego County through Mitigation Measures using Science and Adaptive Management. San Diego Zoo Institute for Conservation Research, Escondido, CA.

Marczak, S. 2023.Burrowing Owl Monitoring, Research and Conservation in San Diego County. Diego Zoo Wildlife Alliance. 2023 Burrowing Owl Symposium, February 6-7, 2023, Riverside, CA. The Wildlife Society. https://sites.google.com/tws-west.org/2023buowsymposium/abstracts?authuser=0

Marine Corps Air Ground Combat Center (MCAGCC). 1996. Multiple Land Use Management Plan, Twentynine Palms, California 1996-2000.

Marsh, R.E. 1987. Ground Squirrel Control Strategies in Californian Agriculture. Pp. 261-267 *in* C.G.J. Richards and T.Y. Ku (editors). Control of Mammal Pests. Taylor and Francis, London, New York, and Philadelphia.

Martell, M., H.B. Tordoff, and P.T. Redig. 1994. The Introduction of Three Native Raptors into the Midwestern United States. Raptor Conservation Today, 465-470.

Marti, C.D. 1974. Feeding Ecology of Four Sympatric Owls. Condor 76: 45-61.

Marti, C.D. and J.S. Marks. 1989. Medium-Sized Owls. *In* Proceedings of the Western Raptor Management Symposium and Workshop. National Wildlife Federation, Washington, D. C.

Martin, D.J. 1973. Selected Aspects of Burrowing Owl Ecology and Behavior. Condor 75: 446-456.

McCormick Biological, Inc. 2016. Draft Habitat Management Plan, Panoche Valley Solar Project Conservation Lands, San Benito and Fresno Counties. Prepared for Panoche Valley Solar, LLC.

McGregor, R.C. 1898. Note on *Speotyto cunicularia obscura* Stephens. Auk. Volume XV, No. 2, April 1898, p. 187.

McGregor, R.C. 1901. A List of the Land Birds of Santa Cruz County, California. Pacific Coast Avifauna No. 2. Cooper Ornithological Club of California, p. 8.

McGriff, D. 2007. Burrowing Owl Data in the California Natural Diversity Database. Pages 178-184 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

McNerney, J.T. 2005-2014. Biannual Monitoring Reports of the Burrowing Owl Reserve at Yolo County Grasslands Park from 2005-2006; 2010-2014.

McNerny, J.T. and M. Sears. 2007. Burrowing Owl Protection at the Local Level: The City of Davis Disking Ordinance. Pages 137-140 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

Meads, L. 2023. Review and Lessons Learned Over 40 Years of Captive Bred Reintroduction of the Western Burrowing Owl (*Athene cunicularia hypugaea*) in the Grasslands of British Columbia, 1983-2022. Burrowing Owl Conservation Society of BC. 2023 Burrowing Owl Symposium, February 6-7, 2023, Riverside, CA. The Wildlife Society. https://sites.google.com/tws-west.org/2023buowsymposium/abstracts?authuser=0

Medenhall, V.M. and L.F. Pank. 1980. Secondary Poisoning of Owls by Anticoagulant Rodenticides. Wildlife Society Bulletin 8: 311-315.

Medvitz, A. and A.D. Sokolow. 1995. Population Growth Threatens Agriculture, Open Space. California Agriculture 49(6): 11-15.

Menzel, S. 2014. An Assessment of Artificial Burrows for Burrowing Owls in Northern California. Master's Thesis, San Jose State University.

Menzel, S. 2015. Burrowing Owls Covered Under Conservation Plans in California – Are These Plans Actually Protecting the Species? California Burrowing Owl Consortium Conference, October 2015.

Menzel. S. 2018. Artificial Burrow Use by Burrowing Owls in Northern California. Journal of Raptor Research 52(2):167–177.

Menzel, S. C. Portman and R.L. Wilkerson. 2024. Precipitous Decline of Western Burrowing Owls in Yolo County, Northern California. Burrowing Owl Preservation Society and Institute for Bird Populations. Manuscript submitted for publication.

Mercado-Borrayo, B.M., Cram, H.S., Rosas Pérez, I., Hernández Quiroz, M., and Ponce De León Hill, C. 2015. Organophosphorus and Organochlorine Pesticides Bioaccumulation by *Eichhornia crassipes* in Irrigation Canals in an Urban Agricultural System. International Journal of Phytoremediation 17(7):701–708. doi: 10.1080/15226514.2014.964841

Merriam, C.H. 1899. Results of a Biological Survey of Mount Shasta California. North American Fauna No. 16. U.S. Department of Agriculture, Division of Biological Survey. Government Printing Office, Washington.

Merriam, F.A. 1896. Notes on Some of the Birds of Southern California. Auk. Vol. XIII, No. 2, April 1896, p. 117.

Miles, S.R. and C.B. Goudey. 1997. Ecological Subregions of California. USDA Forest Service, Pacific Southwest Region, San Francisco, CA.

Miller, J.K. 2007. Petition to List the Western Burrowing Owl in California. Pages 169-177 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

Miller, J.M. 1903. Notes on the Bird Conditions of the Fresno District. Condor. Volume V, Number 4, July-August 1903, pp. 89-90.

Millsap, B.A. 2002. Survival of Florida Burrowing Owls Along an Urban-Development Gradient. Journal of Raptor Research 36:3-10.

Millsap, B.A. and C. Bear. 1988. Cape Coral Burrowing Owl Population Monitoring. Annual Performance Report, Florida Game, Freshwater Fish Commission. Tallahassee, Florida.

Mineau, P. and H. Kern. 2023. Neonicotinoid Pesticides, Failing to Come to Grips with a Predictable Environmental Disaster. American Bird Conservancy. https://abcbirds.org/wp-content/uploads/2023/07/2023-Jul20-ABC-Neonicotinoid-Insecticides-Report.pdf

Mineau, P., M.R. Fletcher, L.C. Glaser, N.J. Thomas, C. Brassard, L.K. Wilson, J.E. Elliott, L. Lyon, C.J. Henny, T. Bollinger, and S L. Porter. 1999. Poisoning of Raptors with Organophosphorus and Carbamate Pesticides with Emphasis on Canada, U.S. and U.K. Journal of Raptor Research 33(1): 1-37.

Monson, G. and A.R. Phillips. 1981. Annotated Checklist of the Birds of Arizona. University of Arizona Press, Tucson, Arizona.

Moore Laboratory of Zoology (MLZ). 2001. Collection data provided by James Northern, Collections Manager. Moore Laboratory of Zoology, Occidental College, Los Angeles, California.

Mowbray, M.V. 1947. Notes on the Birds of the Upper Salinas Valley, California. Condor. Volume 49, Number 4, July-August 1947, pp. 173-174.

Mueller, T. 2001. Natural Communities Conservation Planning (NCCP): Does Delegation of Endangered Species Protection to the States Protect Species? Published by the Environmental Protection Information Center, Garberville, CA.

Murray, G.A. 1976. Geographic Variation in the Clutch Sizes of Seven Owl Species. The Auk 93:602-613.

Murray, K.G., K. Winnett-Murray, Z.A. Eppley, G.L. Hunt, Jr., and D.B. Schwartz. 1983. Breeding Biology of the Xantus' Murrelet. Condor. Volume 85, Number 1, February 1983, p. 16.

Museum of Southwestern Biology (MSB). 2001. Collection data provided by Maureen Leonard, Curatorial Assistant, Division of Birds. Museum of Southwestern Biology, University of New Mexico.

Museum of Vertebrate Zoology (MVZ). 2001. Database of U.C. Berkeley Museum of Vertebrate Zoology specimens.

Nadeau, C., C. Conway and N. Rathbun. 2015. Depth of Artificial Burrowing Owl Burrows Affects Thermal Suitability and Occupancy. Journal of Field Ornithology.

National Museum of Natural History (NMNH). 2001. Collection data provided by Craig Ludwig, Scientific Data Manager, Division of Birds and Mammals. National Museum of Natural History, Smithsonian Institution, Washington, DC.

Natomas Basin Conservancy. 2021. Biological Effectiveness Monitoring for the Natomas Basin Habitat Conservation Plan Area. 2020 Annual Survey Results.

Naval Air Weapons Station (NAWS) China Lake. 2002. Draft Environmental Impact Statement for Proposed Military Operational Increases and Implementation of Associated Comprehensive Land Use and Integrated Natural Resources Management Plans. Prepared with the cooperation of the Bureau of Land Management, Ridgecrest, California.

Naz S., Iqbal, S.S., Manan, A., Chatha, M., and Zia, M. 2023. The Web of Life: Role of Pesticides in the Biodiversity Decline. International Journal of Forest Sciences.

Neff, J.A. 1941. A Note on the Food of Burrowing Owls. Condor. Volume 43, Number 4, July-August 1941, pp. 197-198.

Newton, I., I. Wyllie, A. Gray, and C.V. Eadsforth. 1994. The Toxicity of the Rodenticide Flocoumafen and its Elimination Via Pellets. Pesticide Science 41: 187-193.

Noss, R.F. and A.Y. Cooperrider. 1994. Saving Nature's Legacy: Protecting and Restoring Biodiversity. Island Press, Washington, D. C.

Noss, R.F., M.A. O'Connell, and D.D. Murphy. 1997. The Science of Conservation Planning: Habitat Conservation Under the Endangered Species Act. Island Press.

Oakland Museum (OM). 2001. Collection data provided by Tom Steller, Interim Curator of Collections. Oakland Museum, Oakland, California.

Ocken, M.A. 2017. Seasonal Habitat Requirements and Use by the Western Burrowing Owl (*Athene cunicularia hypugaea*) in the Northern Sacramento Valley, California. Master's Thesis, California State University, Chico.

O'Connor, R.J., E. Dunn, D.H. Johnson, S.L. Jones, D. Petiti, K. Pollock, C.R. Smith, J.L. Trapp, and E. Welling. 2000. A Programmatic Review of the North American Breeding Bird Surveys. Report of a Peer Review Panel.

Office of Environmental Health and Hazard Assessment (OEHHA). 2023. CalEnviroScreen 4.0 Indicator Maps, Pesticide Use Percentile. https://experience.arcgis.com/experience/ed5953d89038431dbf4f22ab9abfe40d/page/Indicators/?views=Pesticide-Use

Office of Migratory Bird Management (OMBM). 1995. Migratory Nongame Birds of Management Concern in the United States: The 1995 List. U.S. Fish and Wildlife Service, Washington, D. C.

Ohlendorf, H.M. and W.J. Fleming. 1988. Birds and Environmental Contaminants in San Francisco and Chesapeake Bays. Marine Pollution Bulletin 19: 487-495.

Ohlendorf, H.M., D.J. Hoffman, M. Saiki, and T.W. Aldrich. 1986. Embryonic Mortality and Abnormalities of Aquatic Birds: Apparent Impacts of Selenium from Irrigation Drainwater. Sci. Total Environ. 52: 49-63.

Ohlendorf, H.M., R.L. Hothem, T.W. Aldrich, and A.J. Krynitsky. 1987. Selenium Contamination of the Grasslands, a Major California Waterfowl Area. Sci. Total Environ. 66: 169-183.

Ohlendorf, H.M., A.W. Kilness, J.L. Simmons, R.K. Stroud, D.J. Hoffman, and J.F. Moore. 1988. Selenium Toxicosis in Wild Aquatic Birds. Journal of Toxicology and Environmental Health 24: 67-92.

Ohlendorf, H.M. and K.C. Marois. 1990. Organochlorines and Selenium in California Night-Heron and Egret Eggs. Environmental Monitoring and Assessment 15: 91-104.

Olberding Environmental. 2023a. Year 1 (2023) Monitoring Report for the Cayetano Creek Mitigation Bank, Contra Costa and Alameda Counties, California.

Olberding Environmental. 2023b. Eagle Ridge Preserve East Suitable Burrowing Owl Foraging Habitat. Letter to CDFW.

Paige, C. 1998. Species Management Abstract: Western Burrowing Owl (*Athene cunicularia hypugaea*). The Nature Conservancy, Wings of Americas Program, Arlington, Virginia.

Palacios, E., D.W. Anderson, E. Meltink, and S. Gonzalez-Guzman. 2000. Distribution and Abundance of Burrowing Owls on the Peninsula and Islands of Baja California. Western Birds 31:89-99.

Pandolfino, E.R., L.A. Douglas, T.D. Manolis and C. Conard. 2021. Sacramento County Breeding Birds, A Tale of Two Atlases and Three Decades of Change. Central Valley Bird Club Special Publication No. 2.

Parsons Harland Bartholmew & Associates, Inc. (PHBA). 2002. Mace Ranch Community Park Draft Environmental Impact Report. Prepared for City of Davis.

Peabody Museum of Natural History (PMNH). 2001. On-line database of Yale University Peabody Museum of Natural History specimens. www.peabody.yale.edu

Peakall, D.B. 1970. Pesticides and the Reproduction of Birds. Scientific American 213: 255-261.

Pemberton, J.R. 1928. Additions to the Known Avifauna of the Santa Barbara Islands. Condor. Volume XXX, Number 2, March-April 1928, pp. 144-147.

Pemberton, J.R. and H.W. Carriger. 1915. A Partial List of the Summer Resident Land Birds of Monterey County, California. Condor. Volume XVII, Number 5, September-October 1915, p. 194.

Pest Management Regulatory Agency (PMRA). 1995. Carbofuran. Decision Document E95-05. Pest Management Regulatory Agency, Health Canada, Ottawa, Ontario.

Peterson, N.R. 2023. Population Trends of Breeding Western Burrowing Owls at Two Conserved Sites in Western Riverside County, 2015–2022. California Department of Fish and Wildlife. 2023 Burrowing Owl Symposium, February 6-7, 2023, Riverside, CA. The Wildlife Society. https://sites.google.com/tws-west.org/2023buowsymposium/abstracts?authuser=0

Pettingill, O.S. 1981. A Guide to Bird Finding West of the Mississippi. Second edition. Oxford University Press, New York.

Pimm, S.L. 1991. The Balance of Nature?: Ecological Issues in the Conservation of Species and Communities. University of Chicago Press, Chicago, Illinois.

Placer County Conservation Program. 2020. Western Placer County Habitat Conservation Plan/Natural Community Conservation Plan. https://ecos.fws.gov/docs/plan_documents/thcp/thcp_3186.pdf

Plaza P.I., Martínez-López, E., and Lambertucci, S.A. 2019. The Perfect Threat: Pesticides and Vultures. Science of the Total Environment 687:1207–1218. doi: 10.1016/j.scitotenv.2019.06.160.

Plumpton, D.L. 1992. Aspects of Nest Site Selection and Habitat Use by Burrowing Owls at the Rocky Mountain Arsenal, Colorado. M.S. Thesis, Texas Tech. Univ., Lubbock, Texas.

Plumpton, D.L., and R.S. Lutz. 1993. Influence of Vehicular Traffic on Time Budgets of Nesting Burrowing Owls. Journal of Wildlife Management 57: 612-616. https://www.jstor.org/stable/3809291

Point Blue Conservation Science. 2010. Burrowing Owls on the Farallones??! https://www.pointblue.org/farallones_blog/burrowing-owls-on-the-farallones/

Port of Oakland. 1997. Airport Development Program, Oakland International Airport FEIR.

Port of Oakland. 2023. Oakland International Airport Terminal Modernization and Development Project. Draft Environmental Impact Report.

Portman, C. and P. Nieberg. 2012. Burrowing Owl Mitigation Has Failed. Article in the Davis Enterprise, November 11, 2012.

Poulin, R.G., L.D. Todd, E.A. Haug, B.A. Millsap and M.S. Martell. 2020. Burrowing Owl (*Athene cunicularia*). Birds of the World. https://birdsoftheworld.org/bow/species/burowl/cur/introduction

Power, M.E., D. Tilman, J.A. Estes, B.A. Menge, W.J. Bond, L.S. Mills, G. Daily, J.C. Castilla, J. Lubchenco, and R.T. Paine. 1996. Challenges in the Quest for Keystones. Bioscience 46:609-620

Price, W.W. 1898. Birds of the Campus. The Sequoia 7(26): 310-311.

Priest, J.E. 1997. Age Identification of Nestling Burrowing Owls. The Burrowing Owl: Its Biology and Management. Journal of Raptor Research Report 9:125-127.

Purdue University Cooperative Extension Service (PUCES). 2008. Pesticides and Wildlife: An Introduction to Testing, Registration, and Risk Management. https://ag.purdue.edu/department/extension/ppp/ppp-publications/ppp-30.pdf

Quad Knopf. 2014. Maricopa Sun Solar Complex Project Final Habitat Conservation Plan. Prepared for Maricopa Sun, LLC.

Rado, T. 2002. BNSF Lateral Pipeline Project Post-Project Biological Monitoring Report, San Bernardino County, California. Prepared for Kinder Morgan Energy Partners, Orange, California, October 2002.

Rahn, M.E., H. Doremus and J. Diffendorfer. 2006. Species Coverage in Multispecies Habitat Conservation Plans: Where's the Science? BioScience 56(7): 613–619.

Rappole, J.H., S.R. Derrickson, and Z. Hubalek. 2000. Migratory Birds and Spread of West Nile Virus in the Western Hemisphere. Emerging Infectious Diseases 6(4): 319-328.

Ratcliff, B.D. 1986. The Manitoba Burrowing Owl Survey, 1982-1984. Blue Jay 44: 31-37.

Ray, M.S. 1906. A-Birding in an Auto. Auk. Vol. XXIII, No. 4, October 1906, pp. 400-414.

Ray, M.S. 1916. More Summer Birds for San Francisco County. Condor. Volume XVIII, Number 6, November-December 1916. p. 224.

Remsen, J.V., Jr. 1978. Bird Species of Special Concern in California. Prepared for the California Department of Fish and Game. p. 19.

Resource Environmental Solutions (RES). 2021-2023. 2020-2023 Elsie Gridley Mitigation Bank Solano County, California. Prepared for Wetland Resources LLC.

Resource Environmental Solutions (RES). 2022. 2022 Annual Report (Year 20), Dolan Ranch Conservation Bank.

Rich, T. 1986. Habitat and Nest-Site Selection by Burrowing Owls in the Sagebrush Steppe of Idaho. Journal of Wildlife Management 50:548-555.

Richmond, J. 1985. Birding Northern California. Mt. Diablo Audubon Society. 142 pp.

Riesz, K. and M. Rodriguez. 2014. CA Department of Fish and Wildlife Perspective on Burrowing Owl. California Department of Fish and Wildlife.

Rigal, S., et al. 2023. Farmland Practices are Driving Bird Population Decline Across Europe. Proceedings of the National Academy of Sciences 120.21: e2216573120.

Riverside County Transportation and Land Management Agency. 2023. Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP). https://rctlma.org/western-riverside-county-multiple-species-habitat-conservation-plan-mshcp-1

Roberson, D. 1985. Monterey Birds. Monterey Peninsula Audubon Society. pp. 11-12, 144.

Roberson, D. 1993. Atlas of the breeding birds of Monterey County. Monterey Peninsula Audubon Society. pp. 164-165.

Roberts, T.A. and C.O. Gaber. 2007. Habitat Loss and Population Status Estimate for Burrowing Owls in the San Joaquin Valley. Pages 70-75 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

Robertson, J.M. 1929. Some Observations on the Feeding Habitats of the Burrowing Owl. Condor. Volume XXXI, Number 1, January-February 1929, pp. 38-39.

Robertson, J.M. 1930. Roads and Birds. Condor. Volume XXXII, Number 3, May-June 1930, p. 144.

Robertson, J.M. 1931. Some Changes in the Bird Life of Western Orange County, California. Condor. Volume XXXIII, Number 5, September-October 1931, pp. 204-205.

Rohm and Haas Company. 1991. Material Safety Data Sheet for Kelthane Technical B Miticide. Philadelphia, PA, pp. 6-46.

Ronan, N.A. 2002. Habitat Selection, Reproductive Success, and Site Fidelity of Burrowing Owls in a Grassland Ecosystem. M.S. Thesis, Oregon State University, Corvallis, OR.

Ronan, N.A. and D.K. Rosenberg. 1999. Burrowing Owl Demography Study: Carrizo Plain 1999 Progress Report.

Ronan, N.A. and D.K. Rosenberg. 2014. Response of Burrowing Owls to Experimental Removal of Satellite Burrows. The Journal of Wildlife Management 78:1115–1119.

Rosenberg, D.K. 1999. Burrowing Owl Demography Study: Carrizo Plain 1999 Progress Report. Institute for Bird Populations. Point Reyes Station, California.

Rosenberg, D.K., and D.F. DeSante. 1997. Demographic Characteristics of Burrowing Owl Populations in California. Progress Report, September 1997. Institute for Bird Populations. Point Reyes Station, California.

Rosenberg, D.K. and K.L. Haley. 2004. The Ecology of Burrowing Owls in the Agroecosystem of the Imperial Valley, California. Studies in Avian Biology 27, pages 120-135.

Rosenberg, D. and J. Gervais. 2009. An Updated Management Plan for the Burrowing Owl Population at Naval Air Station Lemoore, Lemoore, California. Cooperative Agreement No. N62473-07-2-0033. Prepared by Oregon Wildlife Institute and The Institute for Bird Populations.

Rosenberg, D.K., J.A. Gervais, H. Ober, and D.F. DeSante. 1998a. An Adaptive Management Plan for the Burrowing Owl Population at NAS Lemoore. Institute for Bird Populations. Point Reyes Station, California. Publication No. 95.

Rosenberg, D.K., L.A. Trulio and D.F. DeSante. 1998b. The Burrowing Owl Demography and Space-Use Research Project in California: Annual Report 1998. Institute for Bird Populations, Publication No. 96.

Rosenberg, D.K., L. Trulio, and D. DeSante 2000. Studies on Space-Use and Demography of Burrowing Owls in California. Annual Field Progress Report.

Rosenberg, D.K., D. Catlin, and K. Tice. 2003. Dispersal of Burrowing Owls in California. The Institute for Bird populations, Unpublished Report.

Rosenberg, K.V., R.D. Ohmart, W.C. Hunter, and B.W. Anderson. 1991. Birds of the Lower Colorado River Valley. University of Arizona Press, Tucson, Arizona.

Rosier, J.R., N.A. Ronan and D.K. Rosenberg. 2006. Post-Breeding Dispersal of Burrowing Owls in an Extensive California Grassland. American Midland Naturalist 155:162–167

Rowe, M.P., R.G. Coss, and D.H Owings. 1986. Rattlesnake Rattles and Burrowing Owl Hisses: A Case of Acoustic Batesian Mimicry. Ethology 72, 53-71.

Russell, S. 2002. West Nile Virus Killing U.S. Birds. San Francisco Chronicle, September 15, 2002, p. A3.

Sacramento Regional County Sanitation District (SRCSD). 2002. Case Study: Burrowing Owls.

Sacramento Regional County Sanitation District (SRCSD). 2004. Sacramento Regional Wastewater Treatment Plant Bufferlands Annual Report 2003.

Sacramento Regional County Sanitation District (SRCSD). 2006. Sacramento Regional Wastewater Treatment Plant Bufferlands Annual Report 2006.

Sales, L.P. and L. Parrott. 2024. The Owls are Coming: Positive Effects of Climate Change in Northern Ecosystems Depend on Grassland Protection. Science of the Total Environment, 907, p.167944. https://www.sciencedirect.com/science/article/pii/S0048969723065713

Salmon, T.P., W.P. Gorenzel, and W.J. Bentley. 1982. Aluminum Phosphide (Phostoxin) as a Burrow Fumigant for Ground Squirrel Control. Proceedings of the 10th Vertebrate Pest Conference, Monterey, California. Pp. 143-146.

San Bernardino County Museum (SBCM). 2001. Collection data provided by U.S. Bureau of Land Management records, Riverside Office.

San Diego. 1998. Final Multi Species Conservation Program MSCP Plan.

San Diego Museum of Natural History (SDMNH). 2001. Collection data provided by U.S. Bureau of Land Management records, Riverside Office.

San Diego Zoo Institute for Conservation Research (SDZICR). 2017. Burrowing Owl Conservation and Management Plan for San Diego County. San Diego Zoo Institute for Conservation Research, Escondido, CA.

San Diego Zoo Wildlife Alliance (SDZWA). 2018. Project Report 2018 Advancing Burrowing Owl Conservation in San Diego County through Mitigation Measures using Science and Adaptive Management. Authors Wisinski C.L, S. Marczak, R.R. Swaisgood and M. Merrick. Prepared for Metropolitan Airpark, LLC.

San Diego Zoo Wildlife Alliance (SDZWA). 2022. Metropolitan Airpark Project Report 2022 Advancing Burrowing Owl Conservation in San Diego County through Mitigation Measures using Science and Adaptive Management. Authors Wisinski C.L, S. Marczak, R.R. Swaisgood and M. Merrick. Prepared for Metropolitan Airpark, LLC.

San Joaquin Council of Governments (SJCOG). 2000. San Joaquin County Multi-Species Habitat Conservation and Open Space Plan.

San Marcos Foothills Association (SMFA). 2002. A Plan for the Preservation and Stewardship of San Marcos Foothills. www.sanmarcosfoothills.org

Santa Barbara Museum of Natural History (SBMNH). 2001. Collection data provided by Krista Fahy, Assistant Curator, Department of Vertebrate Zoology. Santa Barbara Museum of Natural History, Santa Barbara, California.

Santa Clara Valley Open Space Authority (SCVOSA). 2019. Seizing a Once-In-A-Generation Opportunity to Preserve San Jose's Last Great Landscape, Coyote Valley. https://news.openspaceauthority.org/blog/north-coyote-valley-acquisition

Santa Clara Valley Audubon Society (SCVAS). 2010. Haera Wildlife Conservation Bank. Report.

Santa Clara Valley Habitat Agency (SCVHA). 2016. Santa Clara Valley Habitat Plan 2016 Burrowing Owl Breeding Season Surveys.

Santa Clara Valley Habitat Agency (SCVHA). 2024. Western Burrowing Owl Program Update. Santa Clara Valley Habitat Plan, Public Advisory Committee.

Sapphos Environmental. 2013. Results of Habitat Assessment for Proposed Mitigation Lands of the Manzana Wind Energy Project, Kern County, California.

Sauer, J.R., S. Schwartz, and B. Hoover. 1996. The Christmas Bird Count. Version 95.1. U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, Maryland.

Sauer, J.R., J.E. Hines, and J. Fallon. 2002. The North American Breeding Bird Survey, Results and Analysis 1966-2001. Version 2002.1. USGS Patuxent Wildlife Research Center, Laurel, Maryland.

Schoenherr, A.A., C.R. Feldsmith, and M.J. Emerson. 1999. Natural History of the Islands of California. California Natural History Guide.

Schreiber, R.W. 1970. Breeding Biology of Western Gulls (*Larus occidentalis*) on San Nicolas Island, California, 1968. Condor 72: 133-140.

Schulz, T.A. 1997. Observations, Resightings, and Encounters of Rehabilitated, Orphaned, and Relocated Burrowing Owls. Pp. 128-131 *in* Lincer, J.L. and K. Steenhof (editors). 1997. The Burrowing Owl, Its Biology and Management. Raptor Research Report Number 9.

Schwarzbach, S.E. 1991. The Role of Dicofol Metabolites in the Eggshell Thinning Response of Ring-Neck Doves. Archives of Environmental Contamination and Toxicology 20: 200-205.

Sequoia Riverlands Trust. 2014. Deed of Natural Conservation Easement.

Sharp, C.S. 1907. The Breeding Birds of Escondido. Condor. Volume IX, Number 3, May-June 1907, p. 87.

Sheffield, S.R. 1997a. Current Status, Distribution, and Conservation of the Burrowing Owl (*Speotyto cunicularia*) in Midwestern North America. Pages 399-407 *in* J.R. Duncan, D.H. Johnson, and T.H. Nichols (editors). Biology and Conservation of Owls of the Northern Hemisphere. USDA Forest Service, General Technical Report NC-190. North Central Forest Experiment Station, St. Paul, Minnesota.

Sheffield, S.R. 1997b. Owls as Biomonitors of Environmental Contamination. Pages 383-398 *in* J.R. Duncan, D.H. Johnson, and T.H. Nichols (editors). Biology and Conservation of Owls of the Northern Hemisphere. USDA Forest Service, General Technical Report NC-190. North Central Forest Experiment Station, St. Paul, Minnesota.

Sheffield, S. 2021. Population Dynamics and Conservation of the Western Burrowing Owl (*Athene cunicularia hypugaea*) in North America: A 20-Year Update. https://www.researchgate.net/publication/350471917

Sheldon, H.H. 1909. Notes on some Birds of Kern County. Condor. Volume XI, Number 5, September-October 1909, p. 171.

Shuford, D.W. 1993. The Marin County Breeding Bird Atlas. A Distributional and Natural History of Coastal California Birds. California Avifauna Series 1. Point Reyes Bird Observatory.

Shyry, D.T., T.I. Wellicome, J.K. Schmutz, G.L. Erickson, D.L. Scobie, R.F. Russell, and R.G. Martin. 2001. Burrowing Owl Population-Trend Surveys in Southern Alberta: 1991-2000. Journal of Raptor Research 35(4): 310-315.

Sierra Army Depot (SAD). 1992. Wildlife Management Plan for Sierra Army Depot, Herlong, California. Sierra Army Depot, Division of Environmental Management. Herlong, California.

Sissons, R.A, K.L. Scalise, and T.I. Wellicome. 2001. Nocturnal Foraging and Habitat Use by Male Burrowing Owls in a Heavily Cultivated Region of Southern Saskatchewan. Journal of Raptor Research 35:304-309.

Skirm, J. 1884. List of Birds of Santa Cruz, Cal. Ornithologist and Oologist. Vol. IX, No. 12, December 1884. pp. 149-150.

Small, A. 1974. The Birds of California. Winchester Press, New York, New York.

Smallwood, K.S. 2004. Comment letter to Winters City Council on Negative Declaration for the proposed Winters Highlands Subdivision, May 19, 2004.

Smallwood, K.S. 2008. Wind Power Company Compliance with Mitigation Plans in the Altamont Pass Wind Resource Area. Environmental & Energy Law Policy Journal 2: 229–285.

Smallwood, K.S. 2011. Comment on Mount Signal and Calexico Solar Farm Projects DEIR. Submitted to County of Imperial Planning and Development Services Department, 21 December 2011.

Smallwood, K.S. 2012. Comment on Solar Gen 2 Array Project DEIR. Submitted to County of Imperial Planning and Development Services Department, 8 April 2012.

Smallwood, K.S. 2013a. Comparing Bird and Bat Fatality-Rate Estimates Among North American Wind-Energy Projects. Wildlife Society Bulletin 37: 19–33.

Smallwood, K.S. 2013b. 21 February 2013 comment letter to City of Davis Public Works Department on Sewer Trunk Rehabilitation Mitigated Negative Declaration.

Smallwood, K.S. 2013c. Comments on Imperial Valley Solar Company 2 Project DEIR. Submitted to Imperial County Planning and Development Services February 18, 2013.

Smallwood, K.S. 2015a. Comments on Draft Desert Renewable Energy Conservation Plan DEIR/DEIS. Submitted to California Energy Commission February 25, 2015.

Smallwood, K.S. 2015b. Comments on Proposed Regulation for California Fish and Game Code Section 3503.5. Submitted to California Department of Fish and Wildlife, 22 September 2015.

Smallwood, K.S. 2021. Comments on the Draft Subsequent Environmental Impact Report for the Mulqueeney Ranch Wind Repowering Project.

Smallwood, K.S. 2022. Utility-Scale Solar Impacts to Volant Wildlife. Journal of Wildlife Management: e22216. https://doi.org/10.1002/jwmg.22216

Smallwood, K.S. 2022b. Comments to Riverside County Planning Department on Renaissance Ranch Commerce Center Draft Environmental Impact Report, 10 August 2022.

Smallwood, K.S. 2023a. Ecology and Recent Population Trend of Burrowing Owls in the Altamont Pass Wind Resource Area. 2023 Burrowing Owl Symposium, February 6-7, 2023, Riverside, CA. The Wildlife Society. https://sites.google.com/tws-west.org/2023buowsymposium/abstracts?authuser=0

Smallwood, K.S. 2023b. Renewable Energy Impacts to Burrowing Owls. 2023 Burrowing Owl Symposium, February 6-7, 2023, Riverside, CA. The Wildlife Society. https://sites.google.com/tws-west.org/2023buowsymposium/abstracts?authuser=0

Smallwood, K.S. 2023c. Comments to the City of Lathrop on Ashley Warehouse Project, 1 October 2023.

Smallwood, K.S. 2023d. Comments to the City of Desert Hot Springs on PODS Warehouse Initial Study and Mitigated Negative Declaration, 27 February 2023.

Smallwood, K.S. and D.A. Bell. 2020. Effects of Wind Turbine Curtailment on Bird and Bat Fatalities. Journal of Wildlife Management 84:684-696. DOI: 10.1002/jwmg.21844

Smallwood, K.S. and D.A. Bell. 2022. Ground Squirrel Abundance and Repeat Raptor Surveys at Vasco Caves Regional Preserve, 2006–2019. Report to the East Contra Costa County Habitat Conservancy, Science and Research Grant Program.

Smallwood, K.S. and B. Karas. 2009. Avian and Bat Fatality Rates at Old-Generation and Repowered Wind Turbines in California. Journal of Wildlife Management 73: 1062–1071.

Smallwood, K.S. and M.L. Morrison. 2018. Nest-Site Selection in A High-Density Colony of Burrowing Owls. Journal of Raptor Research 52(4):454–470.

Smallwood, K.S. and M.L. Morrison. 2019. Efficacy of Mitigating Burrowing Owl Habitat Loss.

Smallwood, K.S. and L. Neher. 2004. Repowering the APWRA: Forecasting and Minimizing Avian Mortality without Significant Loss of Power Generation. PIER Energy-Related Environmental Research, CEC-500-2005-005. California Energy Commission: Sacramento, CA.

Smallwood, K.S. and L. Neher. 2009. Map-Based Repowering of the Altamont Pass Wind Resource Area Based on Burrowing Owl Burrows, Raptor Flights, and Collisions with Wind Turbines. Public Interest Energy Research–Environmental Area, Contract No. CEC-500-2009-065. California Energy Commission: Sacramento, CA.

Smallwood, K.S. and N.L. Smallwood. 2023. Measured Effects of Anthropogenic Development on Vertebrate Wildlife Diversity. Diversity 2023, 15(10), 1037. https://doi.org/10.3390/d15101037

Smallwood, K.S. and C.G. Thelander. 2004. Developing Methods to Reduce Bird Mortality in the Altamont Pass Wind Resource Area. Final Report to the California Energy Commission, Public Interest Energy Research – Environmental Area, Contract No. 500-01-019. Sacramento, CA: California Energy Commission.

Smallwood, K.S. and C.G. Thelander. 2008. Bird Mortality in the Altamont Pass Wind Resource Area, California. Journal of Wildlife Management 72: 215–223.

Smallwood, K., B. Wilcox, R. Leidy and K. Yarris. 1998. Indicators Assessment for Habitat Conservation Plan of Yolo County, California, USA. Environmental Management 22: 947–958.

Smallwood, K.S., C.G. Thelander, and L. Spiegel. 2003. Toward a Predictive Model of Avian Fatalities in the Altamont Pass Wind Resource Area. California Energy Commission, Sacramento, CA.

Smallwood, K.S., C.G. Thelander, M.L. Morrison and L.M. Rugge. 2007. Burrowing Owl Mortality in the Altamont Pass Wind Resource Area. The Journal of Wildlife Management 71(5): 1513-1524.

Smallwood, K.S., L. Neher and D.A. Bell. 2009a. Map-Based Repowering and Reorganization of a Wind Resource Area to Minimize Burrowing Owl and Other Bird Fatalities. Energies 2009, 2, 915-943. doi:10.3390/en20400915

Smallwood, K.S., L. Neher, D.A. Bell, J. DiDonato, B. Karas, S. Snyder, and S. Lopez. 2009b. Range Management Practices to Reduce Wind Turbine Impacts on Burrowing Owls and Other Raptors in the Altamont Pass Wind Resource Area, California. Final Report to the California Energy Commission, Public Interest Energy Research – Environmental Area, Contract No. CEC-500-2008-080. Sacramento, CA: California Energy Commission.

Smallwood, K.S., L. Rugge and M.L. Morrison. 2009c. Influence of Behavior on Bird Mortality in Wind Energy Developments: The Altamont Pass Wind Resource Area, California. Journal of Wildlife Management 73: 1082–1098.

Smallwood, K.S., L. Neher, J. Mount and R.C.E Culver. 2013. Nesting Burrowing Owl Density and Abundance in the Altamont Pass Wind Resource Area, California. Wildlife Society Bulletin 37(4):787–795.

Smallwood, K.S., L. Neher and D.A. Bell. 2017 Turbine Siting for Raptors: An Example from Repowering of the Altamont Pass Wind Resource Area. Chapter 7 *in* Wildlife and Wind Farms.

Smith, G.J. 1992. Toxicology and Pesticide Use in Relation to Wildlife: Organophosphorus and Carbamate Compounds. C.K. Smoley, Boca Raton, FL, pp. 3-18.

South, C.A. 1940. Winter Record of Burrowing Owl in Northern California. Condor. Volume XLII, Number 5, September-October 1940, p. 266.

South Valley Biology Consulting LLC (SVB). 2015-2019. 2014-2018 Annual Monitoring Reports for Coles Levee Ecosystem Preserve. Prepared for Aera Energy LLC.

Southern California Association of Governments (SCAG). 2019. Local Profiles. http://www.scag.ca.gov/DataAndTools/Pages/LocalProfiles.aspx

Southern California Association of Governments (SCAG). 2023. Draft Program Environmental Impact Report for the Southern California Association of Governments' 2024–2050 Regional Transportation Plan/Sustainable Communities Strategy.

Sperry, C.C. 1941. Burrowing Owls Eat Spadefoot Toads. Wilson Bulletin 53: 45.

Stallcup, R. and R. Greenberg. 1974. Middle Pacific Coast Region Report. American Birds, Volume 28, Number 5, p. 945.

Stanton, E.J. and S. Teresa. 2007. Management of Burrowing Owl Habitat on Mitigation Lands. Pages 132-136 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

Stebbins, G.L. and D.W. Taylor. 1973. A Survey of the Natural History of the South Pacific Border Region, California. Prepared for the National Park Service, United States Department of the Interior. Institute of Ecology, University of California, Davis.

Stephens, F. 1895. *Speotyto cunicularia obscura*. Auk. Volume XII, October 1895, p. 372.

Stephens, F. 1902. Owl Notes from Southern California. Condor, Vol. IV, March 1902, p. 40.

Stephens, L.A. and C.C. Pringle. 1933. Birds of Marin County. Audubon Association of the Pacific, San Francisco, California.

Stone, R.D. and V.A. Sumida. 1983. The Kingston Range of California: A Resource Survey. Publication No. 10, Environmental Field Program. University of California, Santa Cruz.

Stoner, E.A. 1922. Behavior of a Barn Owl in Captivity. Condor. Volume XXIV, Number 3, May-June 1922, p. 100.

Stoner, E.A. 1932a. Notes on the Western Burrowing Owl. Condor. Volume XXXIV, Number 5, September-October 1932, p. 228.

Stoner, E.A. 1932b. The Approximate Louse Population of a Burrowing Owl. Condor. Volume XXXIV, Number 5, September-October 1932, p. 230.

Stoner, E.A. 1933a. Some Subsistence Items of Western Burrowing Owls. Condor. Volume XXXV, Number 5, September-October 1933, p. 204.

Stoner, E.A. 1933b. Burrowing Owls Occupying Unusual Quarters. Condor. Volume XXXV, Number 1, January-February 1933, p. 36.

Storer, T.I. 1926. Range Extensions by the Western Robin in California. Condor. Volume XXVIII, Number 6, November-December 1926, p. 266.

Streator, C.P. 1886. List of Birds Observed in the Vicinity of Santa Barbara, Cal., During the Year 1885. Ornithologist and Oologist. Vol. XI, No. 5, May 1886, p. 67.

Streator, C.P. 1888. Notes on the Birds of the Santa Barbara Islands. Ornithologist and Oologist. Vol. XIII, No. 4, April 1888, pp. 52-54.

Streator, C.P. 1947. Birds of Santa Cruz County, California; A List. Santa Cruz, Santa Cruz Public Library.

Sullivan, B.L., C.L. Wood, M.J. Iliff, R.E. Bonney, D. Fink and S. Kelling. 2009. eBird: A Citizen-Based Bird Observation Network in the Biological Sciences. Biological Conservation 142: 2282-2292.

Sumner, L. and J. S. Dixon. 1953. Birds and Mammals of the Sierra Nevada. University of California Press, Berkeley, California.

Sustain Environmental. 2007-2009. Grasslands Park Burrowing Owl Reserve Reports 2007, 2008, 2009.

Swarth, H.S. 1900. Avifauna of a 100-Acre Ranch. Condor. Volume 2, Number 1, January-February 1900, p. 16.

Swaisgood, R.R. and C.L. Wisinski. 2023. Engineering Better Burrows: Establishing Ground Squirrels and Improving Artificial Burrow Design. 2023 Burrowing Owl Symposium, February 6-7, 2023, Riverside, CA. The Wildlife Society. https://sites.google.com/tws-west.org/2023buowsymposium/abstracts?authuser=0

Swaisgood, R.R., C. Wisinski, J.P. Montagne, S. Marczak, D.M. Shier, and L.A. Nordstrom. 2014. Project Report 2014: An Adaptive Management Approach to Recovering Burrowing Owl Populations and Restoring a Grassland Ecosystem in San Diego County. San Diego Zoo Institute for Conservation Research, Escondido, CA.

Talon Ecological Research Group. 2023. Status, Distribution, and Management of Burrowing Owls in Santa Clara County. Menzel, S., P. Higgins, R. Phillips, A. Bradshaw and G. Hube. 2023 Burrowing Owl Symposium. 70th Annual Meeting of The Wildlife Society, Western Section. February 6-7, 2023, Riverside, CA.

Taylor, M.F.J., K.F. Suckling and J.J. Rachlinski. 2005. The Effectiveness of the Endangered Species Act: A Quantitative Analysis. BioScience 55: 360–367.

Tenaza, R.R. 1967. Recent Records of Land Birds from South Farallon Island, California. Condor. Volume 69, Number 6, November-December 1967, p. 579.

Thompson, C.D. and S.H. Anderson. 1988. Foraging Behavior and Food Habits of Burrowing Owls in Wyoming. Prairie Naturalist 20: 23-28.

Thomsen, L. 1971. Behavior and Ecology of Burrowing Owls on the Oakland Municipal Airport. Condor. Volume 73, Number 2, Summer 1971, pp. 177-192.

Ting, I.P. and B. Jennings. 1976. Deep Canyon, a Desert Wilderness for Science. The Phillip L. Boyd Deep Canyon Desert Research Center, Palm Desert. University of California, Riverside.

Townsend, C.H. 1887. Field Notes on the Mammals, Birds, and Reptiles of Northern California. Extract from Proceedings of the U. S. National Museum. Washington.

Townsend, S.E. and C. Lenihan. 2007. Burrowing Owl Status in the Greater San Francisco Bay Area. Pages 60-69 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

Townsend, W.L. 1968. Birds Observed on San Nicolas Island, California. Condor 70: 266-268.

Trulio, L.A. 1994. The Ecology of a Population of Burrowing Owls at a Naval Air Station in Northern California. Dept. of the Navy. San Bruno, CA.

Trulio, L.A. 1995. Passive Relocation: A Method to Preserve Burrowing Owls on Disturbed Sites. Journal of Field Ornithology 66: 99-106.

Trulio, L.A. 1997. Strategies for Protecting Western Burrowing Owls (*Speotyto cunicularia hypugaea*) from Human Activities. Pp. 461-465 *in* Duncan, J.R., D.H. Johnson, and T.H. Nicholls (editors). Biology and Conservation of Owls of the Northern Hemisphere. USDA Forest Service General Technical Report NC-190. St. Paul, Minnesota.

Trulio, L.A. 1997b. Burrowing Owl Demography and Habitat Use at Two Urban Sites in Santa Clara County, California. Pp. 84-89 *in* J.L. Lincer and K. Steenhof, editors. The Burrowing Owl, Its Biology and Management. Raptor Research Report No. 9.

Trulio, L.A. 1998a. The Burrowing Owl as an Indicator of CEQA Effectiveness and Environmental Quality in Silicon Valley. Environmental Monitor. Fall 1998. pp. 4-5.

Trulio, L.A. 1998b. Native Revival: Efforts to Protect and Restore the Burrowing Owl in the South Bay Area. Tideline. Volume 18, Spring 1988, pp. 1-3.

Trulio, L.A. 2002. Burrowing Owl Ecology and Demography Study: NASA Yearly Summary Report for 2001. Prepared Environmental Services Division, NASA/Ames Research Center, Moffett Federal Airfield, Moffett Field, CA.

Trulio, L.A. 2003. Burrowing Owl Habitat Disappearing in Silicon Valley. Silicon Valley 2002 Environmental Index. Silicon Valley Environmental Partnership. Pg. 28.

Trulio, L.A. and D.A. Chromczak. 2007. Burrowing Owl Nesting Success At Urban and Parkland Sites in Northern California. Pages 115-122 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

Trulio, L.A. and P. Higgins. 2012. The Diet of Western Burrowing Owls in an Urban Landscape. Western North American Naturalist, 72(3), pp.348-356.

Trulio, L.A., D.A. Chromczak, P.G. Higgins, S. Menzel, C.M. Bossu and K. Ruegg. 2023. Combining Genomic and Field Analyses to Reveal Migratory Status in a Burrowing Owl Population. Conservation Genetics, pp.1-11.

Tyler, J.G. 1913a. Some Birds of the Fresno District, California. Pacific Coast Avifauna, Number 9. Cooper Ornithological Club.

Tyler, J.G. 1913b. Notes on Some Fresno County Birds. Condor. Volume XV, Number 1, January-February 1913, p. 18.

U.S. Army. 2009. Final Environmental Impact Statement: Master Planned Redevelopment at Camp Parks. U.S. Army Garrison, Fort Hunter Liggett, CA.

United States Army Corps of Engineers (USACE). 1991. Environmental Assessment for the Closure and Realignment of Hamilton Army Airfield (HAAF), California. Prepared for Dept. of the Army Headquarters, Forces Command, Fort McPherson, Georgia.

United States Army Corps of Engineers (USACE). 1995. Draft Environmental Impact Statement, Hamilton Army Airfield Disposal and Reuse. Prepared by the U.S. Army Corps of Engineers, Sacramento District, with technical assistance from Jones & Stokes Associates, Inc.

United States Army Corps of Engineers (USACE). 1998. Final EIR for the Oakland Harbor Navigation Improvement (-50 Foot) Project. U.S. Army Corps of Engineers, San Francisco District. https://ceqanet.opr.ca.gov/Project/1997072051

United States Army Corps of Engineers (USACE). 2023. Regulatory In Lieu Fee and Bank Information Tracking System. https://ribits.ops.usace.army.mil/ords/f?p=107:2

United States Bureau of Land Management (USBLM). 2002. *Athene cunicularia* - Burrowing Owl. Bureau of Land Management records, Barstow Field Office.

United States Bureau of Land Management (USBLM). 2004. Final Environmental Impact Report and Statement for the West Mojave Plan. A Habitat Conservation Plan and California Desert Conservation Area Plan Amendment.

United States Bureau of Land Management (USBLM). 2012. El Centro Office Draft Environmental Impact Statement/Draft CDCA Plan Amendment Ocotillo Sol Project. U.S. Department of the Interior, BLM/CA/ES-2012-009+1793, DES 20-12, DOI-BLM-CA-D000-2012-0005-EIS. El Centro, California. https://ceqanet.opr.ca.gov/2012044003

United States Department of Agriculture (USDA). 1978. Big Sur Coastal Planning Unit. Final Environmental Statement. U.S. Forest Service, Los Padres National Forest.

United States Department of Agriculture (USDA) and United States Department of the Interior (USDI). 1996. North Fork Eel River watershed analysis. USDA Forest Service Pacific Southwest Region, Six Rivers National Forest and USDI Bureau of Land Management California State Office, Arcata Resource Area.

United States Environmental Protection Agency (USEPA). 1991. Environmental Fact Sheet for Carbofuran. Office of Pesticides and Toxic Substances, Washington, DC, pp. 3-34.

United States Environmental Protection Agency (USEPA). 2003. Vulnerable Listed (Endangered and Threatened) Species Pilot Project: Proposed Mitigations, Implementation Plan, and Possible Expansion. Draft Plan. USEPA, Office of Pesticide Programs. June 2023.

United States Fish and Wildlife Service (USFWS). 1995. Biological Information Report. Palm Springs Ground Squirrel Survey, August 11, 1995.

United States Fish and Wildlife Service (USFWS). 1998. Federal, State Cooperation Secure "Stay of Execution" for California Birds. USFWS Press Release, April 6, 1998.

United States Fish and Wildlife Service (USFWS). 2001. Final Environmental Impact Statement, Metro Air Park Project. https://www.fws.gov/policy/library/2001/01fr43265.html

United States Fish and Wildlife Service (USFWS). 2003. Status Assessment and Conservation Plan for the Western Burrowing Owl in the United States. Klute, D.S., L.W. Ayers, M.T. Green, W.H. Howe, S.L. Jones, J.A. Shaffer, S.R. Sheffield and T.S. Zimmerman.

U.S. Fish and Wildlife Service (USFWS). 2018. Joshua Tree Species Status Assessment. Dated July 20, 2018. 113 pp. + Appendices A–C.

United States Fish and Wildlife Service (USFWS). 2021. Birds of Conservation Concern 2021. Migratory Bird Program.

United States Fish and Wildlife Service (USFWS). 2023. Conservation Plans Region Summary HCP. ECOS Environmental Conservation Online System. https://ecos.fws.gov/ecp/report/conservation-plans-region-summary?region=8&type=HCP

United States National Park Service (USNPS). 1937. Check-List of the Birds of the National Parks. Department of the Interior, Washington, D.C. p. 29.

United States Navy (USN). 2002. Bird/Animal Strike Hazard Program.

Unitt, P. 1984. The Birds of San Diego County. San Diego Society of Natural History.

Unitt, P. 2002. San Diego County Bird Atlas: Breeding Bird Species Accounts. San Diego Natural History Museum.

University of California, Irvine (UCI). 1995. UC Irvine Ecological Preserve Draft Management Plan. http://conbio.bio.uci.edu/ep

University of California, Los Angeles (UCLA). 2001. Collection data provided by Kathy Molina, D.R. Dickey Bird and Mammal Collection Manager. University of California, Los Angeles.

University of California, Santa Barbara (UCSB). 2001. Collection data provided by Mark Holmgren, Associate Director. Museum of Systematics and Ecology, University of California, Santa Barbara.

University of California, Santa Cruz (UCSC). 2001. Collection data provided by Jeff Davis, Senior Museum Scientist. Museum of Natural History Collections, University of California, Santa Cruz.

University of Washington Burke Museum (UWBM). 2001. Collection data provided by Robert Faucett, Collections Manager, Ornithology. Burke Museum, University of Washington.

URS. 2002. Natural Environment Study/Biological Assessment, Merced Campus Parkway. Prepared for Merced County Department of Public Works, Merced, California, and Caltrans, District 10, Stockton, California.

Van Denburgh, J. 1899. Notes on Some Birds of Santa Clara County, California. Proc. Amer. Phil. Soc. 38: 157-180.

Van Dyke, T.S. 1888. Southernmost California. *In* J. Muir (editor). Picturesque California and the Region West of the Rocky Mountains, from Alaska to Mexico. Republished as West of the Rocky Mountains, by Running Press, Philadelphia, PA, 1976.

Van Mantgem, E.F. 2002. Colonel Allensworth State Historic Park Burrowing Owl Quarterly Report, July 15, 2002. Unpublished report.

Van Rossem, A. 1914. Notes from the San Bernardino Mountains. Condor. Volume XVI, Number 3, May-June 1914, pp. 145-146.

Voous, K H. 1988. Owls of the Northern Hemisphere. M.I.T. Press, Cambridge, Massachusetts.

Walker C.H. 1983. Pesticides and Birds — Mechanisms of Selective Toxicity. Agriculture, Ecosystems & Environment, Volume 9, Issue 2. Pages 211-226. ISSN 0167-8809, https://doi.org/10.1016/0167-8809(83)90042-7.

Walston, L.J., Jr., K.E. Rollins, K.E. LaGory, K.P. Smith and S.A. Meyers. 2016. A Preliminary Assessment of Avian Mortality at Utility-Scale Solar Energy Facilities in the United States. Renewable Energy, 92, 405–414.
https://doi.org/10.1016/j.renene.2016.02.041

Waples, R.S. 1991. Definition of "Species" Under the Endangered Species Act: Application to Pacific Salmon. NOAA (National Oceanic and Atmospheric Administration) Technical Memorandum NMFS (National Marine Fisheries Service) F/NWC-194, Northwest Fisheries Science Center, Seattle.

Warnock, R. 1996. Spatial, Temporal and Turnover Dynamics of Burrowing Owls in the Extensively Fragmented Grasslands of Saskatchewan. M.S. Thesis. University of Regina, Regina, Saskatchewan. 112 pages.

Warnock, R. 1997. Is Habitat Fragmentation a Factor in the Decline of the Burrowing Owl in Saskatchewan? Blue Jay. Vol. 55, No. 4: 222-228.

Warnock, R.G., and P.C. James. 1997. Habitat Fragmentation and Burrowing Owls (*Speotyto cunicularia*) in Saskatchewan. Pages 477-486 *in* J.R. Duncan, D.H. Johnson, and T.H. Nichols (editors). Biology and Conservation of Owls of the Northern Hemisphere. USDA Forest Service, General Technical Report NC-190. North Central Forest Experiment Station, St. Paul, Minnesota.

Warrick, S F. 1982. The Natural History of the UC Santa Cruz Campus. Publication No. 11, Environmental Field Program. University of California, Santa Cruz.

Wauer, R.H. 1962. A Survey of the Birds of Death Valley. Condor. Volume 64, Number 3, May-June 1962, pp. 220-226.

Wauer, R.H. 1964. Ecological Distribution of the Birds of the Panamint Mountains, California. Condor. Volume 66, Number 4, July-August 1964, p. 290.

Weathers, W.W. 1983. Birds of Southern California's Deep Canyon. University of California Press, Berkeley, Los Angeles, London.

Wedgwood, J.A. 1976. Burrowing Owls in South-Central Saskatchewan. Blue Jay 34: 26-44.

Wedgwood, J.A. 1978. The Status of the Burrowing Owl in Canada. Prepared for the Committee on the Status of Endangered Wildlife in Canada. Canadian Wildlife Service, Ottawa.

Wellicome, T.I. 1997. Status of the Burrowing Owl (*Speotyto cunicularia hypugaea*) in Alberta. Wildlife Status Report No. 11. Alberta Environmental Protection, Wildlife Management Division, Edmonton, Alberta.

Wellicome, T.I. and E.A. Haug. 1995. Second Update of Status Report on the Burrowing Owl (*Speotyto cunicularia*) in Canada. Committee on the Status of Endangered Wildlife in Canada, Canadian Wildlife Service, Environment Canada, Ottawa, Ontario.

Wellicome, T.I. and G L. Holroyd. 2001. The Second International Burrowing Owl Symposium: Background and Context. Journal of Raptor Research 35(4): 269-273.

Wellicome, T.I., G L. Holroyd, K. Scalise and E.R. Wiltse. 1997. The Effects of Predator Exclusion and Food Supplementation on Burrowing Owl (*Speotyto cunicularia*) Population Change in Saskatchewan. Pages 487-497 *in* J.R. Duncan, D.H. Johnson and T.H. Nicholls (editors). Biology and Conservation of Owls of the Northern Hemisphere: Second International Symposium. USDA, For. Serv. Gen. Tech. Rep. NC-1901 North Central For. Exp. Station.

West, E.W. 1973. Indian Valley Project. Wildlife ecology and management study of Indian Valley Reservoir, California. Yolo County Flood Control & Water Conservation District.

Western Environmental Law Center (WELC). 2002. Center for Biological Diversity and California/Nevada Desert Committee of the Sierra Club Comments on the Draft Environmental Impact Report/Environmental Impact Statement and Draft Habitat Conservation Plan for the Imperial Irrigation District Water Conservation and Transfer Project. Submitted to Bureau of Reclamation, Phoenix, AZ, and Imperial Irrigation District, Imperial, CA.

Western Foundation of Vertebrate Zoology (WFVZ). 2001. Collection data provided by Rene Corado, Collections Manager. Western Foundation of Vertebrate Zoology, Camarillo, California.

Western Riverside County regional Conservation Authority. 2021. Western Riverside County Multiple Species Habitat Conservation Plan Annual Report, 2021.

Westervelt Ecological Services. 2009-2023. Burke Ranch Conservation Bank 2008-2022 Annual Reports.

Westervelt Ecological Services. 2013. Summary of Wildlife Observations on the Proposed Dutchman Creek Conservation Bank Property.

Westervelt Ecological Services. 2014. Exhibit H-1 Biological Resources Survey Summary Report.

WRA. 2013-2020. 2012-2019 Annual Monitoring Reports Elsie Gridley Mitigation Bank, Solano County, California. Prepared for Wetland Resources LLC.

Wheeler, C.M., J.R. Douglas, and F.C. Evans. 1941. The Role of the Burrowing Owl and the Sticktight Flea in the Spread of Plague. Science, September 12, 1941, p. 560-561.

Whitney, K.L. and K.E. Kudrak. 1997. Burrowing Owl. Draft report submitted to Vandenberg Air Forde Base.

Widdicombe, J.H. 2007. Nesting Burrowing Owls in Solano and Yolo Counties, California, 2000-2005. Pages 52-59 *in* Proceedings of the California Burrowing Owl Symposium, November 2003. Institute for Bird Populations and Albion Environmental, Inc. Bird Populations Monographs No. 1.

Wiemeyer, S.N., J.W. Spann, C.M. Bunck, and A.J. Krynitsky. 1989. Effects of Kelthane on Reproduction of Captive Screech Owls. Environmental Toxicology and Chemistry 8: 903-913.

Wilder, H.E. 1916. Some Distributional Notes on California Birds. Condor. Volume XVIII, Number 3, May-June 1916, p. 128.

Wildlands. 2011. Alta Oak Creek Mojave Mitigation Preserve, Kern County, California.

Wildlands. 2012. Cuddeback Lake Preserve Habitat Management Lands Acquisition Package for the Alta Oak Creek Mojave Project Infill. CDFG Incidental Take Permit No. 2081-2011-009-04, San Bernardino County, California.

Wildlife Research Institute (WRI). 2009. WRI Burrowing Owl Update #5.

Wiley, J.W. 1975. The Nesting and Reproductive Success of Red-Tailed Hawks and Red-Shouldered Hawks in Orange County, California, 1973. Condor. Volume 77, Number 2, Summer 1975, p. 133.

Wilkerson, R.L. and R.B. Siegel. 2010. Assessing Changes in the Distribution and Abundance of Burrowing Owls in California, 1993-2007. Bird Populations 10:1-36.

Wilkerson, R.L. and R.B. Siegel. 2011. Distribution and Abundance of Western Burrowing Owls (*Athene cunicularia hypugaea*) in Southeastern California. The Southwestern Naturalist 56(3):378–384.

Willett, G. 1908. Summer Birds of the Upper Salinas Valley and adjacent foothills. Condor. Volume X, Number 4, July-August 1908, p. 138.

Willett, G. 1910. A Summer Trip to the Northern Santa Barbara Islands. Condor. Volume XII, Number 5, September-October 1910, p. 172.

Willett, G. 1912. Birds of the Pacific Slope of Southern California. Pacific Coast Avifauna Number 7. Cooper Ornithological Club, Hollywood, California, 1912. p. 53.

Wilson, I.D. 1945. Birds of the Kettleman Hills Area, California. Condor. Volume 47, Number 4, July-August 1945, pp. 149-153.

City of Winters (Winters). 2006. Winters Highlands Environmental Impact Report. https://www.cityofwinters.org/DocumentCenter/View/1074/Winters-Highlands-Environmental-Impact-Report

Wisinski, C.L., S.M. Hennessy, J.P. Montagne, S. Marczak, M. Stevens, J. Hargis, D.M. Shier, R.R. Swaisgood and L.A. Nordstrom. 2016. Project Report 2016: An Adaptive Management

Approach to Recovering Burrowing Owl Populations and Restoring a Grassland Ecosystem in San Diego County. San Diego Zoo Institute for Conservation Research, Escondido, CA.

Wisinski, C. L., S. Marczak, S. M. Hennessy, M. Stevens, S. Perez, D. Angel, K. Hines, R. R. Swaisgood, and L. A. Nordstrom. 2020a. Project Report 2019: Advancing Burrowing Owl Conservation in San Diego County through Mitigation Measures using Science and Adaptive Management. San Diego Zoo Institute for Conservation Research, Escondido, CA.

Wisinski, C. L., S. Marczak, S. M. Hennessy, M. Stevens, S. Perez, D. Angel, K. Hines, R. R. Swaisgood, and L. A. Nordstrom. 2020b. Project Report 2019: Advancing Burrowing Owl Conservation in San Diego County through Mitigation Measures using Science and Adaptive Management. San Diego Zoo Institute for Conservation Research, Escondido, CA.

Wisinski, C.L., S.M. Hennessy, S.A. Marczak, D. Mayer, T. Nelson, L.A. Nordstrom, K. Rice, H. Sin, M.T. Stevens and R.R. Swaisgood. 2021. Building a New Burrowing Owl Subpopulation Through Collaboration and Translocation. Ecology and Conservation of Birds. The Wildlife Society.

Wisinski, C.L., S. Marczak, R.R. Swaisgood and M. Merrick. 2022. Metropolitan Airpark Project Report 2022: Advancing Burrowing Owl Conservation in San Diego County through Mitigation Measures using Science and Adaptive Management. San Diego Zoo Wildlife Alliance, Escondido, CA.

Wisinski, C.L., S. Marczak, R.R. Swaisgood and M. Merrick. 2023. Burrowing Owl Translocation Report 2023. San Diego Zoo Wildlife Alliance, Escondido, CA.

Wyllie, I. 1995. Potential Secondary Poisoning of Barn Owls by Rodenticides. Pesticide Outlook 5: 19-25.

Yolo County. 2023. Crop Statistics. https://www.yolocounty.org/government/general-government-departments/agriculture-cooperative-extension/agriculture-and-weights-measures/crop-statistics

Yolo Habitat Conservancy (YHC). 2017. Yolo HCP/NCCP Public Review Draft, May 2017. Appendix A, Covered Species Accounts.

York, M., D.K. Rosenberg, and K.K. Strum. 2002. Diet and Food-Niche Breadth of Burrowing Owls (*Athene cunicularia*) in the Imperial Valley, California. Western North American Naturalist 62: 280-287.

Zarn, M. 1974a. Burrowing Owl. U.S. Department of the Interior, Bureau of Land Management. Tech. Note T-N-250, Denver, Colorado, 25pp.

Zarn, M. 1974b. Habitat Management Series for Unique or Endangered Species. Report no. 12: Osprey (*Pandion haliaetus carolinensis*). U.S. Department of the Interior, Bureau of Land Management. Technical note T-N-254. 41 pp.

Zeiner, D.C., Jr., W.F. Laudenslayer, K.E. Mayer, and M. White (editors). 1990. California's Wildlife. Volume II. Birds. California Statewide Wildlife Habitat Relationships Systems. Sacramento, California: California Department of Fish and Game. 732 pp.

Personal Communication Sources

Chris Alford, Alford Environmental, consultant for Yolo Habitat Conservancy

Jake Aucelluzzo, CDFW Unit Wildlife Biologist, Yolo Bypass Wildlife Area

John H. Barclay, Albion Environmental, Inc., Santa Cruz, CA

Jack Bath, Ph.D., Professor of Zoology, California State Polytechnic University, Pomona, CA

Doug Bell, Ph.D., Wildlife Program Manager, East Bay Regional Park District

Peter Bloom, Western Foundation of Vertebrate Zoology, Camarillo, CA

Craig Breon, Executive Director, Santa Clara Valley Audubon Society, Cupertino, CA

Nikolle Brown, Wildlife Biologist, Clovis, CA

Debra Chromczak, Burrowing Owl Specialist, Mountain View, CA

Charlie Collins, Biological Sciences Professor, California State University, Long Beach, CA

Chris Conard, Natural Resource Specialist with Sacramento Bufferlands

Michael Connor, Executive Director, Desert Tortoise Preserve Committee, Riverside, CA

Daniel Cooper, Director of Bird Conservation, Audubon California, Los Angeles, CA

Penelope Delevoryas, Wildlife Biologist, Shoreline Park, Mountain View, CA

Dr. David DeSante, Biologist/Executive Director, Institute for Bird Populations, Point Reyes Station, CA

Joseph DiDonato, Wildlife Program Manager, East Bay Regional Park District, Oakland, CA

Linda Dye, National Park Service, Channel Islands National Park

Jim Estep, Estep Environmental Consulting, consultant for Yolo Habitat Conservancy

Abigail Fateman, Executive Director, East Contra Costa County Habitat Conservancy

Jennifer Gervais, Assistant Professor of Research, Department of Forest, Range and Wildlife Sciences, Utah State University, Logan, UT

Daniel Guthrie, Professor of Biology, Claremont McKenna College; President, Pomona Valley Audubon Society, Claremont, CA

Rob Hansen, Hansen Biological Consulting, Visalia, CA

Roger Higson, local active birder, Blythe, CA

Geoff Holroyd, Research Scientist, Canadian Wildlife Service, Edmonton, Alberta

Robert Huddleston, Biologist, California Department of Fish and Game, Mendota Wildlife Area, CA

Grainger Hunt, Santa Cruz Predatory Bird Research Group, Santa Cruz, CA

Jeff Kidd, Western Foundation of Vertebrate Zoology, Camarillo, CA

Chuck Klein, Wildhorse Golf Course Manager

Kim Kreitinger, Biologist, Endangered Species Recovery Program, California State University, Fresno, CA

Brian Latta, Santa Cruz Predatory Bird Research Group, Santa Cruz, CA

Jeff Lincer, Research Director, Wildlife Research Institute, San Diego, CA

Janet Linthicum, Santa Cruz Predatory Bird Research Group, Santa Cruz, CA

John McNerney, Natural Resource Specialist, City of Davis

Richard Montijo, Senior Biologist, AMEC Earth and Environmental, Santa Barbara, CA

Stephen Myers, Wildlife Biologist, AMEC Earth and Environmental, Riverside, CA

Pamela Nieberg, Co-founder Burrowing Owl Preservation Society

Ed Pandolfino, former board member of Institute for Bird Populations, Western Field Ornithologists, Sierra Foothills Audubon Society, and San Francisco Bay Bird Observatory

Robin Panza, Section of Birds, Carnegie Museum of Natural History, Pittsburgh, PA

Catherine Portman, Burrowing Owl Preservation Society, Woodland, CA

Shawn Smallwood, Ph.D., Biologist, Davis, CA

Glenn Stewart, Ph.D., Professor of Zoology, California State Polytechnic University, Pomona, CA

Lynne Trulio, Associate Professor, Department of Environmental Studies, San Jose State University, San Jose, CA

Philip Unitt, Collection Manager, Department of Birds and Mammals, San Diego Natural History Museum, San Diego, CA

Brian Walton, Santa Cruz Predatory Bird Research Group, Santa Cruz, CA

Dennis Warren, San Luis National Wildlife Refuge, Los Banos, CA

Colleen Wisinski, Conservation Program Manager, Burrowing Owl Recovery Program, San Diego Zoo Wildlife Alliance