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Burrowing Owl Report

Burrow Usage, Habitat Survey, and Recommendations for the Dangermond Preserve, Cojo Terrace



Cheadle Center for Biodiversity and Ecological Restoration

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Wilhelm-Safian

September 2025

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Introduction

This report, however cursory, provides the first official assessment of burrowing owls on the Jack and Laura Dangermond Preserve, located in Santa Barbara County, California, including prevalence, usage of burrows, habitat assessment, threats, recommendations, and restoration opportunities. The Dangermond Preserve consists of 24,000 acres of diverse habitats including Bishop pine, oak woodland, chaparral, coastal sage scrub, riparian, grassland, wet meadow, dune, beach, intertidal, and more, from the Santa Ynez mountains to the Pacific Ocean and includes the dynamic place where the coast of California stops trending east west and begins trending north again. This report focuses specifically on the Cojo Terrace, 1,046 acres of low elevation, almost entirely flat land encompassing the areas around Cojo Bay, Government Point, and Point Conception at approximately 10-40 m above sea level.

Excepting the California condor, Western burrowing owls easily represent the rarest raptor in Santa Barbara County, where they are exceedingly rare even as wintering birds and extirpated as a breeding species. Located in the heart of what was previously premier burrowing owl territory in coastal California, the Dangermond Preserve- particularly the Cojo Terrace- now represents the most significant remaining piece of habitat for the species within Santa Barbara County. This is due to its size, topography, vegetation, and the goals and ambitions of its managers. Undeveloped flat, low-elevation terrain in Southern California is exceedingly rare and represents both the only potential breeding habitat and best wintering habitat for burrowing owls. Therefore the importance of the Cojo Terrace to burrowing owls in the region is immense. This survey and report have been conducted solely through the lens of this species, since many of its stressors are counterintuitive, hard to appreciate, and even celebrated in the conservation community (e.g. *plant more trees*).

Here we will narrow our focus on the Cojo Terrace and wider region as experienced solely through the requirements of these owls specifically. Simultaneously, this report will zoom out in space and time on the history and causation that has resulted in their current situation. In so doing, a clearer picture emerges of the urgency, opportunity, and potential that exists on the Dangermond Preserve regarding their future in the region.

The Western burrow owl (*Athene cunicularia hypugaea*) is a small ground-nesting owl that ranges in size from 19-25cm and weighs approximately 150g ([USFWS](#)) Burrowing owls are roughly 1/3 the weight of the average California ground squirrel (Trulio, personal communication). Although the sexual dimorphism between males and females is very slight, males are slightly larger on average. Males can be distinguished

by behavior during the breeding season, and by subtle morphological differences according to some authorities. According to David Johnson, the sex and age of burrowing owls can be determined by both wing morphology and banding, and the wings of males are shaped slightly more like a kestrel than females (Johnson, personal communication). Burrowing owls are found in the New World in short grassland, scrub, desert, dune, and some agricultural habitats from the Caribbean Islands and Florida in the East, into southern Canada's grasslands in the North, areas of the Midwest including Minnesota and Iowa, the arid regions of states in the West, the coast of California including the offshore islands, and south into much of South America (allaboutbirds.org). In North America, there are two recognized subspecies, the Western and the Florida burrowing owl. The Florida Burrowing owl (*Athene cunicularia floridiana*) is a distinct subspecies that, while similar in appearance, is distinguished by genetic, morphological, and behavioral differences. There is some evidence that some genetic differences among populations on Guadeloupe and Clarion Islands in Mexico warrant separate subspecies status (Conway et al., 2010).

While burrowing owls are broadly considered stable due to their large range across the Americas, their declines throughout much of their former range in Canada, Mexico, and the USA are well-documented. They are listed as state-level endangered in Minnesota and Iowa, state-level threatened in Colorado and Florida, a species of special concern in California, Washington, Oregon, Montana, Utah, Wyoming, Oklahoma and Arizona, a "species of concern" in Kansas, a "species of special concern" in Nebraska, a "bird of conservation concern" in Nevada, a "species of greatest conservation need" in New Mexico, South Dakota, and Texas, and a "species of conservation priority" in North Dakota. If the environmentally progressive state of California is any barometer, they are not doing well anywhere; they are severely depleted from historic numbers across the state save for a few exceptions. Especially along the coast, they are well beyond a "species of special concern", and are belatedly under review for listing as threatened or endangered in California (CDFW, 2022). Many or most available range maps display historic ranges, more recent maps are often over 30 years old, and few if any reflect the declines in abundance and function the owls have experienced in recent decades. Burrowing owls appear to be stable in some parts of the US and Mexico where conditions have permitted or agriculture has been compatible or beneficial.

In the western United States, burrowing owls are both resident and migratory, with breeding populations in the north partially or entirely migrating south for the winter months, and populations in the southern half of California, Arizona, New Mexico, and much of Texas being non-migratory due to mild winters. In some instances where northerly winters are not too harsh, males, unburdened by the job of feeding a female

and owlets, will remain on good breeding sites feeding on rodents to be the first claiming territory at good burrows when females arrive in the spring. Therefore, winter migrants into California are often (but not always) first-year males or females (Johnson, personal communication). Male burrowing owls will decorate their burrow entrances with various objects, and it is not completely understood why. One theory is that they do this to tell other males *"I am here, I am fit, back off this is mine"* (Johnson, personal communication). Others have theorized that it is done to mask the scent of nests from mammalian predators, or to attract dung beetles. Curiously, one burrowing owl deemed unfit for release and used as an ambassador bird by the Ojai Raptor Center decorated the outside of its burrow, after one was provided inside its enclosure.

Migratory behavior of Western burrowing owls in North America is generally divided by the Rocky Mountains, with populations in Alberta, Saskatchewan, Montana, Colorado, Kansas and eastward migrating into South Texas, New Mexico, Arizona, or Mexico for the winter, and populations in British Columbia, Washington State, Oregon and Northern California migrating into Southern California and Western Mexico including Baja (Trulio and Johnson, personal communication). Since large portions of these populations rely on the owls spending essentially half their lives each year in places that may require migrations of over 1000 miles, winter habitat is crucial for the survival and maintenance of northern populations. The loss of both wintering sites and stopover sites to reach them is considered a major cause of declines in the far northern parts of their range (Trulio and Johnson, personal communication). In Canada, only half of breeding adults, and a *mere 6% of young* return each year to their breeding grounds (Hinterland, CWS, CWF). While breeding populations in the southerly latitudes used for over wintering by northern populations are considered non-migratory, owls do disperse outside of them.

In California today, burrowing owls breed almost exclusively in low-elevation, flat or nearly flat valleys but over-winter in more rolling terrain to several thousand feet elevation. Additionally, as in other portions of the Western United States (e.g. Yellowstone National Park), burrowing owls are noted to have historically bred in some flat, treeless sections at higher elevations in California such as the Modoc Plateau (Miller and Grinnell, 1944), migrating to warmer, lower elevations during the winter. This population apparently still exists today but represents a very small percentage of the breeding in the state (Wilkerson, 2010).

Today the breeding stronghold of burrowing owls in California (+/- 70%) is the naturally flat, desert ecosystem of the Imperial Valley, which has experienced a well-documented increase in burrowing owls in recent decades due to the introduction of compatible, irrigated agriculture. Similarly, recent burrowing owl population increases

have been associated with irrigation agriculture in the deserts of Baja, Mexico (Trulio, personal communication). The Imperial Valley numbers, however, may be threatened and beginning to decline both due to the cementing of formerly soil-banked irrigation canals which provided the squirrel burrows the owls use, and the expansion of solar and wind farms. Water efficiency has motivated the cementing of canals due to increased water demand and drought. The Imperial Valley is irrigated with water from the Colorado River, which is currently in a state of crisis regarding water allotments, forecast to only worsen (Suzuki, 2025). To make matters worse in the Imperial Valley stronghold, vast lithium deposits have been discovered there and will surely be developed (Brennen 2025). Conservation concerns in places like this highlight the importance of burrowing owl attention and restoration elsewhere in the state.

Burrowing owls are known to be a species largely occurring today on private lands, (Gervais, et al., 2008, pg. 220) making population data harder to come by. A few local anecdotes indicate potential recent breeding attempts in Santa Barbara County. One is a report of the playing of a recorded call that received a return call in the springtime from Santa Barbara Potrero around 2016-2017 from Elihu Gevirtz. Another is a report of a pair reportedly seen together on a private ranch on Highway 1, also in the spring with no specific date, that “flew to a place where there were a lot of ground squirrels” sometime around the 2010s, from Sally Isaacson. Previously recorded behavior that is outside the norm includes an owl being reported in mid July in Santa Barbara in 1994 (Lehman, 2024). A recent report of a camera capture of a burrowing owl in the steep, brushy foothills of the Ventura Hills Nature Preserve behind Ventura CA in mid July of 2025 is also anomalous. Another audio capture from the same general area and time with 10% certainty adds more mystery (Pavlisca, personal communication). It is unclear if these individually represent, breeding attempts, desperate or discombobulated owls in the modern world, or are just anomalies. It is likely that much more “anomalous” behavior once existed throughout the vast expanse of their historic range in California when populations and habitats were intact and interacted, and it is unknown how much of this may still exist, or to what degree, especially on private land. As of 2010, all of California’s coastal breeding is considered extirpated except for what remains in a small portion of Orange and San Diego Counties. This represents just 0.5% of the remaining breeding in California (Wilkerson, et al., 2010) (Figure 1). While some small potential exists for extant breeding in Santa Barbara and Ventura counties, this is generally assumed to be lost, particularly along the coast. Wilkerson et al. cites that Kidd et al., (2007) determined that breeding populations in western Santa Barbara, Ventura, and Los Angeles counties had been extirpated (Wilkerson, 2010, pg. 21).

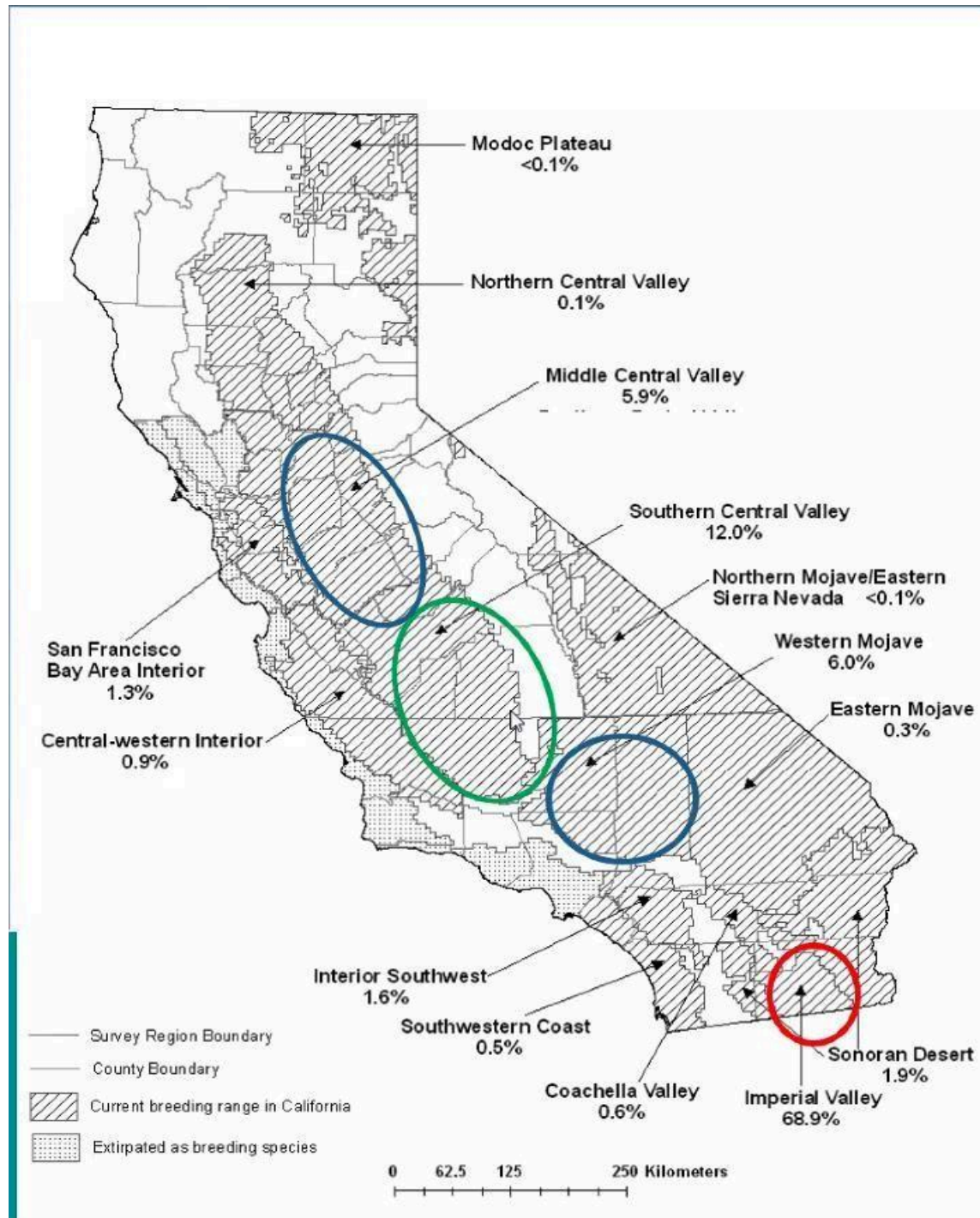


Figure 1. Burrowing owl breeding highlighted with circles in California (adapted from Wilkerson, 2010)

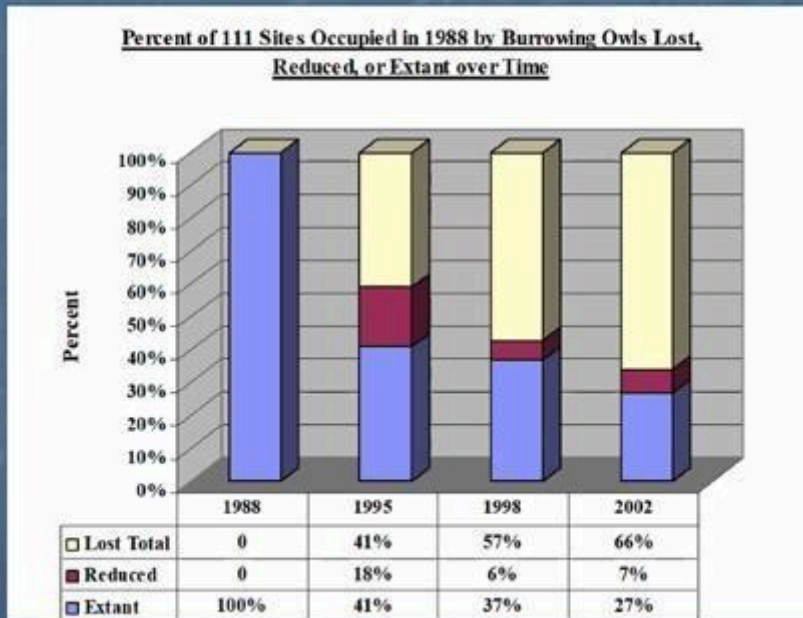
Additional examples on recent reductions of breeding numbers in California are shown below, adapted from an online burrowing owl workshop in 2022. It should be noted that these population reductions are only partial reflections of the greater historic

losses as the baselines they reflect begin in the 1980s after significant losses had already occurred.



Figure 2. Breeding status of Western burrowing owls in California (Trulio, 2022)

Example: Santa Clara County



Between 1988
and 2002, 66%
of locations lost

Fewer than 50
pairs of birds
remain in all of
Santa Clara
County

Santa Clara
Valley Habitat
Plan

Figure 3. Examples of breeding losses from Santa Clara County (Trulio, 2022)

Wintering birds generally have lower habitat requirements than breeding birds and can over-winter in both smaller patches of habitat, and in structures such as rock piles, culverts, and similar. Wintering burrowing owls may also utilize steeper terrain and higher elevations. Breeding birds, however, are semi-colonial, require larger expanses of habitat, and require burrows that are conducive to raising chicks complete with dens and adequately long tunnels. In California these are either the burrows of large ground squirrels (*Otospermophilus beechii*, *variegatus*, and *douglasii*), some kangaroo rats (*Dipodomys sp.*) or more rarely the abandoned breeding dens of American badgers (*Taxidea taxus*). While Western burrowing owls are agreed to differ from the Florida subspecies in that they do not create their own burrows and the latter do. According to some authorities, some Western burrowing owls will modify or scratch out burrows (Gervais, et al., 2008, pg 221) but, unlike the Florida subspecies, they do not dig their own (Trulio, personal communication).

The badger burrows common on the Dangermond preserve we observed appeared to be almost entirely the result of foraging for Botta's pocket gophers (*Thomomys bottae*) or California voles (*Microtus californicus*) and were therefore relatively short digs without dens. These are utilized by burrowing owls for wintering shelter but are not sufficient for breeding. The survey looked at hundreds of burrows, few of which appeared to be potential badger dens, based on the spoils left at their bases and the relatively shallow/short-tunneled nature they displayed. In Oregon, where ground squirrels and their burrows are too small for burrowing owls to utilize, badger burrows are used exclusively. The presence of badgers on the Dangermond preserve is an ecological plus, however the addition of breeding-type artificial burrows with badger exclusions and the encouragement and expansion of ground squirrels is necessary if burrowing owl breeding is to ever occur.

In vast, expansive spaces in the west where burrowing owls and badgers co-occur, badgers dig and abandon breeding dens that are then utilized by owls. Badgers dig these as they have no other options with regard to vegetation type or topography (much like golden eagles sometimes resort to nesting on the ground in Mongolia in the absence of preferred options). Since the majority of the Dangermond Preserve is steeper, brushier, or wooded, and these habitats are relatively adjacent to the flat expanse at the Cojo Terrace, badgers *may* be preferentially seeking out these places with better cover to dig their breeding dens, potentially decreasing the likelihood of owls finding abandoned dens in flat areas.

California's year-round habitat for burrowing owls is generally considered from the Bay Area southward, where immense human population growth and habitat conversion have made them decline substantially, including significant areas of near or complete extirpation of both wintering and especially breeding populations (Trulio, Personal communication). Most of the flat acreage in Los Angeles, Ventura, and Santa Barbara Counties is completely converted and is no longer suitable for burrowing owls, even as winter migrants. These flat, expansive areas were the former breeding sites for burrowing owls here and across North America for likely millions of years, with fossil evidence dating back to the late Pliocene of their closest ancestral relative, the slightly larger *Speotyto megalopeza* (Kansas).

Burrowing owls once were considered year-round breeding residents in Santa Barbara County along the coast and in the inland valleys ([Lehman, 2024](#)). These resident populations would have been seasonally bolstered by additional winter migrants occupying the hundreds of thousands of acres of flat and foothill habitat in the region.

Significant or severe declines have been well-documented from Canada to Mexico, and throughout the United States, even in recent decades. The Canadian breeding range has generally declined by more than half since the 1970s and far more severely in the far north (COSEWIC, 2016), while some Northeastern Mexican colonies have declined by 37% in a single decade (Ayma et al., 2016). These data are almost a decade old and numbers have likely declined further. In 1944 Grinnell and Miller described them as “almost throughout” the state where favorable habitat (“level, treeless”) existed, and described them as “originally common, even ‘abundant’”. By then they also noted their declining numbers in places “settled” by man (Grinnell and Miller, 1944, pg. 202). Lacking data on most private land notwithstanding, burrowing owls are now incredibly rare in Santa Barbara County, even as winter migrants, and are generally considered fully extirpated as breeding residents.

Some of the habitat loss typical to Los Angeles, Ventura, and Santa Barbara Counties is elucidated below.



Figure 4. The LA Basin today.



Figure 5. Typical conversion of flat land near Somis, Ventura County. Note even the wintering habitat in the foothills are infested with prohibitively tall *Brassica nigra*.



Figure 6. The Ventura Plain, where burrowing owls (and badgers) once occurred in abundance, is now functionally lost.



Figure 7, Flat land in Lompoc, CA, converted to ultra-efficient, incompatible agriculture.

Causes of Decline in SB County

While the most obvious reasons for burrowing owl losses coincide with the fate of almost all flat acreage in Southern California: intensive habitat loss due to development and agriculture, many other causes have contributed. Many are well-documented; others are less intuitive. Their cumulative effects on burrowing owls have been devastating. They include:

Cessation of Indigenous Burning

Probably the earliest causal factor contributing to the decline of burrowing owls in our region likely began as early as the late 1700's, when then Governor Jose Joaquin de Arrillaga outlawed the burning of vegetation by Californian Indians statewide. While this was practiced by almost all California Indian cultures in almost every vegetation type except the deserts, its outlawing was motivated specifically by Chumash along the coast of Santa Barbara, where Arrillaga resided, and was first posted at the presidio there in 1793 ([Timbrook](#), 1982). This millennia-old practice almost certainly maintained untold amounts of acreage as herbaceous and grass-dominated where its natural succession would have been coastal sage scrub or chaparral. This is supported by evidence. Juan Crespi's diary from the Portola expedition of 1769-1770 reported expansive areas where the Chumash had burnt off grass and vegetation in Santa Barbara County repeatedly in their journals. In May of 1770 they reported a 3-league march (9-miles) across an area through present-day Vandenberg Space Force Base

described as having seen “not a bush, nor a single heathen”, only recently burnt grassland. This area today is covered in coastal sage scrub ([Timbrook](#), 1982, pg. 167), but still maintains the seedbank of red maids, (*Calandrinia menziesii*), the full-sun, grassland species the Chumash were probably managing for. In the 1980s, the Airforce masticated a portion of this chaparral for a project, and base botanist Karen Osland reported thousands of red maids germinating in the scar. Before this chaparral was removed, *Calandrinia* was a plant she had *never seen on base* (Osland, personal communication). This botanically confirms Crespi’s observations.

Crespi’s diary indicates that fire was used all along the coastal tablelands, including and specifically around Pt. Conception. These journals indicate that Chumash management of these areas maintained them as herbaceous, not brushy. There is therefore every reason to believe that burrowing owls once lived on these flat expanses year-round and bred there given the evidence: squarely in the range formerly considered year-round, sandy soils, flat and treeless (Lehman, pg. 233). Crespi’s journals further indicate that they observed brushy vegetation as considerably less expansive historically than it is today. In addition to the burning, they described the mountains, or at least their lower flanks, between Tajiguas and Gaviota, as being covered in grasses in August of 1769, where chaparral is found today ([Timbrook](#), 1982, pg. 167).

Crespi’s diaries provide some of the earliest written records of the ecology, vegetation, and Chumash life along the coast of Santa Barbara County, before the tsunami of rapid change ensued, and help clarify what are otherwise esoteric ecological reference points that help inform the goals and managers of today. Two excerpts from Vegetation Burning by the Chumash are shown below.

These spectacular wildflower displays were seen in the very same area which Crespi had noted as having been burned the previous summer.

Crespi's diaries provide both excellent descriptions of the topography and vegetative cover of the Santa Barbara coastal area at the beginning of the Spanish colonial period, and very specific evidence of grassland burning by the Chumash, or "heathens." It is apparent from these descriptions that the shrub communities of coastal sage scrub and chaparral were once considerably less extensive than they are today. For example, the mountains between Tajiguas and Gaviota—or at least their lower flanks—were described as covered with grasses in August 1769, whereas dense chaparral is found there today. In addition, "not a bush" was seen in the South Vandenberg area north of Point Arguello in May, 1770; today the vegetation there is coastal sage scrub (see Smith 1976: 21-24 for a

On August 27, 1769, after leaving Chumash settlements near Point Conception, Crespi again mentioned that in some places the grassy tablelands had been burned.

Continuing northward past Chumash villages at Jalama Beach and Cañada Agua Viva, the expedition rounded Point Arguello. On August 29, 1769:

... we set out from the San Juan Bautista Village on a due northwest course, across level ground near the shore. We soon passed the second point, and made out still another afar off, making a sort of large bight. We went almost all the way over salt-grass, all very much burnt off by the heathens, with some descents to dry creeks. On going about a league and a half, we reached a stream [Honda Canyon] with a good amount of fresh water emptying into the sea, but no village nor soil of any worth upon it. The soldiers had scouted up to this point, and it was not a full day's march, nor was there grass for the animals, as it had all been burned off.... On going about three hours,

Figures 8 & 9. Excerpts from Crespi's diary, adapted from *Vegetation Burning by the Chumash*, Timbrook, 1982.

Native Americans have generally not been given enough credit for shaping the landscapes Westerners encountered in North America, and controlled fire was the most effective and ubiquitous tool they had. Burning by the Chumash undoubtedly maintained many thousands of acres of grassland as potential habitat for burrowing owls and other grassland specifics. The outlawing of this practice appears to have allowed the natural succession of these acres into brush, effectively displacing the owls and other taxa that are habitat restricted to grasslands.

Fire is a bit contradictory for burrowing owls today, as it can be a beneficial disturbance that exposes soil, reduces thatch, and suppresses brush. On the other hand, it can disturb owls at critical times, potentially fumigate burrows, or otherwise create direct mortality. More severe fire in the short-term leaves behind a landscape that is devoid of small vertebrates and invertebrates. There is consensus that fires can be beneficial for burrowing owls in context (Trulio, personal communication), but for already imperiled animals sensitive to disturbance may also be a negative.

Introduced Plants

Subsequent invasions of exotic plants such as black mustard and to a lesser extent annual grasses, now unavoidable and ubiquitous in essentially every mid to low-elevation herbaceous system in California, can be as effective at extirpating burrowing owls as development. As burrowing owls need relatively short, sparse vegetation (≤ 12 in. max) for predator, prey and burrow visibility, even grasses such as

Erharta, *Avena*, and others can hinder or preclude necessary ecosystem function. Black mustard (*Brassica nigra*), fennel (*Foeniculum vulgare*), and other herbaceous weeds can easily reach over 7' in height and these plants and the thatch they leave behind at sufficient density will completely extirpate burrowing owls. It is impossible to overstate the percentage of acreage remaining in California not converted to housing, industry, or agriculture but otherwise “natural”, that is ruined for burrowing owls by these weeds.



Figure 10. Image of the Dangermond Preserve in early May, 2025, on a soil type that was likely formerly grassland. *Brassica nigra* is prohibitively tall and extirpates burrowing owls at this density. Hundreds of thousands of acres in California are no longer short-grass vegetation because of this one taxa, alone. Note there are also anthropogenic perches in this image.

Persecution of Fossorial Mammals

Only the Florida subspecies of burrowing owl (*Athene cunicularia floridiana*) dig their own burrows. Western burrowing owls rely on burrows created by large ground squirrels, prairie dogs, some kangaroo rats, and badgers. The decline of American badgers across much of their range is well documented, either by habitat conversion and loss or the incidental result of the poisoning of coyotes and rodents. The extent of

shooting and poisoning of ground squirrels and prairie dogs in the Western United States has been profound and incalculable. In California, ground squirrels have been identified as a keystone species for 76 facultative species and 74 obligate species, including burrowing owls ([Alvarez, 2023](#)). These burrows are used for breeding, foraging, refuge, brumation and hibernation, thermoregulation, and more by a diversity of both vertebrates and invertebrates. Generally viewed as a pest, and not without justification, the importance of ground squirrels and their burrows on the landscape for burrowing owls cannot be overstated. Accordingly, the detrimental impacts the reduction of squirrel populations and their burrows have had and continue to have on burrowing owls historically to the present day cannot be overstated either. In habitats such as valley oak savannas, where burrowing owls were once known to both breed and overwinter, the presence of sporadic trees that provide predator-advantages to raptors such as red-tailed hawks and great horned owls otherwise make these spaces impossible for burrowing owls without abundant burrows. Presumably, only with enough burrows that provide adequate refuge from these larger raptors without flying long distances are oak savannas with light to moderate tree density functionally usable for burrowing owls.

Excessive Tree Planting and Abundance

The threat posed to burrowing owls from avian predation is high and present at all hours, 24/7 (Johnson, personal communication). Predatory species include American crows, ravens, great horned owls, Swainson's, ferruginous, red-tailed, red-shouldered, and Cooper's hawks, Northern harriers, merlin, prairie and peregrine falcons, golden eagles, and more. These animals have coexisted with burrowing owls for millennia to mutual advantage, however the abundance of planted trees, particularly non-native trees, into many formerly treeless spaces have had significant negative impacts on burrowing owl survival and have contributed to their total extirpation as breeders in the region. Blue gum eucalyptus are by far the most prevalent of these along the Gaviota Coast and have effectively turned what was once largely an expansive grassland ecosystem punctuated by scrub and coast live oaks into a forested landscape, where the influence of these trees cannot be escaped.



Figure 11. Millions of eucalyptus trees now occur throughout the Gaviota Coast, Nipomo, Lompoc, and many other areas within Santa Barbara County.

The height of these trees is as notable as their abundance; growing to over 250' tall, blue gum eucalyptus are the tallest flowering plant (angiosperm) in the Americas, taller than any native tree in the Amazon Basin (Ritter, personal communication). Where canopies of coast live oaks are usually wider than tall, especially on exposed terraces where burrowing owls might be found, and usually no taller than 50', blue gums provide far greater avian predator visibility and perching opportunities. No native tree of similar height, habit, or abundance occurs naturally in this ecoregion.

Trees are generally oversimplified as objectively good for their beneficial attributes such as shade, beauty, and wildlife support. While some evolutionary psychologists have suggested that humans evolved to prefer landscapes resembling savannas, more recent research indicates that tropical forests (with far more trees) are preferred (Moura et al., 2018). There is little doubt that people have a strong, subjective proclivity for planting trees (afforestation) in landscapes, especially those that are relatively treeless. This commonly accepted act of "environmental benevolence", when viewed from the perspective of many grassland species, and other ecological metrics, is the opposite. Many of the world's terrestrial ecosystems and their associated floras and faunas evolved without trees. Afforestation is undoubtedly a factor in the decline of Western burrowing owls by facilitating more perching, hunting, and nesting opportunities for raptors that utilize and favor trees. Afforestation also contributes to the declines of other grassland-specific birds in our region, such as Western meadowlarks, since many of the same avian predators of burrowing owls also prey on these and other birds.

Research conducted by Thiele, et al. on the usage of black-tailed prairie dog colonies by Western burrowing owls in South Dakota found that planted tree canopy at distances of 800m and 1200m was associated with decreased likelihood of occupancy by burrowing owls. Thiele further states that *“Even in areas where grasslands are not decreasing, habitat suitability is diminished by the presence of planted trees. Woody vegetation negatively affects the occurrence, density, and productivity of grassland birds at multiple scales across their range.”* (Thiele et al., 2019). In other words, the increase of woody vegetation affects grassland birds in an immediate area, across a site, and across an entire region. These distances are significantly greater than the conservative 150 yard buffer from trees we used.

During consultation with David Johnson of the Global Owl Project for the creation of burrowing owl habitat on the North Campus Open Space on the UCSB campus, he advised keeping all burrowing owl perches at 24” (61 cm) and considered anything taller than 36” (91cm) to be a perch for predators of burrowing owls (Johnson, personal communication). The stress and danger burrowing owls experience from these perches increases as they get older and taller. It should be noted that he was describing breeding burrowing owls, and a location where ravens occur more commonly and prey on owlets.

Other Factors

In addition to those previously discussed, burrowing owls face a myriad of other threats, both naturally and artificially. These include things like burrow collapse, flooding/drowning, hypothermia, hyperthermia, predation by mammals (weasels, bobcats, coyotes, badgers, raccoons, opossums, striped skunks, and foxes), snakes, malnutrition, starvation and others. Additional man-made threats include poisoning by rodenticides and insecticides, vehicle strikes, shooting, fence collisions, overgrazing, predation by domestic cats and dogs, incidental take by falconry, burrow fumigation, and the erection of utility lines, signs, structures, and other unnatural perches.

The Survey

Cojo Terrace Survey and Assessment

During the spring of 2025 Cheadle Center staff conducted a survey of 1046 acres of the Cojo Terrace for burrowing owl use, suitability, threats, and recommendations for restoration. Surveys were conducted in conjunction with a wetland delineation of the same area, which was more expansive and continued into the summer. Due to the timing of funding and start of work, owl surveys were performed late in the wintering period, which almost certainly influenced (lowered) the number of owls observed.

However, owl droppings and pellets would most likely still be visible for some time after an owl's departure, so the scrutiny of burrows and the immediate areas around them was a reasonably viable method of determining a burrowing owl's presence, if imperfect.

From their winter ranges, burrowing owls typically begin to arrive in late September, with the majority probably arriving in the first two weeks of October. They then begin to return northward in March and April. The latest observation of a burrowing owl during this survey was April 9. No owls were seen after that date, even during the wetland delineation surveys when some new burrows with evidence of usage were recorded.

The days spent surveying specifically for owls and owl burrows were 3/19/25, 3/26/25, 3/31/25, and 4/2/25. Some additional data was also collected on 4/9/25, 5/5/25, 5/19/25, and 5/21/25. For the main surveys between 3/19/25 and 4/2/25, either two or three surveyors were walking, usually with one recording burrow data and one tracking. Therefore, the total number distance tracked as walked was 28.7 miles but when adjusted for the actual number of walking surveyors (2.5 times that) we can deduce that around 71.75 miles were walked. Surveyors were distanced between 10 and 30 yards apart, depending on the vegetation density, so the chances of missing burrows was not zero but low. Burrowing owls tended to flush when a human approached within 200 yards or more, except on very windy days, when they stuck to their burrows until approached within as little as 3-4 yards.

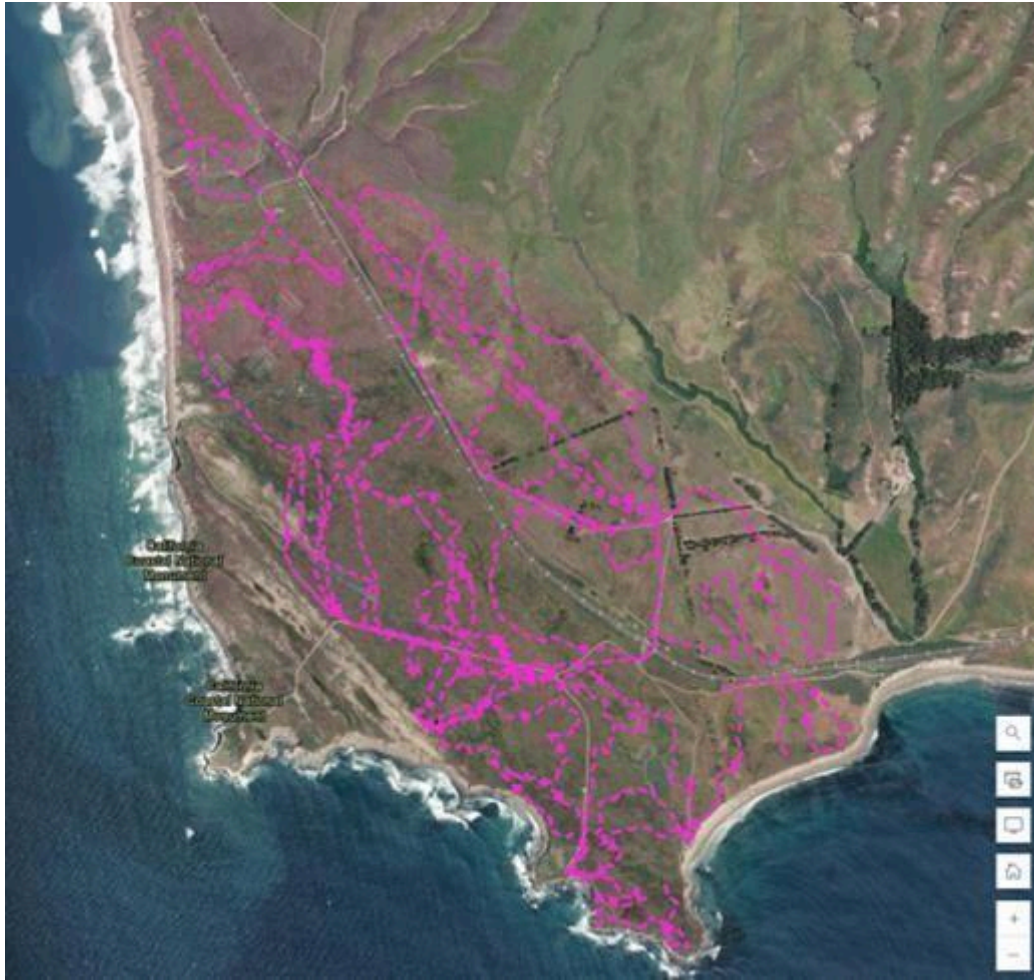


Figure 12. Layer showing the survey tracks. Since some surveyors were collecting data and not recording, recorded tracks underrepresent actual mileage and paths walked. This also denotes the general survey area, but without a boundary line.

Data on the survey area was collected in field maps and post processed in ArcGIS Pro. The terrace was divided into a grid of 10 meter square (10m X 10m) plots and recorded burrows, their ranking, and any owls or signs of use by burrowing owls. The distances measured to trees or other perches was made from the center of each plot where the burrow or owl was recorded to the nearest identified tree, pole or crossing sign. Pellets were noted and collected for future analysis on burrowing owl diets on the preserve. Pellets were sometimes retrieved inside burrows at maximum arm's length. It was assumed that if an owl was resident, no rattlesnakes would be. Some of the pellets appeared months old upon collection. Noteworthy details were reflected in the survey's notes section, see Appendix A, Burrowing Owl Survey Data.

Burrows were only considered worth recording as viable owl burrows if they appeared to be at least +/-36" (91cm) in length; the minimum *estimated* length to

escape a predatory raptor. Even this may have been too short for significant occupation, but assessing both burrow length and depth was difficult due to burrows often making sharp turns. Burrow depth was ascertained with the use of a flashlight or a stem prod sourced in the field. Even when burrows did not make a sharp turn, neither method could ascertain the full extent of the burrows. Burrows that were within +/-100 yards of eucalyptus or cypress trees were not recorded or rated outside of one or two exceptions and although these were investigated, they generally showed no burrowing owl activity due to that very association. Meaning most surveying was not done near trees, although a significant amount of walking and observing did occur near them. Burrows near trees were not recorded or given ratings as they were considered too close to trees to be useful for burrowing owls. However, any evidence of use would have been noted had it been observed; it never was.

Grading criteria were as follows:

- 1) **Good burrow with evidence of owl presence** (owl occupation, droppings, or pellets).
- 2) **Good burrow without evidence of owl presence** (adequately long/deep, but unused).
- 3) **Substandard burrow obscured by non-native plants** (appeared adequately long/deep but obscured).
- 4) **Substandard burrow obscured by native plants** (appeared adequately long/deep but obscured).

Burrows by Rating

Overall, 292 burrows were recorded (figure 18). An uncounted number in the hundreds represented former burrows, or burrows too shallow for burrowing owls to utilize. These were rendered as such almost entirely by the activities of pocket gophers- the very animals the badgers who created most of them were looking for. Possibly some of the backfilling may have been due to vole activity. Of the 292 burrows recorded, only 20 were made by ground squirrels, with the remainder (272) appearing to be the result of badgers digging for gophers and voles.

46 burrows (16%) had a rating of **1 (Good burrow with evidence of owl presence)**. Of these 46 burrows, none were recorded as being made by ground squirrels, which were only noted in two main locations. Below, a burrow with abundant droppings is shown, and another with both droppings and pellets.



Figures 13 & 14. Two badger burrows representative of a “1” rating, showing burrowing owl use. Figure 13 shows abundant droppings, while figure 14 also has pellets present. Sometimes pellets are expelled inside the burrows or roll sufficiently far into them that they cannot be observed.

171 burrows (59%) had a rating of **2 (Good burrow without evidence of owl presence)**. 15 of these were made by ground squirrels. Of the 171, 24 were noted as being very freshly dug by badgers. Below is an example of a suitable-appearing burrow with no evidence of owl visitation.



Figure 15. Badger burrow typical of a “2” rating that appeared suitable for burrowing owl use but shows no sign of visitation. Note the encroaching ice plant.

66 burrows (23%) had a rating of **3 (Substandard burrow obscured by non-native plants)**. 4 of these were made by squirrels.

9 burrows (3%) had a rating of **4 (Substandard burrow obscured by native plants)**. One of these burrows was made by squirrels.

Owls Observed

A preliminary visit to the area on November 17, 2024, documented **6 owls** but only covered a small portion of the survey area. Another short, preliminary site visit on March 4, 2025, documented **3 owls**. **19 owls** were seen during the survey (outside of the 11/17/24 and 4/7/25 dates) although **3** of these were almost certainly the same owls seen more than once.

Of the owls seen on March 4, 2025, one or two were reobserved again during the survey. Of the owls seen in November, at least half of them were apparently absent from these same areas later in the spring, and the burrows they were observed using in November showed no sign of having existed in March 2025. This highlights both the

relatively ephemeral nature of burrows on the Cojo terrace due to its sandy soils, their rapid reabsorption by gopher activity, and the corresponding necessity of burrowing owls using them to be adaptive and relocate frequently. This is notable because burrow fidelity from year to year, a trait well documented by burrowing owls, would be unlikely or impossible under these circumstances. Hundreds of shallow or former burrows were observed that were partially or entirely filled in by pocket gophers during this survey.



Figures 16 & 17. Two images of the same badger dig that had been backfilled by gopher activity. Burrows like these were not recorded as they were too shallow for burrowing owl use. These burrows outnumbered recorded burrows, and future data on these would be informative. Note the burrow from distance appears much deeper than it is.

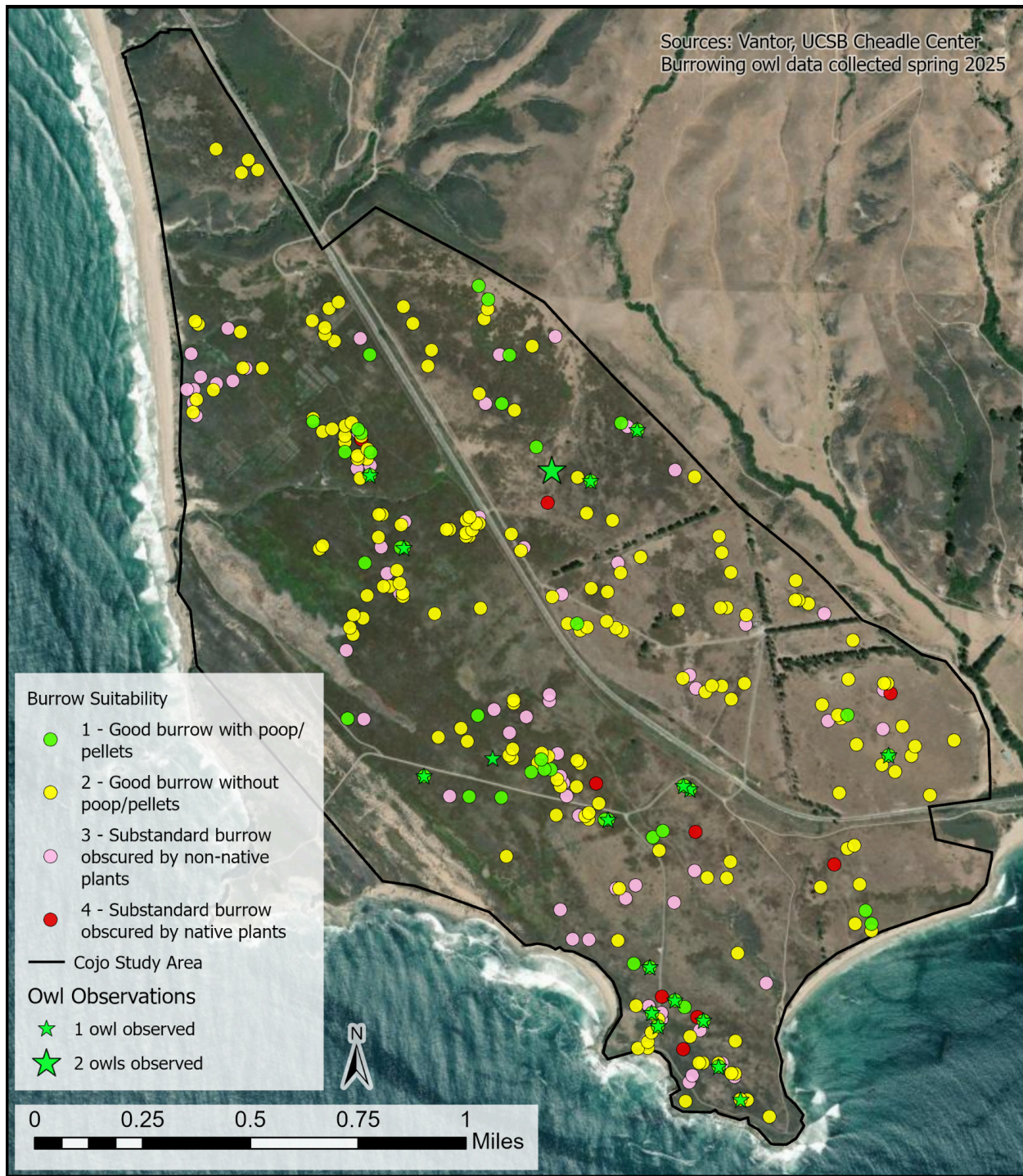


Figure 18. Map of the 292 burrows recorded, and the 19 owl sightings.

Comments on the Habitat for Burrowing Owls on the Cojo Terrace

Predator Abundance

The abundance and diversity of wildlife on the Dangermond preserve is profound, however it is noteworthy that from the perspective of burrowing owls this acts as a negative, since many of their predators are present, with some having been significantly advantaged by recent anthropogenic changes. While burrowing owls have prohibitively strict requirements for thriving both individually and communally, animals such as red-tailed hawks, great horned owls, bobcats, coyotes, and others either had the resilience to have never suffered serious setbacks from the same changes that severely impacted burrowing owls, or the ability to adapt to them. Indeed, many of the habitat alterations on the Cojo Terrace objectively remove the advantages burrowing owls once enjoyed and transfer them to their predators- most of whom are not rare taxa. Predator abundance was notable, so giving these species advantages over burrowing owls is likely to cause significantly lower burrowing owl function and survival.

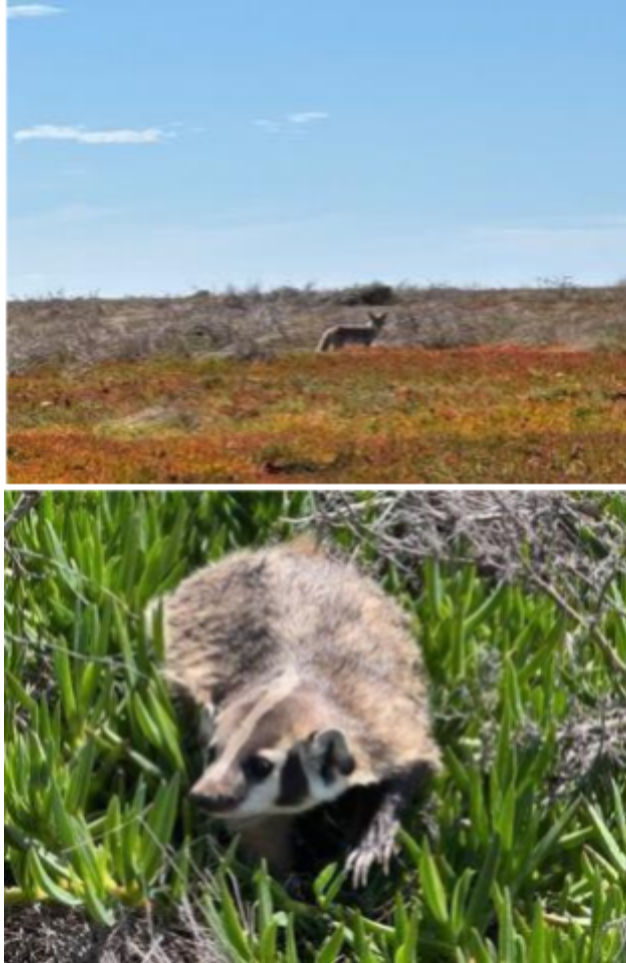
Raptors observed during our field visits that prey on burrowing owls included the golden eagle, peregrine falcon, Cooper's hawk, merlin, red-tailed hawk, and Northern harrier. The presence of great horned owls on the preserve is also well documented. Northern harriers were seen essentially every visit, as were red-tailed hawks, which were practically visible somewhere at each and every given moment throughout the day. Red-tailed hawks, great horned owls, and Northern harriers are among the greatest predators of burrowing owls (Trulio, Johnson, personal communication). David Johnson reports that Northern harriers are one of the most serious avian threats to burrowing owls, their relative rarity compared to red-tailed hawks and great horned owls notwithstanding. Northern harriers are closely associated with grassland habitats, often flying low to the ground and are often seen standing on the ground. Although they will utilize taller perches on the landscape, they also nest on the ground. Johnson has captured images of Northern harriers with their bodies pressed against burrow entrances, fully extending their entire legs and talons inside the burrow attempting to catch the burrowing owls inside them. He has also noted that artificial burrows with 6" tunnel entrances for breeding have higher fledgling success rates than 4" burrows, as the "bottleneck" effect for chicks is reduced with wider entrances when owlets rush in to escape a suddenly appearing harrier or other predator. He has also reported that harriers are smart, excellent hunters who will continuously and repeatedly revisit burrows where burrowing owls reside, attempting to catch them off guard. It should be noted that anthropogenic changes that have advantaged red-tails and great horned owls have likely resulted in competitive disadvantages to harriers as well, who, like burrowing owls, are habitat-restricted and rarer than these widely-adaptable generalists.

Coyotes, another significant predator of burrowing owls, are abundant on the preserve. These not only pose threats to owls on the ground caught unawares but, like red-tailed hawks and great horned owls, are direct competitors for many important food items such as Jerusalem crickets, various species of mice, California voles, gophers and other small vertebrates. One of the owls we observed and flushed on a windy day was immediately seen being stalked by a coyote after settling. American badgers are something of a double-edged sword. On the one hand they produce most of the burrows the owls are using but are serious predators as well (especially where breeding occurs to young owlets) and will smell and dig out any owls caught underground. Wintering burrowing owls have a strong tendency to fly (+/- 150-300 yards), often to a satellite burrow, when approached by a ground-dwelling disturbance such as a dog, human, coyote, etc. They retreat into burrows almost exclusively for escape from other birds (Trulio, personal communication, personal observation). This is evidently an evolutionary adaptation to avoid having their main burrow be located by a ground-based predator, to avoid being trapped, dug out, and eaten. Some burrowing owls do, however, display a tendency to retreat underground when approached, or may already be underground when a predator approaches. Any owls with this tendency would potentially have a reduced chance of surviving the entire winter on the Cojo Terrace, due to the sandy soils, short nature of many of the burrows, and high prevalence of digging predators like coyotes and badgers there.

The “problem” of avian predators is essentially a problem of non native trees and other man-made structures that allow them to nest, raise young, and hunt widely on the Cojo Terrace that would not be possible under natural conditions.



Figure 19. Red-tailed hawk on the preserve, utilizing a man-made sign on the preserve.



Figures 20 & 21. Coyotes and badgers on the preserve. Coyotes are the more common and represent the greater threat to burrowing owls though badgers are also potential predators. Badgers are the creators of the majority of the burrows used currently, but would be more significant predators should nesting (and owlets) ever occur.

Vegetation structure

Burrowing owls need short grass. More accurately, they need short grass and ideally some access to bare soil. Not only is thick vegetation problematic during growth, but the thick dead thatch it leaves behind is as well. Cover like this obscures gophers, voles, and other important prey such as beetles. It also obscures both burrows and potentially predators like bobcats and coyotes. Grasses and herbaceous cover over significant areas of the survey site were too tall or too dense for good burrowing owl function. Specifically, the thickness and abundance of *Ehrharta calycina* was noteworthy, but included were *Festuca perennis*, *Bromus diandrus*, *Raphanus sativus*, and others. Some *Erharta* fields seemed so dense as to even prohibit badger activity.

Outside the scope of this survey, but relevant to burrowing owls on the preserve, significant acreage across much or most of the Dangermond Preserve's higher elevation foothill "grasslands" are also infested with tall dense stands of *Brassica nigra*. Vegetation in the survey area was not mapped nor a layer in AGO but the graphic below generally characterizes the vegetation we observed during the surveys.

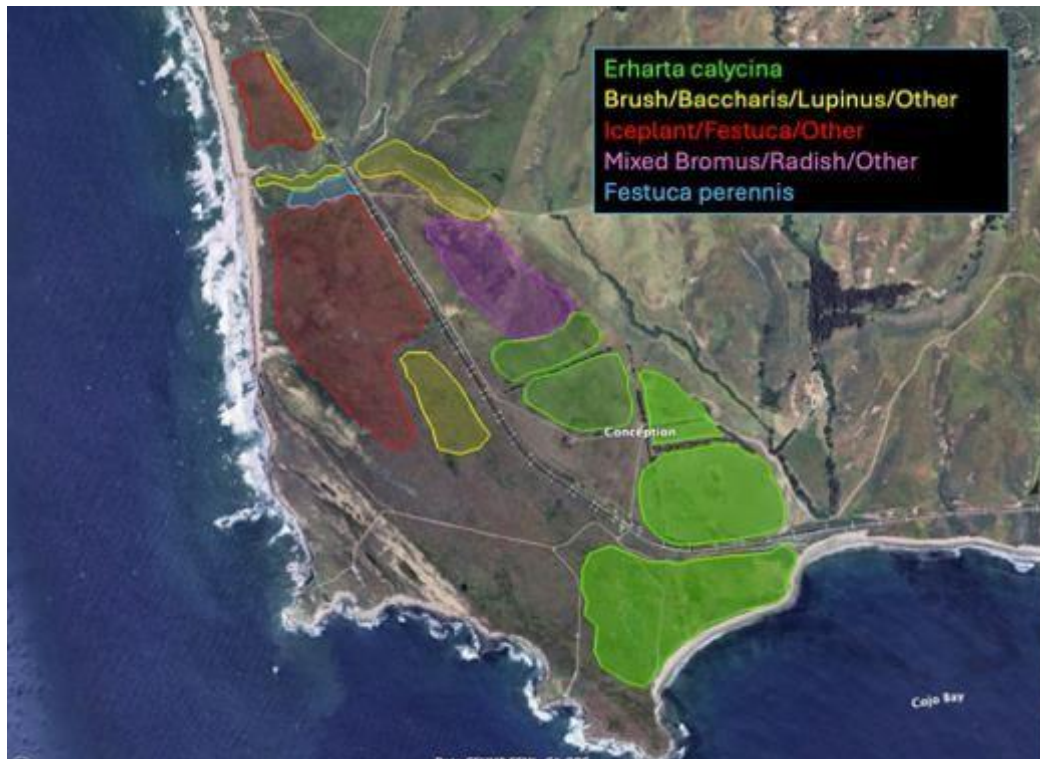


Figure 22. vegetation map showing general vegetation types across the Cojo Terrace. Broadly speaking the vegetation was thicker than ideal for burrowing owls. The easternmost *Erharta* was especially dense.

While it is known from telemetry data that burrowing owls fly at about 35 mph when migrating, it is not known how high they fly (Johnson, personal communication). However, there is evidence that the blonde grasslands of Southern California are what keys them into settling, and the tragic reality is, when they do, they find many changes in today's landscapes that translate into difficulty. No insignificant percentage of these migrating owls each year undoubtedly land in places that are apparently good from a birdseye view, but much worse on the ground. In other words, migrating burrowing owls do not settle because they see ideal short vegetation and burrows, they settle because they see the broader vegetation type as distinct from what they are not compatible with—trees and brush. Throughout their deep evolutionary past, these systems were replete with burrows and native vegetation, now the owls that visit them undoubtedly experience severe hardship due to these significant recent changes.

Burrowing owls are known to prefer sites with drained soils and grass or vegetation limited by environmental factors such as low precipitation, poor soils, salts, grazing, burning, mowing, or similar, so that the height is around **6" (15cm)** (Wildlife Research Institute, 2005). It is important to note that this recommendation is presumably pointed towards the now-ubiquitous annual grass-dominated systems in California, that generally yield much less bare ground than the bunchgrass-dominated grasslands of old. It is likely slightly taller grass would be acceptable if some visible, bare ground was also available, and the grasses were spaced. These conditions are crucially important for predator, prey, and burrow visibility. For burrowing owls, grassland height is thought to be more important than composition ([Dring, 2000](#)). Some authors have adjusted grass height recommendation to 12" (30cm), while some indicate even 8-10" (20-25cm) is too tall.

Strict height is likely not as good an indicator as thickness and height combined. Below is an example of *Ehrharta calycina* on the Cojo Terrace that is much too dense and thick, with no visible ground or burrows. Even walking in this is difficult and energy consuming, and the presence of badgers in these areas also seemed reduced.



Figure 23. Thick *Ehrharta calycina* on the preserve. Aside from a management issue botanically, the density and thickness of this grass is structurally too thick for burrowing owls. We did observe one burrow in this vegetation type with a high number of droppings and pellets, so it can be utilized. It is better than taller non-native monocultures like *Brassica nigra*, but highly prohibitive to burrowing owl function nonetheless.

Trees and Power Lines

One of the most distinctive characteristics of good burrowing owl habitat is flat terrain with low vegetation, in large, expansive areas. The Cojo Terrace formerly had these attributes, but the installation of exotic trees, power lines, and other structures associated with the railway and ranch life have changed this habitat profoundly, despite being a small percentage of the overall cover.

It is not that burrowing owls will not use small trees, large shrubs, and shrub edges. Heterogeneity amongst coastal sage scrub and grassland can provide beneficial foraging and sheltering opportunities for burrowing owls, and they will dive into brush when disturbed, especially when burrows are not available. Some burrowing owls will occasionally use burrows located relatively close to trees. However, with dwindling options, this may sometimes be done out of *desperation*. Burrowing owls in Arizona seem to sometimes occur near saguaro cactus, and the Florida burrowing owl will apparently nest in residential front yards, with the houses immediately adjacent. However, trees clearly offer perching, concealment, observation, and hunting platforms for some of the most serious predators to burrowing owls. According to all authorities and our data, burrowing owls go to great lengths to avoid trees. Non-native trees are particularly problematic due to their often having much greater heights than coast live oaks, as has been discussed. They therefore are stressful to burrowing owls and should be removed whenever important burrowing owl or other grassland-specific bird habitat is available.

While trees appear to have a relatively insignificant footprint on the Cojo Terrace in terms of percent cover, when seen through the behavior of burrowing owls, their outsized influence is clear. During our survey, we preemptively did not record or consider most burrows within +/-100 yards of trees or power lines as viable. In retrospect, even more data taken on otherwise good burrows with no evidence of use by owls near trees would have underscored the point that habitat near trees and powerlines is strictly avoided by burrowing owls. Many good burrows without evidence of use (yellow) were recorded within 1-200 yards of trees and powerlines (Figure 27). However, *no* observations of utilized burrows (droppings, or pellets) were within 150 yards of trees, and only 9% (4 of 46) of utilized burrows were within the general 150-yard perch buffer. All of these were near utility poles. So, the data did capture this in essence. Only 10.5% (2 of 19) owl sightings were within this buffer and these were both on the margin and were located near utility poles and not trees, the latter of which effectively produced a wider buffer.

Many powerlines ran along tree lines and were therefore more or less made obsolete by trees. One main power line running across otherwise open country ran

roughly northeast from the intersection of roads that lead to the lighthouse. The closest utilized burrow from this line was 146 yards away. Utility poles and lines are undoubtedly unhelpful structures for burrowing owls that represent significant perches, but it is probably the case that they are easier for burrowing owls to see predatory raptors and other birds on against the skyline than trees are, and therefore not as problematic as trees. However, they still represent threats, stress, and food competition to burrowing owls as they allow for miles of unnatural, anthropogenic perching for their predators. Many birds of prey as well as corvids utilize power lines and poles. Two of the most common and predatory of these from a burrowing owl's perspective are shown below, the red-tailed hawk, and great horned owl.



Figure 24. Red-tailed hawk on a power pole. These structures are under-appreciated for their use by large raptors to observe and hunt the landscapes they frequently occur on.



Figure 25. Great horned owl utilizing a powerline. In addition to creating threats directly, great horned owls can also hunt for many burrowing owl foods on these than would be possible naturally.



Figure 26. Powerlines and poles occur in the open in places on the terrace and are concurrent with planted trees in others.

The closest utilized burrows to trees as denoted by the plot number were 4172 (164 yards, the closest utilized burrow to a tree we recorded) and 3622 (174 yards). Both were adjacent to the comparatively shorter Monterey cypress. *The closest utilized burrow to a taller blue gum eucalyptus was 16236 (197 yards)* (Figure 27). In the center of figure 27, two occupied burrows were measured relatively close to eucalyptus, but these were short, wind-pruned trees of another species, not blue gums. Since the utility poles behind them were taller, the distance to these, not the trees, was measured.

When evaluating the tree cover on the terrace, including the lone cypress in the southeast corner, we see that over $\frac{1}{4}$ the total survey area is avoided by burrowing owls

due to their presence. These likely impact all habitat-restricted grassland birds by fragmenting the very wide-open spaces these taxa depend on. In actuality, the area is greater; their influence continues to the north and northeast on potential burrowing owl habitat but was excluded here because it was not within the survey boundary. The single cypress alone removes a conservative 7 acres which is also underrepresented due to excluding the areas outside the survey boundary to the east. When we add the same buffer for the power line running northeast from the intersection leading to the lighthouse, we remove roughly another 50 acres of suitable burrowing owl habitat.

Again, the “avoidance buffer” from the power line near the lighthouse is truncated by running into DOD land outside the survey area towards Point Conception, so was underrepresented in terms of actual habitat acreage affected. In total, the non-native trees and erected power poles effectively create a **315 acre** “power line and tree avoidance area”, or 30% of the Cojo Terrace within the survey area. It should be understood that if the rare, low-elevation grassland is recognized as valuable to habitat-restricted taxa like burrowing owls in both habitat structure and in terms of its unbroken size, the effect of fragmentation and habitat reduction by trees and power lines on the terrace is significant and should be mitigated.

To summarize; of the 49 owls or active burrows we identified, only 9% (4) were located within a 150-yard buffer from trees or utility poles. All 4 of these were nearest **power poles**, not trees, indicating that while posing a threat, they were easier for burrowing owls to identify predatory raptors on than trees. Of the 19 owl sightings, only **two** were within this buffer, both at the margin, also near power poles, not trees (figure 27).

It is noteworthy that all of our observations of burrowing owls and utilized burrows in the northern half of the survey area were clustered well below the crossing sign in the upper left and above the string of poles and the line running between them in the center of the graphic below; denoting a significant avoidance of that power line (Figure 27). It has been reported that burrowing owls will sometimes occupy burrows or even nest beneath powerlines, and that they are less problematic than background-obscuring trees where predatory raptors are concerned. However, for this site, our limited data suggest these utility lines are avoided by burrowing owls and significantly reduce and fragment their habitat.

This data demonstrates the hyper-awareness burrowing owls have of the threat of avian predators, the structures that give them advantages, and how just over 1% percent tree and utility pole/line cover on a landscape can exert disproportionately large negative effects on burrowing owl behavior and use of habitat. The tree cover on the terrace consists of just 11.32 acres; 1.08% of the 1046-acre survey area. If we round up

to 1.1% to include the utility poles and lines, that 1.1% of cover effectively removes over 30% of the survey area from burrowing owls! These artificial perches not only pose more threats of direct predation to burrowing owls, but present easy and plentiful opportunities for great horned owls and red-tailed hawks to hunt by perching, thereby directly competing for food in ways that was never possible previously.

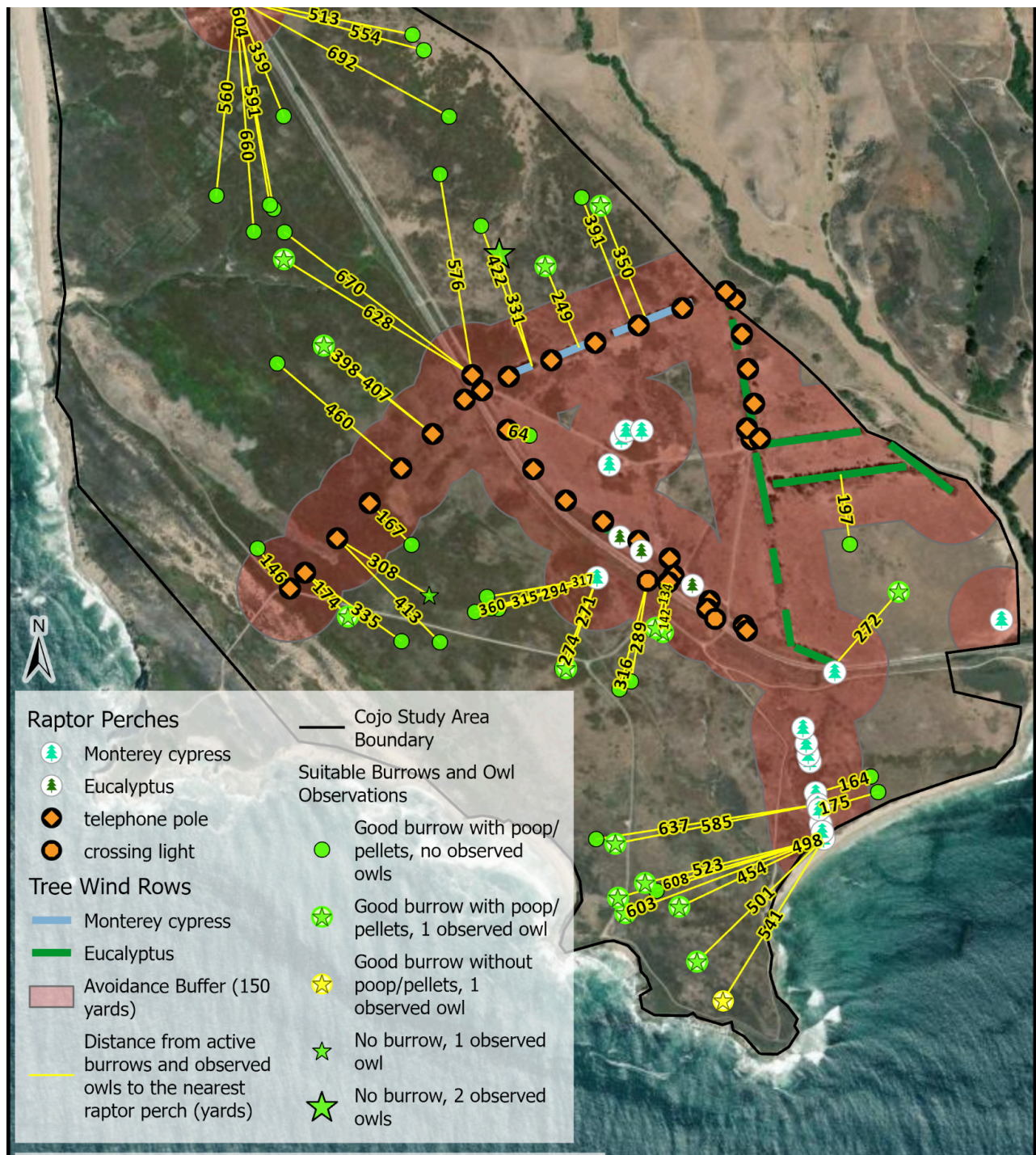


Figure 27. Map displaying the 150-yard buffer from trees and power poles and lines. Only 10.75% of utilized burrows (4) were recorded inside this buffer, 3 of these being on the buffer's margin. The closest recorded utilized burrow to a blue gum was 197 yards. Note only individual trees are denoted by tree symbols- the rows of trees in the northeast are not.

Other Artificial Perches

Burrowing owls are on a level playing field with their natural avian predators when their ecosystems are undisturbed and natural. When burrows are reduced, disappear, or become inaccessible, when vegetation shifts, woody vegetation or structures over 36" (91 cm) are introduced, burrowing owls simply experience greater stress, danger, and predation as the advantages tilt towards their predators. While non-native trees are by far the greatest contributing factor on the terrace, the railroad is another such source of man-made perching opportunities. Although removal of the railroad is clearly outside of the scope of reasonable ambition for the Dangermond Preserve, it is worth noting that it does, in fact, create dozens of potential perches for serious burrowing owl predators, probably most notably, great horned owls. This point not only emphasizes the threat that perches create, but how many there are on the landscape when viewed through the eyes of this imperiled owl than seem apparent.

The railroad extends through the survey area for 2.3 miles and of course extends into habitat beyond the survey area as well. Lower perches have lower sight lines than taller ones, and therefore confer less predator advantage, but the droppings on signs, signals, and other erected objects in an area indicate they are utilized widely. These are relatively minor landscape alterations compared to non-native trees, but the droppings on these perches is evidence they are being used frequently. Again, these are almost certainly being utilized by larger raptors that pose both a predation threat, and an increased competition for food by facilitating otherwise impossible hunting opportunities.



Figure 28a. Even parked railroad cars, as shown above, represent potential perches. Though subtle, they are still higher than anything naturally available.



Figure 28b. This mule deer forages among a backdrop of railroad signals, each of which is a perch that gives predators the advantage where burrowing owls are concerned. Droppings on the sign below is evidence of utilization in the area as the tallest available perch in the vicinity.



Figure 28c. This stop sign is the highest point around, and bears what appears to be bird droppings. It is likely these are at least partly from large raptors.



Figure 28d. Railroad signals with evident droppings from large birds, some of which are almost certainly the predators of burrowing owls.

A Final Note on Sight Lines and Burrowing Owls

Work done on the construction and placement of artificial burrows for burrowing owls has not only involved the awareness, avoidance, and removal of perches detrimental to burrowing owl well-being, but has also given considerable thought to the size and placement of those which are beneficial. The graphic below (Johnson et al, 2013) refers to perch height and sight lines for burrowing owl artificial burrow construction, highlighting the importance of low perches. According to Johnson, it is important that the perches are placed in front of the burrows, not behind them (for artificial burrows with entrances with 90° angles, unlike those shown below), to confer an advantage to the burrowing owls and not their predators (Johnson et al, 2013).

Choosing the Site for Your Artificial Burrow System

In this section we focus on characterizing burrow site selection at the nest site and landscape levels.



Figure 27. Conceptual diagrams (left column) of the open visual sightline characteristics of critical importance for successful burrowing owl nest sites (G.A. Green pers. comm.). These sightline characteristics allow the owls to detect potential predators and are required for positive owl use of ABS.

Figure 29. Graphic relating to perches and sightlines, adapted from Johnson, et al., 2013

The graphic below was created by the author, to highlight the distinction between native trees and the now ubiquitous blue gum eucalyptus, and the sight line/predator advantages that *unnaturally tall non-native trees* impose on the landscape. While the ecology of nonnative trees is nuanced, the significantly greater heights many of these taxa commonly achieve beyond native tree heights in California and the consequences these mean for burrowing owls and other grassland birds is significantly under acknowledged.

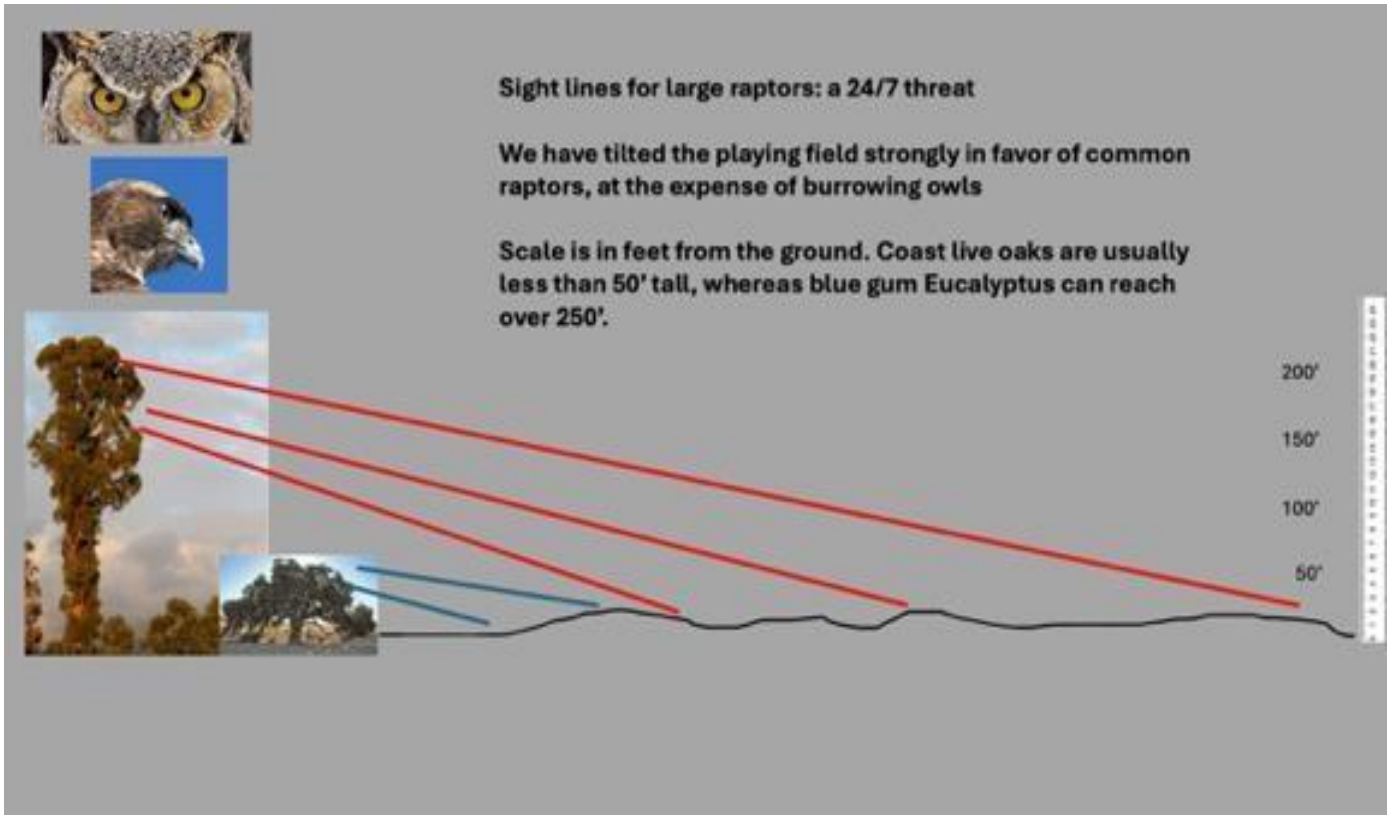


Figure 30. Graphic elucidating the increased raptor threat that non-native trees, such as blue gums, impose on the landscape, as they are many times taller than coast live oaks.

The image below is taken from the UCSB campus mesa, looking roughly north at the Goleta Slough, Santa Barbara airport, and Santa Ynez mountains. Steve Timbrook reported that this was the “go to” place for burrowing owls in the 70’s and 80’s- none occur there now (although they occasionally occur in the airport property beyond- only to find no burrows as ground squirrels are controlled). This was the first restoration site I worked on beginning in 1998; burrowing owls were never observed there by myself or others, nor have they been in the subsequent decades although they sometimes are in the slough. The oaks in the image are relatively young (< 50 years), and the blue gums even younger. The blue gums are recruiting from the main campus to the south, across Mesa Road. The height difference between the eucalyptus and the coast live oaks is notable, despite their being relatively young and below full size. This is just another example of the silent, continual erosion of burrowing owl spaces on the South Coast.



Figure 31. The area in the middle of this image is a place where burrowing owls could reportedly be seen commonly in the 70's and 80's- they are no longer present there today- largely due to the expansion of trees.

Paucity of Burrows

If we consider the California grassland ecosystems from the beginning of the Holocene (+/- 11,000 ya) to the mid 1500's (when Cabrillo's expedition would have had the first known opportunity to significantly perturb the native peoples or ecosystems in the area with the introduction of diseases, plants, or other organisms), and compare that to the grasslands of today, the differences are remarkable. Of all of California's plant communities, its low elevation grasslands are among the most altered. Grasslands existing today are a combination of both introduced and natural features, but have endured many changes that affect some taxa more than others. In California, the widespread persecution of various species of ground squirrels as ecosystem engineers and keystone species is among the alterations that carry outsized weight in terms of cascading effects downstream, particularly for burrowing owls.

While the exact history of ground squirrels and their control on the Dangermond Preserve is unknown, it is highly likely that their numbers were historically reduced during its ranching period. This is a reasonable assumption for a few reasons: 1) California ground squirrels are considered a non-game species in California are widely derided as a pest and a management issue in many respects, 2) ground squirrel burrows are a potential injury threat to horses and cattle, 3) ground squirrels are still commonly controlled today by shooting and poisoning and have been historically, 4) California ground squirrels are native to the preserve, and do exist there today, and 5) we saw very few California ground squirrels during our surveys. Although not systematic, observers were focused on looking for ground squirrels. Ground squirrels and their burrows were only observed in two general areas across the survey area, shown below encircled in yellow (Figure 32).

Burrowing owls are known to benefit from and react to the alarm calls of both ground squirrels and prairie dogs- an important example of interspecies communication. When these rodents are reduced, not only do burrowing owls suffer from the lack of burrows, but from a lack of eyes, ears, and alarms.

We did locate almost 300 burrows that appeared to be suitable for wintering burrowing owls. However, the relative lack of squirrel burrows and colonies, and the relative lack of what appeared to be badger *dens* could be limiting burrowing owls from attempting breeding. Where pocket gophers routinely plug their burrows, ground squirrels do not; an important prerequisite for burrowing owls. While gophers are regularly reabsorbing the badger holes on the terrace by backfilling, so that they are of no use to burrowing owls, ground squirrels maintain theirs as open and accessible.

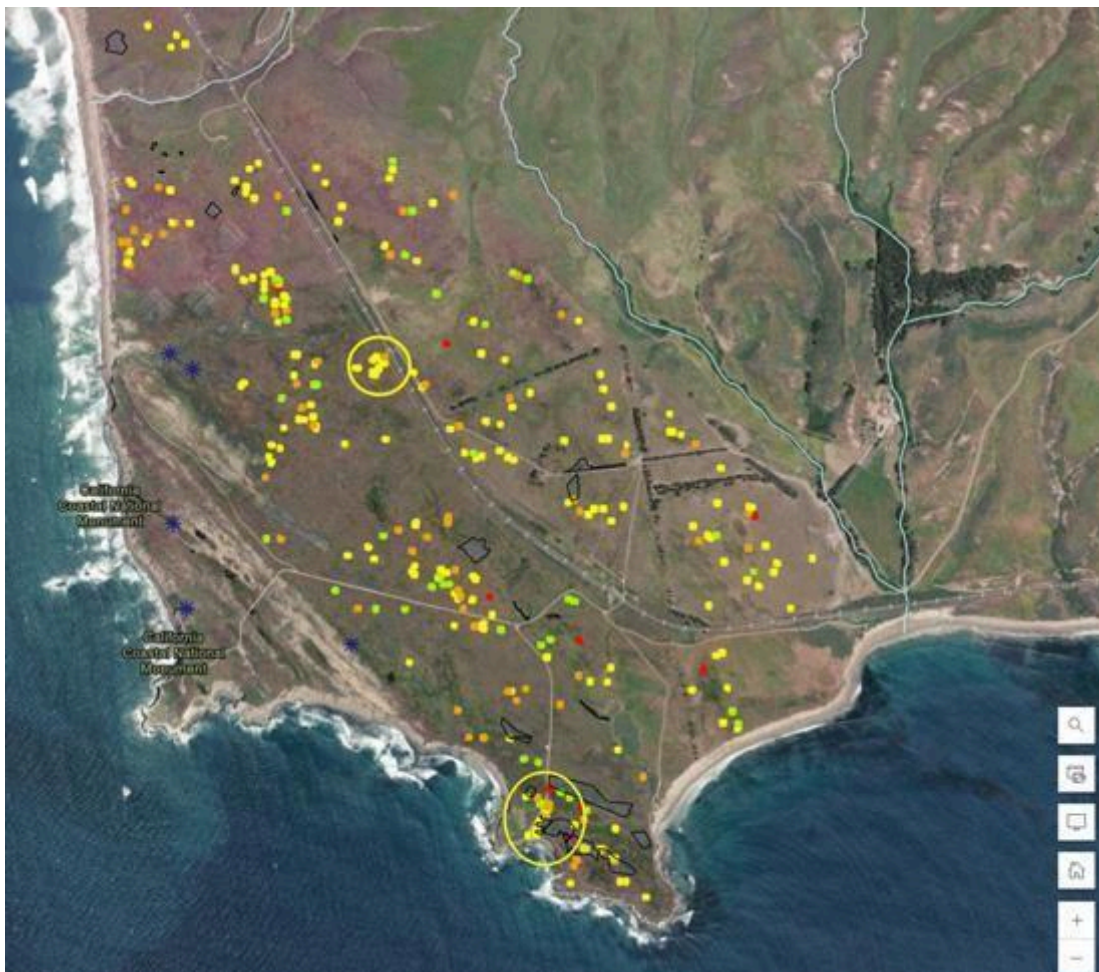


Figure 32. Graphic displaying burrows and their locations recorded during the survey. Note the relative rarity of those made by squirrels (general areas circled in yellow) as compared to badgers.

Overall Assessment

There are many reasons to assume that the situation at the Dangermond Preserve is at once the best thing remaining in the region for burrowing owls, and at the same time suffering from many of the same ubiquitous stressors as the rest of Southern California. In order to maximize burrowing owl conservation and site potential, the terrace needs more direct management for them and other grassland specific species. While the Cojo Terrace displays an outsized number of features among its expansive, wild nature that have benefitted burrowing owls, it has not escaped many of the widespread alterations that Southern California has experienced more broadly. While burrowing owls are likely reported at the preserve at higher numbers than anywhere else in the county per square mile, there are some indications it could be a place fraught with danger and, due to its stressors, more a sink than a refuge. This should be viewed in context, as the entire region of Southern California is now also a sink. The main difference between the terrace and the rest of Southern California is that the Cojo Terrace has the ability to undergo restoration towards its potential that is much higher than what it is today, while most of Southern California cannot. This is especially true of low elevation, flat, coastal prairies.

From the preserve come anecdotal reports of burrowing owls being present in numbers not matched anywhere else in the county (+/-40 seen on a single drive at night). This at first seems indicative of burrowing owls doing quite well there, but the same source also reports that these numbers dwindle as the winter progresses (Reynolds, personal communication). It is expected that they should be absent by the middle or end of April or thereabouts, given that the assumed once-extant breeding year-round birds are now almost certainly extirpated. However, the observation of declining reports throughout the winter could mean several things. The phenomenon of burrowing owls disappearing from wintering sites *mid-winter* in the county is not unprecedented, but in our experience, and the experience of others, owls not stressed by lack of food, an abundance of predators, or other suboptimal conditions at winter sites commonly remain in place *all winter* until they migrate north, often preferring one burrow (Johnson, personal communication, personal observation). Burrowing owls have been well documented as having *strong site-fidelity*, particularly to winter burrows. Even suboptimal refuge such as culverts are utilized and known to be revisited year after year (Woodin, 2006). Culverts in California, during the winter's rain events, will predictably be consumed with flowing water. While the opposite of a dry refuge, and yet they are reportedly utilized, nonetheless.

We do not know what background densities would constitute healthy populations on the Cojo Terrace for comparison but can only assume they were much higher than

today. Some historic accounts of burrowing owl colonies were especially dense. This quote from **Cornell Lab: Birds of the World** is especially striking: *Such colonies were sometimes large; Bent (1938) describes a Florida colony that (in the 1880s) was 3 miles (4.8 km) long and contained “several hundred” pairs of owls.* (Poulin et al. 2020).

If we assume that the Cojo Terrace once had a resident, breeding, non-migratory population that was further supplemented each fall and winter by an influx of wintering owls from the north, one can reasonably assume the same surveys that in modern times report +/-40 owls may have yielded many more- but we don't know that number. Such is the vacuum of lost information and the lack of pristine reference sites. The well documented decline and near total absence of burrowing owls in the region is hard evidence that they are not doing well in general, and is supported by historic records, winter bird counts, dwindling breeding pairs through the decades, and now total extirpation of breeding. Pending listing in the state notwithstanding, from a functional standpoint they are surely critically endangered in the county, and regionally.

Many reports, including and especially from the Dangermond Preserve itself- but including several other ranches as well as San Clemente, Santa Cruz, and Santa Rosa Islands- indicate that burrowing owls are seen clustering on roads at night. These sightings on their faces seem positive, but I would postulate that they also indicate *hardship*. In *every one* of these anecdotes I have recorded, the properties are either under grazed (not grazed consistently enough to maintain ideal grass height throughout the year), or not grazed at all (Channel Islands). It therefore makes sense that the owls congregate on the roads because there they have the opportunity to catch rodents and crawling insects and similar in the open and on the grassy edges, because otherwise finding them in the thick grass on the broader landscape is more difficult. Morgan Ball has conducted nighttime surveys of burrowing owls for the US Navy on San Clemente Island. His night vision surveys inform that burrowing owls stand on roads, or perch for hours in one place where they have a good view of the ground and wait for prey to happen by or reveal themselves.

We can compare this to seeing fleas on a dog or cat's back- they may be there, but they are invisible unless one checks the belly of the animal where hair is short and thin. Mice, voles, gophers and invertebrates are in dense grass or the soil beneath it, but they are only visible to burrowing owls if the ground is partially visible, or if the grass is sufficiently short or sparse to allow it.

It is possible that thickening grass may cause owls to abandon areas on the Cojo Terrace throughout the winter rainy season when annual grasses grow, and when the owls are present, because of the difficulties it creates for the locating and capturing of food and access to burrows. The reality however is that owls that move to escape

unfavorable conditions will almost certainly move on to similarly difficult situations elsewhere, as these conditions are ubiquitous. A recent consultation with CDFW confirmed that in their experience in San Diego, when the grazing is ceased and grass goes unmanaged, the burrowing owls leave (Hillborn, personal communication).

Since there are many reports and observations of burrowing owls staying at one main area, and one preferred burrow within that area, during winter stays in Southern California, their propensity to sometimes decline or disappear from these sites is mysterious (Bee, Reynolds, personal communication, personal observation). It could be assumed that these owls become absent during the winter for the following reasons: 1) they moved on because the site was a stopover site and another site was the destination, 2) they relocate to avoid stressful predator interactions, disturbances, incompatible vegetation structure, lack of food, or other less-than-ideal conditions, or 3) they are being killed, most likely by predators. Since they are conspicuous birds that often post directly in front of their burrows by day, usually flush when approached too closely, and are often seen on roads at night by drivers, it seems the possibility that they are still present but not being seen in most of these cases so unlikely that it can safely be ruled out. Where predation is concerned, as previously discussed, many of their avian predators utilize adjacent trees and similar vegetative cover and likely carry captured burrowing owls to these areas to avoid coyotes or similar on the ground, so it is not unreasonable to assume that burrowing owl remains left over by predation events would only occasionally be found. However, we do have evidence of this.



Figure 33. A wing given to the author in the early 2000's found along Calle Real, just north of Hwy 101 on the Gaviota Coast. The area has two separate utility lines that parallel the freeway that are over 70' in height, and many planted trees. It is possible this owl was predated on from those lines or trees and subsequently eaten on the lines.



Figure 34. Feathers from San Marcos foothills found on November 9, 2021. Until sheep grazing and, more importantly, artificial burrows were installed there, no burrowing owls have been observed on the property residing the full winter term; post modifications, it occurred two years consecutively.



Figure 35. Remains of a burrowing owl from the NCOS site on UCSB, killed by a red-tailed hawk on April 6, 2021. The owl spent a full 6 months on the site and would likely have migrated north imminently. This serves as a reminder that even in habitats designed specifically for burrowing owls, with removed perches and installed burrows, they are lost to predation.



Figure 36. Feathers collected under a planted cypress at Coal Oil Point on October 18, 1999- the first ornithological record of burrowing owls since record keeping began. New linguistic and ethnographic evidence informs us that the Chumash name for Coal Oil Point was *phoq'oy*, possibly a name for burrowing owl.

Burrowing owls have disappeared so thoroughly and so long ago from most of the county that they are all but forgotten as the once common birds they were. While barn owls and the wine and agricultural industry have formed a symbiotic relationship throughout the county (and beyond), resulting in thousands of nest boxes being erected for them, burrowing owls- a far rarer species- have had essentially the structures this author has installed personally or with others at UCSB and Hollister Ranch, or consulted on at the San Marcos foothills. A forthcoming small grant from SB County Fish and Wildlife is set to expand on this in the spring and summer of 2026 on more properties.

Anecdotal reports about how they “used to breed here” or were commonly seen in this place or that from the area are not too difficult to find. These are usually from the 1980s or earlier. But the degree to which they were once very common in the Santa Barbara area seems to have disappeared from the ornithological conscience decades ago. Early records are rare, but on burrowing owls in SB County, Lehman has reports from as early as 1886 from S.F. Streater “*common, breeds*” and Willett, 1912 “*common resident from the coast to the base of the mountains*” (Lehman, 2024), (Gervais et al. cite this report as being from 1933).

If we consider the thicker-than-ideal herbaceous vegetation in many places, the >315 acres effectively removed because of trees and powerlines, the diversity, density, and prevalence of predators, low numbers of ground squirrels, and the lack of good

burrows in general, we see that the Dangermond Preserve at the low-elevation Cojo Terrace is in fact a greatly modified and degraded environment for burrowing owls. If we zoom out and consider the whole preserve including the foothill areas mapped as grasslands, there is dense cover of non-native grasses, or worse, thick *Brassica nigra* on essentially all of that acreage. From a conservation standpoint, that the entire preserve is in far better hands now than it was as a cattle ranch is undeniable, but the shift of management focus away from cattle grazing may have in fact harmed burrowing owls to some degree by thickening herbaceous vegetation, even if the same forces eliminated ground squirrels. This is indeed a paradox that belies the strict habitat specifics burrowing owls require, how easily they are disrupted, and the ubiquity and multitude of stressors they face in modern California.

Chumash Ethnography

The aforementioned record from Coal Oil Point (Figure 36) is especially telling; it was the first record of a burrowing owl from that location since scientific records were kept. However, recent linguistic and historic evidence indicates that the place name given to Coal Oil Point by the Chumash may have been the same name, or a variant of, for burrowing owl.

James Yee, grandson of the last first-speaker Mary Yee who worked extensively with ethnographer John P. Harrington, has discovered that the place today known as Coal Oil Point, or Devereaux Point, was called *phoq'oy* or *phok'oy*- and this is, or may be, one of the words recorded in the 'alapakwa language for burrowing owl:

Applegate dictionary: phoq'oy [h is superscript showing aspiration], name of a point of land on the coast, west of El Rincon ". (Source not stated.)

Wash dictionary: phok'oy [small h again] name of point west of rock called "sismukiw" [Campus Point, flat rock there], (source is Harrington, Juan Justo, Reel 21). My guess: name contains (the) bound verb root k'oy meaning 'going around, returning'.

This may describe burrowing owl behavior, flying from a burrow, landing nearby and bobbing, then returning.

Wash gives chpokoy [small h again] as "ground owl". looks somewhat similar but aspiration is on c and no glottal (Yee, personal communication).

Juan Justo gave Harrington the name *tspokoy* for ground owl in 1913. He was a full-blooded Chumash consultant of John P. Harrington's from Dos Pueblos, who would have had two fluent, first-speaker parents. This is noteworthy given the immense rarity of first-hand Chumash stories, lore, or other ethnographic information relating to burrowing owls, and the tragic, rapid loss of Chumash culture that was ensuing at that

time. Being fluent in the 'alapkaswa language means Justo may have had crucial conversations with elders that may have relayed placenames, names of flora and fauna, or other information that he may not have heard if raised in a different context, such as a mixed-race household. This allowed him to have this information to relay to Harrington, who, due to his close relationships with Chumash families and individuals, and many years of research, is possibly the single greatest ethnographic source of Chumash ethnography today. Some Chumash of the time did not contribute to John Harrington's notes and took everything they had into the ether.

As is still done today (the Grand Canyon, Los Osos, etc.), Native Americans likewise named places by their literal characteristics or noteworthy features. That Coal Oil Point may have been named "burrowing owl" is an indication it was heavily populated with them, or was notable for their presence. Like so many other places, it is now greatly transformed, heavily treed with non-native trees, and has no burrowing owls today.

It should be noted that Mary Yee (1897-1965), whose mother was fluent, said that the name for the burrowing owl was *pewyoko*'. However, as mentioned, Juan Justo (1858-1941) gave *tspokoy*. Mary Yee's great-grandmother, Luisa Ygnacio (1835?- 1922) who, like Justo had two fluent parents, apparently gave the name *pewiyoko* for "a small hawk that flies at twilight"; seemingly not a burrowing owl but potentially a night jar or poorwill- that may have been the same word Mary Yee called burrowing owl, with the discrepancy being in the ethnographer's spelling. Another record for what may have been the common poorwill in the samala language (Santa Ynez) is *po'yoko*' (Timbrook and Johnson, 2013). It should be noted that the Chumash had no written language, so many of the same words recorded by linguists are spelled differently.

The samala (Santa Ynez) word for burrowing owl was recorded as *pokoy*, which is very similar to *tspokoy*. It was not uncommon that bird names across the Ventura, Santa Barbara, and Santa Ynez Chumash languages were the same or similar (Timbrook and Johnson, 2013). It is possible that Mary Yee mistook the name for burrowing owl for that of a nighthawk or poorwill, or perhaps they had multiple names. Given the esoteric nature of the Chumash languages, and the often difficult-to-interpret writings of John Harrington, it is impossible to be certain whether or not the name Juan Justo gave for Coal Oil Point was in fact named after burrowing owls. It remains a tantalizing piece of the area's history, and mystery.

John Harrington recorded other bits of information from Juan Justo on burrowing owls. In one note, he recorded that Justo said the owl "salutes" or bows to a person and cries *pokō*. Burrowing owls will frequently bob up and down upon being disturbed or discovered. The 2-syllable call he described is likewise evidence the birds once bred in

the coastal reaches of Santa Barbara county; this appears to be an onomatopoeic word for the male's territorial breeding call, which has sometimes been written as "coocoo". It can be heard [here](#). Some of the two-syllable names are likely onomatopoetic. Presumably from Fernando Librado, a Venturenño consultant, Harrington recorded confirmation that red-tailed hawks are one of their eternal predators, writing "*V. kokok = ground-owl. This was the bird that the left-winged hawk was after acc. to story recorded elsewhere*". Harrington recorded that the "left-winged hawk" was the red-tail, because, according to one Chumash informant, they "struck with their left wing" (Harrington, 1913).

Recommendations

It is difficult to make a clear and simple prioritized list of recommendations for burrowing owls on the Cojo Terrace for a few reasons. Firstly, some recommendations have equal priorities and should ideally be implemented together since they affect each other or would either be ineffective, or not nearly as effective alone as they would be in combination. An example of this would be the inclusion of structural improvements such as burrows combined with grass management and tree removal. Some priorities would essentially be useless if not implemented alongside others; such are the needs of burrowing owls. There is no need to manage grass if it is too close to trees; there is no reason to install burrows if they are obscured by thick grass, etc. Implementation of priorities also need to be viewed in the context of other restoration activities the reserve has planned, although burrowing owls can tolerate or benefit from many disturbances especially when efforts are made to consider situational details with them in mind. Lastly, fluctuations of conditions such as rainfall will make the urgency of priorities or the resources needed to address them (such as grass management with grazing or mowing) vary seasonally or annually.

Burrowing owls need more active management and restoration efforts both locally and regionally, and their California stronghold in the Imperial Valley faces an almost certain series of changes that will negatively impact them. However, as has been elucidated here, modifications to existing habitat can and will benefit them on the Cojo Terrace, as has been demonstrated elsewhere. They are a species that responds to restoration when done correctly. Therefore, recommendations are as follows:

Artificial Burrows and Structures- Immediate Owl Security

The first and most urgent priority is the well-being and retention of all owls on the Cojo Terrace, especially in what appears to be the currently existing places with best conditions they prefer. This can be achieved by performing micro-adjustments to make

these sites the best habitat they can be, as soon as possible. The most ideal places already identified (potentially including some areas outside of the survey area) should have artificial burrows, rock piles, experimental concrete mound structures, and any other beneficial structures such as brush or wood piles added to them. Since some of these efforts may be cost or labor intensive initially, and require moving heavy, permanent materials, these efforts may need to be added throughout the year, and in subsequent years, but anything and everything will help immediately. The soils on the Cojo Terrace are sandy, so installation of shallow artificial burrows would be relatively easy digging-wise, but the same soils may require some maintenance to prevent the tubing from occasionally becoming exposed by digging animals or erosion. Installation of artificial burrows, experimental concrete mounds, and rock piles in an experimental framework could help both determine owl preference and overall site-suitability that would help inform larger efforts. Experts in the field such as David Johnson and Lynne Trulio have concurred that more information and data on what burrowing owls prefer and most benefit from regarding wintering structures is lacking and needed.

More on Artificial Burrows

Given the long distances burrowing owls must fly to reach wintering grounds and the major conversion of former habitat in Southern California, it is presumed that exhausted winter migrants are finding few suitable places to settle, therefore are landing in unsuitable places out of desperation, putting them in danger. During the fall of 2024, a burrowing owl was observed in a parking lot in Oxnard. When the meeting had concluded and he returned to his vehicle, the bird was gone (Orcanaza, personal communication).

The decline of burrowing owls in Santa Barbara County both historically and in recent decades has been clearly documented. Due to the prevalence of birders, sightings of burrowing owls have been recorded in places such as the San Marcos Foothills, More mesa, and the UCSB campus. Sightings at these locations however are sometimes years or decades apart. Additionally, these have only consisted of fleeting observations- indicating the owls either moved on (something they generally don't do when content) or had been quickly lost to predation. This phenomenon is representative of the entire region of Southern California being a sink, as is their general population status. The resident populations are extinct, and the incoming winter migrants have low survival rates. Many of the burrowing owl reports throughout much of Southern California appear to consist of short-duration or one-off sightings.

The recent installation of artificial burrows at the San Marcos Foothills and North Campus Open Space at UCSB along with other habitat modifications have resulted in the first modern records of burrowing owls *staying the entire winter period* at both

locations. With these burrows in place and being expanded on, this is now often the norm each winter. This has not been published but the records are clear and have been documented by numerous birders, posted online, and recorded in Christmas bird counts.

There is potentially an outsized inclination for burrowing owl observations to be correlated with the assumption that they are in fact doing well, or that the places they are seen consist of good places for them. Since it's impossible to ascertain the hunger, cortisol levels, fat levels, or other well-being metrics of burrowing owls simply by casually observing them, and given the status of their habitats and populations, it's safe to assume that even when owls are observed they are survivors of- and currently enduring- the same broad stressors that have depleted them so thoroughly.

Land managers must recognize that fleeting or shorter-term observations of burrowing owls that last only for a few days- or even a few months- of the winter season, are not necessarily indications of well-being. Sightings that persist for several months but fall shy of 5-6 months may in fact indicate losses of animals from the population. Most local observations are much shorter than this. If the fate of these owls is to be eventually predated on before ultimately migrating back to their breeding grounds, their contribution to the ecosystem was futile except for serving as a food item for the predator, and their contribution to the population is lost. Burrowing owls can live up to 8-9 years, and individuals we observe here coming from northern populations spend *half their lives* in their winter grounds. Even under ideal natural circumstances, in a world replete with burrows and ideal conditions, burrowing owls are predated on. If they are expected to have a level playing field with their natural predators, and begin to reverse population declines, their specific needs and stressors need to be considered more acutely- especially in managed areas. This is especially important in whatever little good habitat remains.

Numerous lines of evidence, as cited previously, indicate strongly that our burrowing owls today rarely find themselves in ideal situations. It then corresponds to their finding themselves in sub-optimal, stressful, difficult, and dangerous ones. By analyzing landscapes for burrowing owls and their requirements more closely and making sometimes only minor alterations, meaningful results can be had immediately. By combining two or more modifications, these results may amplify significantly.

One of the fastest, easiest, and most immediate ways to secure burrowing owl safety is to create artificial burrows in otherwise good habitat. As noted earlier, burrowing owls have especially high site-fidelity to winter burrows, underscoring their reliance on them and their importance. While the numbers of artificial burrows installed in Santa Barbara County thus far are few, they demonstrate an almost 100% occupancy

rate, if not per burrow, per site where burrows were established. The implementation of the NCOS project on the UCSB campus in 2017 included micro habitats consisting of +/- 1 cu yd piles of broken concrete slabs half-buried in the ground. The original grading of the site and tree removal left a small, but significant piece of habitat that was attractive to burrowing owls looking for wintering grounds, and almost immediately the following fall burrowing owls began to utilize these concrete structures.

This continued annually each season for several years- a phenomenon never observed previously. Subsequent artificial burrows installed on the site in 2020 yielded the same results, and as many as three owls at a time, a profound density considering the usable acreage at the site (+/-14 acres) and how rare they are on the South Coast. Burrowing owls generally preferred artificial burrows over the concrete refugia. Some of these owls have been observed spending 6 full months at the site, and are visible almost all day, every day.

Some of these have also disappeared mid-winter. While we have one confirmed record of a predation event by a red-tailed hawk, we have no indications where the other owls have gone. Regardless, at least 5 burrowing owls have spent a full winter on the site, a modest, but comparatively huge increase compared to previous decades.



Figure 37. Burrowing owl on a buried concrete structure or hibernaculum (on right) at NCOS in Dec 2018.



Figure 38. Burrowing owl utilizing concrete pile at NCOS.



Figure 39. Burrowing owl at the entrance of an artificial burrow at NCOS.



Figure 40. Burrowing owl on concrete pile at NCOS, 2024 (upper left).



Figure 41. This burrowing owl utilized concrete piles at NCOS before artificial burrows were constructed and used this particular one as its secondary refuge. When it was not at its main refuge, it could reliably be found here. Burrowing owls select these for morning sun, a good view of the landscape, and protection from predators and prevailing winds.



Figure 42. Burrowing owl rehabilitated by the Ojai Raptor Institute and released at NCOS in 2024. The bird relocated to a different burrow approximately 30 yards from its release site which it favored and remained at for the rest of the winter.



Figure 43. Although the head of the owl in the background is difficult to see, there are two burrowing owls in this image, highlighting their propensity to share relatively small areas when good habitat is present. These artificial burrows are about 22 yards apart. NCOS, UCSB.

Given that the NCOS site is small, the meso-predator population (skunks, raccoons, opossums, red foxes) is high, populations of red-tailed hawks, great horned owls, and other common large raptors is high, the potential for disturbance by the public

entering closed areas exists, and other sub-optimal factors, burrowing owls face numerous challenges even on a site managed largely with their specific requirements in mind. However, having 3 owls on just 14 acres also highlights the potential of sites with hundreds or thousands of acres. There is no doubt that well-constructed, well-placed burrows attract and are used by burrowing owls, and they have shown tendencies to even prefer these over natural ones (Menzel, 2018).

Burrowing owls have been only sporadically recorded at the San Marcos Foothills Preserve in Santa Barbara in recent decades (Lehman, 2025) with some of these being confirmed predation events. All observations were of short duration, indicating they were all owls that moved on due to sub-optimal conditions, or were lost to predation. In September 2023 experimental winter burrows were installed on the preserve, resulting in the first record of a burrowing owl using the site all winter. This was then repeated in 2024. Consider this again in context- *zero* records of a single burrowing owl at the San Marcos Foothills for longer than a few days since records have been kept, and then at least an owl each winter for the entire 6-month period for two years running after artificial burrows were installed.

Hollister Ranch is another location with at once enormous potential, relatively high counts of burrowing owls, and many of the same detrimental changes to the landscape that are problematic state-wide. Hollister Ranch, like Dangermond, has American badgers, a history of ground squirrel control, and burrowing owls use the burrows badgers dig for gophers like they do at Dangermond. In December of 2024, more experimental burrows were installed at a location where burrowing owls were known to be using badger burrows. This was done to increase the numbers of stable, reliable burrows the owls can use.



Figure 44. Experimental winter burrows being installed at HR.

In a matter of days, a game camera was installed on the burrows. It appeared an individual that had been seen using a badger burrow nearby on the day of construction had immediately relocated to one of the constructed burrows, where it took up residence.



Figure 45. Burrowing owl on Hollister Ranch that upgraded its badger burrow for an artificial one.

We recommend the installation of artificial burrows for several reasons, most importantly they provide immediate security to owls that visit each fall. Though burrowing owls tend to display high site-fidelity and preference for a single burrow when wintering, the presence of many burrows has importance beyond providing a primary burrow for each individual owl. Alternating between a few *preferred* burrows may be necessary to help them evade predators like Northern harriers which are known to revisit burrows repeatedly once an owl is observed there. Furthermore, when wintering, these owls spend most of the daylight hours at their burrow entrance and feed at night

away from the burrow, when great horned owls are their primary avian threat. Even if an owl uses a satellite burrow only once during an entire overwintering period to escape a predator, if that burrow saves its life in a predator-prey interaction, it was just as crucial to its survival as its main one. Therefore, increased frequency of satellite burrows is almost certainly correlated with higher survival.

Artificial burrows for wintering owls can be different from those required for breeding. They can be dug into the ground or buried beneath mounds. In sandy soils, where flooding is not a concern, burying breeding chambers is acceptable, while in heavier soils, burying is recommended. I have designed winter burrows with two or three entrances that have been dug down about 11-14" (28-35cm) deep as measured from the bottom at the San Marcos Foothills and Hollister Ranch and have used David Johnson's breeding design for wintering owls successfully at NCOS, which were buried beneath mounds of approximately 5 cu yards of soil each respectively. Experimentation in burrow entrance number, placement, aspect, diameter, and other design elements would provide important data on owl preference and usage. If breeding were to occur on the Cojo Terrace, artificial burrows with badger prevention built in would be important.



Figure 46. Winter burrow design being installed at Hollister Ranch. This burrow is made of 4" corrugated pipe, with a "Y" at one end, allowing the owls to choose their preferred aspect, and escape from raptors from three different directions without the need for pivoting abruptly in the air to enter. These are easily plunged periodically for maintenance. Designs with two or four entrances can also be constructed. 6" designs should be installed for comparison. 6" is preferred for room to maneuver inside but is more accessible to skunks, opossums, and where they occur, badgers. Burrow reducers or rebar driven off-center inside the entrance can prevent that.



Figure 47. The entrances were hardened with concrete and any available rock, and in this case, were not intended to look extremely “natural” but may be made to look that way. Subsequent reports indicated that the bulls in this pasture may have collapsed tunnels in a few places, specifically directly behind the entrances where they are shallowest, highlighting the need for more experimentation or subtle modification. Even if partially collapsed, these can still be useful and protective to burrowing owls but may preclude their ability to be plunged or let owls traverse their entire lengths.



Figure 48. Breeding artificial burrows designed by David Johnson. These include a halved 55-gallon drum laid over hardware cloth, 10' long 6" tunnels, curved for darkness. Cut and glued into the tops are 3.5-gal buckets with the bottoms cut out. A second, soil filled bucket is placed inside these as a plug to insulate from noise and temperature. The “plug” bucket can be removed and allows for access and banding of owlets.



Figure 49. Burial of breeding-type artificial burrows. This method creates mounds burrowing owl's favor.



Figure 50. Burrowing owl sitting atop the mound that covers the artificial burrows at sunset.



Figure 51. Completed artificial burrows, whose entrances are hardened with rocks. No concrete was used here but is stronger. The investment of building these will provide habitat for decades.

Artificial burrows do require maintenance, depending on the type and situations. Generally this involves plunging once a year to make sure rodents have not clogged the tunnels, but may involve repairing tunnel collapses from cattle. Plunging is relatively fast and easy and could likely be accomplished by a group of volunteers with the GPS coordinates and some training. Some additional maintenance may also be necessary to correct tunnel exposure due to the erosive soils or digging disturbance by animals. Burrows are typically inspected and maintained each summer, before burrowing owls arrive.

Microhabitat and Novel Structures

Another key way to improve burrowing owl habitat is through the introduction of microstructures such as rock, wood and brush piles. This creates subtle but important heterogeneity in relatively monocultured landscapes such as expansive grasslands. These help burrowing owls by providing satellite sheltering areas, perching opportunities for predator and prey detection, and increasing prey diversity and abundance. Like marine life attracted to objects on the monotonous sea floor, burrowing owls are drawn to almost any low-lying irregularity in flat habitat. At the NCOS site on the UCSB campus, broken pieces and slabs of concrete were strategically placed around the restoration site and were the first location burrowing owls were drawn to before artificial burrows were built and are still often used each winter (Figures 37- 41). In this case

each pile consisted of around 1-2 cu yards of material and were recessed approximately 0.5-1 m below grade. Finished piles stood an average of 0.5 m above grade. Piles were subsequently reconfigured by hand to specifically be useful to animals smaller than striped skunks and other mesopredators. Subsequent monitoring of these piles indicates they are widely used by wildlife (Dobson, 2021).

These types of microhabitats have been recommended and included in burrowing owl restoration sites previously. Recommendations are that the rock, brush, and wood piles be sufficiently large to achieve the target goals of providing enough size and complexity to shelter burrowing owls and/or produce food items. The piles installed and recommended by the Wildlife Research Institute were larger than the ones installed at NCOS. Specific details on those are available in City of San Diego's Burrowing Owl Management and Monitoring Plan, lower Otay Lake Management Area, page 18 (Wildlife Research Institute, 2005).

Since burrowing owls are known to be drawn to almost any low-lying objects in flat grasslands, we recommend the investigation of experimental, burrowing-owl-specific structures (figure 52). These experimental structures could be placed in existing ideal areas and monitored with trail cameras and surveys to assess owl usage, then improved upon and mass-produced. The assumption is these would serve numerous advantages: 1) no digging would be necessary, 2) they would look like a subtle, natural, mound of soil but could provide consistent bird watching opportunities for visitors, 3) they could be used as primary winter residences, as predator refuge by nocturnal owls hunting the landscape, and potentially, with modification, for breeding, 4) they would be slightly above even taller-than-ideal grasses prevalent on the preserve and 5), would provide immediate security for owls and immediately help to retain them.



Figure 52. Illustration of theoretical concrete burrowing owl mounds, which could be designed to have inspection ports that are removeable, and one or more entrances. They would be forever-lasting, secure from disturbance from even powerful animals, and importantly, would project slightly above even taller-than-ideal grasses, which are all too common. Designed to look completely natural like a boulder or mound of soil with sandstone-colored concrete dye. Another benefit is they would require no digging or soil disturbance. Proof of concept prototypes could be made, fine-tuned, and monitored before more widespread production and dispersal. These could also be modified to be the entrance to an underground tunnel and breeding chamber.

Squirrels Voles, and Mice

The structures recommended above will also help facilitate the expansion of ground squirrels, which appear to be struggling to do so in the large, relatively homogenous spaces where predators are abundant. In addition to assisting their expansion, supplemental feed might be considered in the hardscape that provides structural habitat for them, temporarily. The expansion of more and larger ground squirrel colonies is an important priority. In the sandy soils of the Cojo Terrace, more, larger, and older squirrel colonies would provide more complex, permanent, and maintained burrows and burrow complexes, something that would benefit burrowing owls greatly.

In addition, experimental **mouse loading**- the feeding of mice and voles in pig-proof containers placed in complex rock piles that also facilitate their security and reproduction- could be considered and experimented with. In conjunction with the monitoring of proof of concept on installed structures, a subset could include feeding

these rodents. This might be particularly helpful towards the goal of convincing wintering burrowing owls to breed on the Cojo Terrace. Conversations with CDFW confirmed that burrowing owls are motivated to stay in a location by food above all else (Hillborn, personal communication).

Management of Grass for Burrowing Owls

This is a high priority regarding the management of burrowing owls on the Cojo Terrace. While the best existing areas are fine tuned for better burrowing owl survival and use, the preserve should consider its grassland management *with burrowing owls in mind*. This could include both existing grass density management with cattle or other grazers, and the longer-term management and treatment of areas infested with *Ehrharta calycina*. Since burrowing owls are more immediately concerned with the height and thickness of vegetation than the species assemblage, the thickness of the grasslands on the Cojo Terrace (and elsewhere) are of utmost importance. Most crucially, managers should recognize vegetation (grass) that is thicker or taller than the generally recognized ideals for burrowing owl, even on the higher end (e.g. 12”), as *stressful and prohibitive to their success and function* and keep this in mind especially during the months of October-April when they are present. Numerous authorities reiterate the importance of grass management, and the general rule is that heights of 6-12” (15-30cm) is ideal depending on density (Hillborn, personal communication, Wildlife Research Institute, 2005).

The management of grass and vegetation may be achieved by adjusting or implementing grazing, mowing, or perhaps even burning. The use of herbicides may be utilized for the control of undesirable taxa. The main recommendation here is that the management of vegetation be considered as it pertains to burrowing owls *in addition to* the difficult problems of species composition and weed control. Where annual grasses dominate, the **general recommendation is 6” in height**. When this is exceeded, burrowing owl behavior is affected acutely and negatively. Locally conducted surveys on the structure of the Cojo Terrace’s vegetation structure and the usage and preference of burrowing owls and other grassland avitaxa of special concern would be valuable.

More intensive management of grass for burrowing owls could also achieve other conservation goals such as the expansion of the endangered Gaviota tar plant through the reduction of thatch that may increase recruitment opportunities for this and other native grassland species. Since the floristic changes that occurred in California happened so early in the historic period, there are often no concrete reference points for managers. Some of the earliest from Crespi’s diaries have been discussed here. Nevertheless, the whole of the Cojo Terrace is today largely a novel ecosystem replete

with non-native grasses and other species, therefore the continued and expanded management with grazers is recommended.

The renewed interest in indigenous and ecological fire is valid but not a monolithic benefit to native flora and fauna as is sometimes assumed. Unfortunately, fires today in California stimulate and expand nonnative vegetation- the very species that alter fire regimes and out-compete natives. Therefore controlled burning, especially at low elevation in the state, cannot be assumed to be a simple way to improve ecosystem function and native diversity in many contexts.

Regarding burrowing owls, fires would be most beneficial if they are implemented during their absence. Presumably, summer would be in alignment with the time of year the earliest Spanish records described burning occurring near the Dangermond preserve. Of course, if year-round owl populations are ever achieved, burning during their occupation would be unavoidable. Furthermore, low-intensity mosaic burning of some percentage (30-70%) of the grasslands in question would likely be most beneficial as they would create heterogeneity and leave both cover and exposed ground that would likely be most conducive for improved burrowing owl foraging. Theoretically, unburned vegetation would continue to provide resources and protective cover to some small mammals and invertebrates. Burned areas would complement these by creating bare ground for prey visibility and capture, and the potential for increased primary productivity in the coming months. This is all speculative but logical. Large, scorching fires tend to have more thorough resets, heat soils to higher temperatures that kill seedbanks, have higher vertebrate and invertebrate mortality, and take longer for the food web to recover.

The goal should be to create subtle disturbances that release food items and reduce thick vegetation while simultaneously improving the next season's primary productivity through increased resprouting and germination. Studying the responses to burned landscapes by invertebrates, small mammals, burrowing owls, and the greater food web would be informative. The problem of expanding or encouraging exotic vegetation that might be in some ways prohibitive to burrowing owls or other conservation goals is something that may require specific management and monitoring.

Monitoring of Current Conditions and New Improvements

Recommendations consisting of a thorough monitoring protocol of burrowing owls on the Cojo Terrace and elsewhere on the preserve is likely outside the scope of this preliminary report, but could include the following:

-Conduct field surveys beginning earlier when owls first arrive and continuing throughout the wintering period, potentially including areas beyond the Cojo Terrace, to better assess owl numbers and movement patterns. Some surveys could also be performed outside the wintering window during the months of April-September to assess potential breeding attempts.

- Dissection and content analysis for pellets to determine diets, how they shift through time, or how they may be associated with vegetation types and management. Analysis is currently underway from pellets collected during this survey, and continued collection over the complete wintering period is recommended.

- Deployment of camera traps to assess behavioral patterns, predator/prey interactions, or other behavior not easily assessed during field surveys, including owl numbers, use or preference of artificial burrows, concrete domes, hardscape piles, and natural burrows. In addition, deployment of AudioMoth may be informative.

-Future monitoring may be expanded to include telemetry, DNA, or isotope analysis for determining local and regional migration and movement patterns.

The Importance of Tree Removal

As illustrated in this report, just over 1% of cover on the Cojo Terrace consists of trees and powerlines yet it effectively removes over 30% of the habitat for burrowing owls- even greater when habitat fragmentation and areas outside the survey are considered. The removal of trees and powerlines is an important step towards the restoration of the flat, open nature of the Cojo Terrace that burrowing owls and other grassland specifics require.

The data is clear; trees and power lines exert extreme negative influence on grassland birds over several spatial scales. Open, unbroken grassland is one of the rarest habitat types in the region, if not the rarest. Aside from burrowing owls, Western meadowlarks, horned larks, grasshopper sparrows, and Northern harriers are all habitat-restricted taxa who once had a niche on the vast Cojo Terrace. The direct predation threats to burrowing owls and the other smaller species that trees and power lines transfer by giving advantages to comparatively common generalists like great horned owls and red-tailed hawks are unambiguous. Additional pressures they relay to burrowing owls through food competition are likely also significant and yet underappreciated. The Dangermond Preserve has tens of thousands of trees in their natural places, and should prioritize restoring this grassland system by removing the trees on the Cojo Terrace.

Highest priority trees would be any outlying individuals or rows where removal would make a more immediate impact on the highest quality habitat around them, and reduce fragmentation of otherwise large sections of habitat. Downed trees would provide valuable on-site material for redistribution as microhabitat piles. The on-site use of this material would reduce labor costs. The goal of putting all powerlines below ground would address an esoteric but undeniable perturbation to wide-open grassland ecology- that perches are problematic to burrowing owls and other declining taxa in many underacknowledged ways.

Concerns regarding the loss of habitat for other wildlife are comparatively unfounded given the need for prioritizing burrowing owl conservation, and the greater restoration of expansive coastal prairie. Great horned owls and red-tailed hawks are not rare birds and occur widely over the entirety of the United States, occurring across all habitat types including suburbia and even New York City. Northern harriers are adapted to grasslands, marshes, and other treeless habitats and would in fact likewise *benefit* from reduced competition from red-tails and great horned owls. *Every* tree on the Cojo Terrace is non-native. These trees facilitate perching and nesting for these raptors that would *not be present on the terrace otherwise*. Paradoxically, every great horned owl and red-tailed hawk breeding event on the Cojo Terrace is not something for the conservation community to celebrate, but to mitigate. All of the trees present on the Cojo Terrace do not occur there naturally and exert an undeniable strain on burrowing owls and all other habitat-restricted grassland birds.

While birds are declining across all habitat types, none have declined more precipitously than grassland specific taxa (Rosenberg, et al., 2019). The encroachment of trees is one of the main reasons for this decline (The Wildlife Society, 2023). Tree removal is one of the most critically important restoration strategies towards restoring this rare and important habitat and its associated taxa in the region.

‘Mima Mounds’ and Wet Meadows

Burrowing owls, while favoring flat landscapes, specifically seek out small hills and gentle slopes for their burrow sites to ensure better burrow drainage and visibility. In regions with high weed density or degraded wetland conditions, the strategic shallow excavation and deepening of some of these areas could significantly enhance the grassland habitat for burrowing owls and other specialized avian species. These enhanced wetlands would theoretically retain water for longer periods, promoting improved heterogeneity and site-wide diversity. Most importantly, the excess soil made available from this process could be repurposed to create ever-important gentle mounds. These would serve as perfect locations for installing artificial burrow systems or microhabitat structure; two subtle but important features for burrowing owls. Several

sizable locations on the Cojo Terrace currently feature homogenous expanses with monotypic wetlands (*Juncus phaeocephalus*, or *Distichlis spicata*) and high non-native grass cover that would benefit from this type of modification. Transforming these into higher-functioning wet meadows would promote ecological heterogeneity, potentially supporting a wider array of native flora. Aside from enhancing wetlands, the resulting mounds would offer dry, well-drained high points that encourage thinner vegetation- a structural preference for burrowing owls- while the adjacent deepened areas would create productive ecotones supporting the invertebrates and small mammals upon which the owls depend.

High Ambitions- a Breeding Population

Realizing the full potential for burrowing owls on the Cojo Terrace is dependent on many things, including improving wintering habitat and wintering bird survival. However, a very ambitious and important goal is the recovery of breeding. Once lost, recovery of breeding is thought to have never been achieved. However, breeding has been known to occur in locations where it has not been recorded previously, or at least recently, when breeding is still occurring at sufficiently close distances. This is not the case here. Establishment of new breeding populations is being attempted by the San Diego Conservation team in the San Diego area and Lynne Trulio and some of her former students in the San Jose area. In Minnesota, Mark Martel was unable to reestablish breeding there (Trulio, personal communication). The potential of the Cojo Terrace given its size, elevation, and *flat topography* makes it the only realistic coastal breeding site in the county save for a few other possibilities- but by far the most likely to succeed due to its management, size, and potential- but only if its potential is fully realized. After the previously detailed improvements are made and wintering birds secured and accumulated, this restoration goal is as realistic as anywhere in the region and should be wholeheartedly attempted. Success here could lay the foundation for other new breeding populations in other suitable areas- something that, if achieved, would be a significant conservation achievement.

Most efforts elsewhere to reestablish breeding have been labor intensive; involving moving animals, creating temporary enclosures, and other significant work. What we suggest for the Dangermond Preserve is a more passive method of significantly improving conditions and habitat and seeing if some first-year male owls are incentivized to claim territory. It is known that in breeding populations some first-year burrowing owls stay locally while some percentage disperse, adding to the genetic diversity in other populations (David Johnson, personal communication). Lynne Trulio recently demonstrated that some winter migrants stay and breed in California (Trulio, et al., 2024).

The Dangermond Preserve's Cojo Terrace already has winter burrowing owls and more surveys and data are needed for a clearer picture of this species there. Some persistent features of the terrace such as thick herbaceous vegetation, tree and perch abundance, and relatively few ground squirrels are suppressing the potential for greater burrowing owl use and function. If the existing numbers can be retained and increased, the likelihood that burrowing owls may attempt to breed there will also increase. With habitat management that secures owls by reducing losses to predation, avoidance, or abandonment for better conditions they will not likely find, breeding may organically occur. Given the responses that we and others have documented by burrowing owls to artificial burrows and other structures installed elsewhere, it is clear the same structures would make meaningful impacts on the Cojo Preserve. Less passive and more proactive efforts to further stimulate breeding behavior would include the playing of territorial calls in the late winter and early spring. The undeveloped Cojo Terrace is particularly important to burrowing owls for its flat topography alone. The site's full potential must be understood and realized- not just for burrowing owls, but all grassland birds of the area.

The Western burrowing owl has suffered significant reductions in its range and still faces a difficult future in California. Of the estimated 22,000,000 acres of grassland the state once had, just 2,000,000 acres remain (Rosenberg, 2009). These have been significantly degraded by invasive plants, afforestation, reduction of burrowing animals, and fragmentation. Increasing economic and population growth, competition for land and resources, and habitat degradation and fragmentation, will continue to shrink this owl's habitat into fewer spaces. In its Imperial Valley stronghold, the impending threats of lithium development, energy production, and water conservation, make this species' expansion and well-being elsewhere in the state even more urgent. The Nature Conservancy has an opportunity here to not only conserve and restore a rare species in its original place, but the opportunity to create the blueprint for the creation of new breeding colonies wherever they can be achieved in the state, something that could be invaluable to the species in California and across the Western United States.

References Cited

Ali, 2022, Scientists use fake poop to lure owls into new homes, The Hill, Jan 27, 2022
<https://thehill.com/changing-america/sustainability/environment/591722-scientists-use-fake-poop-to-lureowls-into-new/>

Alvarez, The Role Of Burrow Systems Of California Ground Squirrels In Sustaining Native Wildlife https://wwwjournal.org/wp-content/uploads/sites/9/2023/11/Alvarez_WW_2023.pdf

Ayma, et al., 2016, Population density of the western burrowing owl in Mexican prairie dog (*Cynomys mexicanus*) colonies in northeastern Mexico, BMC Ecology, https://pmc.ncbi.nlm.nih.gov/articles/PMC5002120/pdf/12898_2016_Article_91.pdf

Bee, Ryanne, Hollister Ranch, personal communication.

Berentson, et al., 2001, The Structure of California ground squirrel burrows: control implications https://www.researchgate.net/publication/258134048_The_structure_of_California_ground_squirrel_burrows_control_implications

Brennan, 2025, Massive Salton Sea's lithium project gets judge's go-ahead, ending advocate's lawsuit, Cal Matters [Salton Sea lithium](#)

CDFW, News Release, 2022 <https://wildlife.ca.gov/News/Archive/fish-and-gamecommission-western-burrowing-owl-becomes-cesa-candidate-wildlifeprosecutor-of-the-year-named-waterfowlers-hall-of-fame-inducteesrecognized>

Conway, et al., 2010, Migratory linkages of Burrowing Owls on DOD installations and adjacent lands Final Report, DOD Legacy Resource Management

COSEWIC, 2006, Assessment and Status Report on the Burrowing Owl In Canada https://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_burrowing_owl_e.pdf

Dobson, 2021, Biodiversity associated with hibernacula at a coastal restoration site <https://escholarship.org/uc/item/4qb9s50f>

Dring, Burrowing Owl Nest Box Specifications & Habitat Management, 2000 https://efotg.sc.egov.usda.gov/references/public/WA/Burrowing_Owl.pdf

Gervais, et al., 2008, Burrowing Owl (*Athene cunicularia*) Studies of Western Birds

Grinnell and Miller, 1944 The Distribution of the Birds in California, (pg. 202), [Grinnell and Miller](#)

Harrington, John P., 1907-1959 National Anthropological Archives, MS Reel 71, Smithsonian Institution

Hennessy et al. 2018, Reconsidering habitat associations in the Anthropocene
<https://www.sciencedirect.com/science/article/pii/S235198941830043X>

Hillborn, Anne, CDFW, burrowing owl lead, personal communication

Hinterland, Who's Who, (Canadian Wildlife Service/Canadian Wildlife Federation),
https://publications.gc.ca/collections/collection_2017/eccc/CW69-4-101-2004-eng.pdf

Johnson et al., 2013, USERS GUIDE TO INSTALLATION OF ARTIFICIAL BURROWS FOR BURROWING OWLS, Wildlife Dept. of Fish and Wildlife
<https://wdfw.wa.gov/sites/default/files/publications/01199/wdfw01199.pdf>

Johnson, D., MS Wildlife Science, The Global Owl Project, personal communication

Lehman, 2024, Birds of SB County, pages 233-234
http://www.sbcobirding.com/index_html_files/BOSBC.2024Summer.pdf

Menzel, 2018, Artificial Burrow Use By Burrowing Owls in Northern California
<https://bioone.org/journals/journal-of-raptor-research/volume-52/issue-2/JRR17-05.1/Artificial-Burrow-Use-By-Burrowing-Owls-In-NorthernCalifornia/10.3356/JRR-17-05.1.full>

Moura et al., The Influence of the Evolutionary Past on the Mind: An Analysis of the Preference for Landscapes in the Human Species, Evolutionary Psychology,
<https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2018.02485/full>

Orcanaza, Louie, Hopper Mountain Reserve Manager, USFWS, personal communication.

Osland, Karen, Botanist and consultant (deceased), Personal communication.

Ostwald, et al., 2024, Invertebrate-biased diet of burrowing owls in a newly restored coastal grassland, Nature Conservation
<https://escholarship.org/uc/item/57c2f0g0>

Pavlisca, Laura, Ventura County Landtrust, personal communication

Personal observation by the author

Poulin, R.G. et al., 2020, Burrowing Owl (*Athene cunicularia*), version 1.0 Birds of the World (A.F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. [link](#)

Reynolds, Mark, personal communication.

Ritter, Matt, Professor of botany, Cal Poly SLO, personal communication.

Rosenberg, et al., 2019, The Decline of the North American Avifauna, Science, Vol. 366, No. 6641

Rosenberg and Gervais, 2009, The Ecology and Synthesis of the Burrowing Owl in California, a Synthesis of Demographic and Space Use Studies, [The Ecology of the Burrowing Owl in California: A Synthesis of Demographic and Space Use Studies](#)

Suzuki, 2025, Imperial County is a refuge for burrowing owls, but do they need more protection? KPBS [KPBS burrowing owls](#)

The Wildlife Society, 2023, Grassland bird numbers are falling [link](#)

Thiele et al., 2019 Tree Cover in the Surrounding Landscape Reduces Burrowing Owl (*Athene cunicularia*) Occupancy of Black-Tailed Prairie Dog Colonies in South Dakota, Journal of Raptor Research, <https://bioone.org/journals/journal-of-raptor-research/volume-53/issue-4/0892-1016-53.4.367/Tree-Cover-in-the-Surrounding-Landscape-Reduces-Burrowing-Owl-Athene/10.3356/0892-1016-53.4.367.full>

Timbrook and Johnson, 2013, People of the Sky: Birds in Chumash Culture, Department of Anthropology, Santa Barbara Museum of Natural History

Timbrook, 1982, Vegetation Burning by the Chumash, <https://www.jstor.org/stable/27825120>

Trulio, et al., 2024, Combining genomic and field analyses to reveal migratory status in a burrowing owl population, Springer Nature

Trulio, L., Burrowing Owl specialist, Professor of Environmental Science, San Jose State University, personal communication

Trulio, L., Western Burrowing Owl online workshop, 2022

USFWS, <https://www.fws.gov/species/burrowing-owl-athene-cunicularia>

Wildlife Institute, 2005, Burrowing Owl Management and Monitoring Plan for Lower Otay Lake Burrowing Owl Management Area

Wilkerson, R.L. and R. B. Siegel. 2010. Assessing changes in the distribution and abundance of burrowing owls in California

1993-2007. Bird Populations

https://www.birdpop.org/docs/pubs/Wilkerson_and_Siegel_2010_Assessing_Changes_in_Dist_and_Abundance_of_BUOW_in_CA.pdf

Woodin et al, 2006, Winter Ecology of the Western Burrowing Owl (*Athene cunicularia hypugaea*) in Southern Texas 1999–2004, USGS Scientific Investigations Report <https://pubs.usgs.gov/sir/2007/5150/pdf/SIR2007-5150.pdf>

Yee, James, linguist, PhD candidate, UCSB, Chumash descendent and grandson of the last first-speaker Mary Yee, personal communication

Appendix A - Burrowing Owl Survey Data

Burrow Suitability Index:

- 1 - Good burrow with poop and/or pellets
- 2 - Good burrow without poop and/or pellets
- 3 - Substandard burrow obscured by non-native vegetation
- 4 - Substandard burrow obscured by native vegetation

Grid ID	Burrow Presence	Owls Observed	Burrow Suitability	Notes	Monitoring Date	X	Y
129	Yes		2	Under lupine skeleton/maybe too brushy	3/19/2025	-120.4533	34.4432
299	Yes		2		3/19/2025	-120.4561	34.4437
318	Yes		2	Very few droppings may be buow secondary burrow maybe meadowlark	3/19/2025	-120.4540	34.4437
320	Yes	1	2	Flushed an owl but may have been an owl we flushed earlier- we saw it come right here	3/19/2025	-120.4542	34.4437
513	Yes		3		3/19/2025	-120.4560	34.4442
567	Yes		3		3/19/2025	-120.4544	34.4443
580	Yes		3	Squirrel/iceplant	3/19/2025	-120.4558	34.4444
602	Yes		2	Very fresh	3/19/2025	-120.4544	34.4444
603	Yes		2		3/7/2025	-120.4545	34.4444
677	Yes	1	1	Owl flushed. Poop pellets	3/19/2025	-120.4550	34.4446
711	Yes		3		3/19/2025	-120.4549	34.4447
712	Yes		2	Maybe not the best but decent/badger dig	3/19/2025	-120.4550	34.4447
717	Yes		2		3/19/2025	-120.4555	34.4447
718	Yes		2		3/19/2025	-120.4556	34.4447

Grid ID	Burrow Presence	Owls Observed	Burrow Suitability	Notes	Monitoring Date	X	Y
904	Yes		4	Artemisia/ badger complex	3/19/2025	-120.4561	34.4451
916	Yes		2	Squirrel hole on road partly obscured by a small rock	3/19/2025	-120.4573	34.4451
921	Yes		2	Squirrel	3/19/2025	-120.4577	34.4451
1024	Yes		2	Squirrel only	3/19/2025	-120.4573	34.4453
1049	Yes		2	Smaller/ ground squirrel	3/19/2025	-120.4544	34.4453
1117	Yes		2	Squirrel, one dropping on mound not definitive	3/19/2025	-120.4559	34.4455
1182	Yes		2	Badger- several one very large and deep	3/19/2025	-120.4572	34.4456
1220	Yes		3		3/19/2025	-120.4556	34.4456
1285	Yes	1	1	No sign now but where we collected pellets and saw one last trip	3/19/2025	-120.4570	34.4457
1337	Yes		3	Several all obscured by iceplant	3/19/2025	-120.4570	34.4458
1375	Yes	1	1	Owl flushed/ pellets collected	3/19/2025	-120.4555	34.4459
1388	Yes		3	Squirrel	3/19/2025	-120.4569	34.4459
1389	Yes		2	Squirrel, only, 2 burrows	3/19/2025	-120.4570	34.4459
1428	Yes		4	Squirrel/ small side	3/19/2025	-120.4557	34.4460
1440	Yes		3	Several substandard/partly obscured	3/19/2025	-120.4570	34.4460
1491	Yes		3	Squirrel	3/19/2025	-120.4569	34.4461
1495	Yes	1	1	Flushed an owl that we flushed earlier from across the road. Must be its secondary burrow	3/19/2025	-120.4572	34.4461
1588	Yes		1	Several pellets way down in the burrow, droppings outside	3/19/2025	-120.4561	34.4463
1603	Yes		3	Possibly occupied by a badger wide and deep	3/19/2025	-120.4573	34.4463
1610	Yes		2	Squirrel	3/19/2025	-120.4577	34.4463
1697	Yes	1	1	Owl seen and flushed across road, 2.5 pellets a few droppings	3/19/2025	-120.4564	34.4465
1756	Yes		4		3/19/2025	-120.4569	34.4466

Grid ID	Burrow Presence	Owls Observed	Burrow Suitability	Notes	Monitoring Date	X	Y
2003	Yes		3		3/19/2025	-120.4534	34.4469
2314	Yes	1	1	2396 owls secondary	3/19/2025	-120.4573	34.4474
2396	Yes		1	We collected pellets here earlier first trip	3/19/2025	-120.4578	34.4475
2642	Yes		2	Somewhat too thatchy with Ehrharta 3 big badger holes	3/19/2025	-120.4543	34.4478
3027	Yes		2	Fresh badger hole/ last night made	3/26/2025	-120.4583	34.4481
3051	Yes		3		3/26/2025	-120.4593	34.4481
3067	Yes		3		3/19/2025	-120.4599	34.4481
3374	Yes		2		4/2/2025	-120.4498	34.4484
3622	Yes		1	Few burrows here extremely thick veldt	4/2/2025	-120.4498	34.4486
3637	Yes		2		4/2/2025	-120.4504	34.4486
4172	Yes		1	Spider web over burrow, not active	4/2/2025	-120.4500	34.4489
4218	Yes		3	Also isocoma	3/26/2025	-120.4603	34.4490
4545	Yes		3		3/19/2025	-120.4565	34.4492
4767	Yes		3		3/26/2025	-120.4581	34.4493
5285	Yes		2		3/26/2025	-120.4583	34.4496
5288	Yes		3	Large and fresh but obscured by iceplant	3/26/2025	-120.4584	34.4496
5367	Yes		2	Too close to trees	4/2/2025	-120.4515	34.4496
5443	Yes		3	Veldt	3/26/2025	-120.4577	34.4496
5487	Yes		2	Fresh dig	4/2/2025	-120.4502	34.4497
5866	Yes		2	Badger hole 3 droppings no pellets	3/19/2025	-120.4547	34.4498
5896	Yes		2	Somewhat older potential not ideal/badger	3/19/2025	-120.4553	34.4499
6305	Yes		3	Badger	3/19/2025	-120.4558	34.4500
6680	Yes		4	Potential droppings/ few	4/2/2025	-120.4511	34.4502
6842	Yes		2	Maybe too shallow but decent/badger	3/19/2025	-120.4546	34.4503
7180	Yes		2	Near artemisia though	3/26/2025	-120.4621	34.4504

Grid ID	Burrow Presence	Owls Observed	Burrow Suitability	Notes	Monitoring Date	X	Y
7537	Yes		2	One single dropping could be anything	3/26/2025	-120.4570	34.4506
7640	Yes		2	Fresh	4/2/2025	-120.4506	34.4507
7824	Yes		2	freshly dug	5/21/2025	-120.4504	34.4507
8302	Yes		1	Possible rain eroded pellet, burrow partially obscured by iceplant	3/26/2025	-120.4572	34.4510
8613	Yes		4	Shallow badger	3/19/2025	-120.4557	34.4511
8656	Yes		1	Partly obscured, no owl seen but , lot of pig activity. Droppings and pellets one seemed fresh	3/19/2025	-120.4568	34.4512
9298	Yes	1	1	Bird flushed	3/26/2025	-120.4587	34.4515
9306	Yes		1	Pellets could be from 9298 bird nearby (it flushed)	3/26/2025	-120.4588	34.4515
9331	Yes		2		3/26/2025	-120.4593	34.4515
9520	Yes		2		3/26/2025	-120.4594	34.4516
9529	Yes		3	Iceplant	3/26/2025	-120.4596	34.4516
9559	Yes		2		3/26/2025	-120.4604	34.4516
9705	Yes		2		3/26/2025	-120.4593	34.4517
10263	Yes		2		3/26/2025	-120.4590	34.4519
10624	Yes		1		3/26/2025	-120.4622	34.4521
10678	Yes		1		3/26/2025	-120.4633	34.4521
10714	Yes		3		3/26/2025	-120.4640	34.4521
10735	Yes		3		3/26/2025	-120.4601	34.4521
10775	Yes		2		4/2/2025	-120.4479	34.4521
10920	Yes		2		4/2/2025	-120.4509	34.4522
11169	Yes	1	1	owl seen	4/9/2025	-120.4559	34.4523
11353	Yes		2		3/26/2025	-120.4597	34.4524
11386	Yes		2		3/26/2025	-120.4603	34.4524
11397	Yes	1	1	Owl here. Looked into this one eyes briefly before it flew	4/2/2025	-120.4561	34.4524

Grid ID	Burrow Presence	Owls Observed	Burrow Suitability	Notes	Monitoring Date	X	Y
11531	Yes		4	Fresh badger tracks	3/26/2025	-120.4591	34.4525
11594	Yes		3		3/26/2025	-120.4602	34.4525
11820	Yes		2		3/26/2025	-120.4604	34.4526
12026	Yes		3		3/26/2025	-120.4603	34.4527
12040	Yes	1	1	Owl spooked	3/26/2025	-120.4648	34.4527
12292	Yes		1	No owl seen	3/26/2025	-120.4612	34.4528
12331	Yes		2		4/2/2025	-120.4491	34.4528
12477	Yes		1		3/26/2025	-120.4606	34.4529
12489	Yes		1		3/26/2025	-120.4608	34.4529
12787	Yes		2		4/2/2025	-120.4495	34.4530
12861	Yes		2	2 burrows, look freshly dug no owl evidence	3/26/2025	-120.4596	34.4530
12941	Yes		2	Possible owls droppings (a few)	3/26/2025	-120.4610	34.4530
13089	Yes		2	two burrows	4/2/2025	-120.4597	34.4531
13152	Yes		1	No owl seen but a few droppings 2 pellet	3/26/2025	-120.4609	34.4531
13201	Yes		2		3/26/2025	-120.4619	34.4531
13231	No	1		Spooked owl could not locate burrow, several fresh badger dogs may have obscured poop	3/26/2025	-120.4625	34.4532
13364	Yes		2		3/26/2025	-120.4607	34.4532
13405	Yes		2		4/2/2025	-120.4485	34.4532
13429	Yes		2		3/26/2025	-120.4620	34.4532
13441	Yes	1	1	Owl seen clean got very close, coyote got involved	4/2/2025	-120.4493	34.4532
13565	Yes		3		3/26/2025	-120.4604	34.4533
13598	Yes		2	Freshly dug	3/26/2025	-120.4609	34.4533
13871	Yes		2		3/26/2025	-120.4619	34.4534
14070	Yes		2		4/2/2025	-120.4484	34.4535
14162	Yes		2		4/2/2025	-120.4503	34.4535

Grid ID	Burrow Presence	Owls Observed	Burrow Suitability	Notes	Monitoring Date	X	Y
14391	Yes		2	Freshly dug (too recent)	3/26/2025	-120.4634	34.4536
14447	Yes		2	Small end	4/2/2025	-120.4471	34.4537
14671	Yes		2		3/26/2025	-120.4644	34.4537
15005	Yes		3		3/26/2025	-120.4620	34.4539
15256	Yes		3	within dense veldt and lupine	4/2/2025	-120.4495	34.4540
15312	Yes		2		3/26/2025	-120.4636	34.4540
15452	Yes		2		4/2/2025	-120.4488	34.4540
15809	Yes		3		4/2/2025	-120.4513	34.4542
15950	Yes		3		3/26/2025	-120.4669	34.4542
15973	Yes		1		3/26/2025	-120.4674	34.4543
16015	Yes		2	slightly shallow	4/2/2025	-120.4509	34.4543
16119	Yes		3		5/5/2025	-120.4614	34.4543
16205	Yes		1	2 burrows few droppings	3/26/2025	-120.4630	34.4543
16236	Yes		1		4/2/2025	-120.4506	34.4544
16253	Yes		2	Maybe on shallow side	4/2/2025	-120.4510	34.4544
16644	Yes		3		3/26/2025	-120.4625	34.4545
16975	Yes		2	Fresh	4/2/2025	-120.4515	34.4546
17069	Yes		2	Possibly too shallow	4/2/2025	-120.4618	34.4547
17236	Yes		3		4/2/2025	-120.4606	34.4547
17299	Yes		2	Possible soil for Mika mounds, some phaeocephalus, slightly denser sandy soil	5/5/2025	-120.4618	34.4548
17373	Yes		2	Fresh	3/31/2025	-120.4545	34.4548
17700	Yes		3		4/2/2025	-120.4606	34.4549
17786	Yes		4	shallow	4/2/2025	-120.4492	34.4550
17885	Yes		2		3/31/2025	-120.4554	34.4550
18031	Yes		3	Ehrharta thick all through here	4/2/2025	-120.4494	34.4551
18134	Yes		3		3/31/2025	-120.4557	34.4551

Grid ID	Burrow Presence	Owls Observed	Burrow Suitability	Notes	Monitoring Date	X	Y
18323	Yes		2		3/31/2025	-120.4549	34.4552
18340	Yes		2		3/31/2025	-120.4552	34.4552
18493	Yes		2		4/2/2025	-120.4493	34.4552
18500	Yes		2		4/2/2025	-120.4494	34.4552
18519	Yes		2	Fresh, close to eucs	3/31/2025	-120.4541	34.4552
18799	Yes		2	Too close tones row and redtails	4/2/2025	-120.4506	34.4553
18862	Yes		2	Fresh	3/31/2025	-120.4562	34.4554
19083	Yes		3		3/31/2025	-120.4559	34.4555
20854	Yes		3		3/26/2025	-120.4675	34.4562
21540	Yes		2	Way too close to row	4/2/2025	-120.4505	34.4564
21943	Yes		2		3/26/2025	-120.4672	34.4566
22139	Yes		2	Too close to cypress	4/2/2025	-120.4582	34.4567
22221	Yes		2		4/2/2025	-120.4596	34.4567
22370	Yes		2	Likely shallow	4/2/2025	-120.4584	34.4568
22380	Yes		2		5/19/2025	-120.4673	34.4568
22421	Yes		2	fresh	4/2/2025	-120.4594	34.4568
22579	Yes		3		3/31/2025	-120.4540	34.4569
22654	Yes		1	pellets and droppings	4/2/2025	-120.4597	34.4569
22666	Yes		2		4/2/2025	-120.4600	34.4569
22807	Yes		2		4/2/2025	-120.4587	34.4570
22994	Yes		2		3/26/2025	-120.4669	34.4570
23209	Yes		2	Too close to trees and bldg	3/31/2025	-120.4540	34.4571
23215	Yes		2		3/26/2025	-120.4672	34.4571
23295	Yes		3		4/2/2025	-120.4514	34.4572
23299	Yes		2	Massive holes complex of a big badger dig, no owl evidence	5/5/2025	-120.4645	34.4572

Grid ID	Burrow Presence	Owls Observed	Burrow Suitability	Notes	Monitoring Date	X	Y
23530	Yes		2		3/31/2025	-120.4563	34.4573
23635	Yes		2	2 7 ft apart, at least 24" deep, one partly obscured by iceplant	5/5/2025	-120.4630	34.4573
23652	Yes		2	Pretty close to trees and at base of two artemisia	3/31/2025	-120.4547	34.4573
23663	Yes		2	2, both large but fresh	3/31/2025	-120.4549	34.4573
23939	Yes		2		4/2/2025	-120.4520	34.4575
24160	Yes		2		4/2/2025	-120.4523	34.4575
24166	Yes		2	fresh	4/2/2025	-120.4524	34.4575
24346	Yes		2	Too close to power lines/trees	4/2/2025	-120.4606	34.4576
24379	Yes		2		3/26/2025	-120.4656	34.4576
24432	Yes		2	Very fresh dig	3/26/2025	-120.4668	34.4577
24538	Yes		3	Also too close to cypress	3/31/2025	-120.4602	34.4577
24583	Yes		2		5/5/2025	-120.4656	34.4577
24586	Yes		3	Iceplant	5/5/2025	-120.4657	34.4577
24667	Yes		2	A minor few droppings possibly owl	3/31/2025	-120.4587	34.4578
24898	Yes		2		3/31/2025	-120.4592	34.4579
25009	Yes		2	Partly iceplant obscured, minor droppings	3/26/2025	-120.4660	34.4579
25019	Yes		2	Minor droppings	3/26/2025	-120.4662	34.4579
25197	Yes		2		3/26/2025	-120.4657	34.4580
25386	Yes		2		4/2/2025	-120.4524	34.4581
25818	Yes		3		3/26/2025	-120.4661	34.4583
25856	Yes		2		3/31/2025	-120.4582	34.4583
25886	Yes		2	Too close to trees	3/31/2025	-120.4545	34.4583
25999	Yes		2	Recent coyote activity	5/5/2025	-120.4658	34.4584
26443	Yes		1	few droppings	3/26/2025	-120.4668	34.4586
26450	Yes		3	Too close to Cypress (<150 ft)	3/31/2025	-120.4583	34.4586
26804	Yes		2	Too close to powerline/cypress	3/31/2025	-120.4576	34.4587

Grid ID	Burrow Presence	Owls Observed	Burrow Suitability	Notes	Monitoring Date	X	Y
27068	Yes		2	Partly obscured by veldt	3/31/2025	-120.4549	34.4589
27172	Yes		2		3/31/2025	-120.4616	34.4589
27281	Yes		2		3/26/2025	-120.4683	34.4590
27340	Yes	1	1	Right next to burrow with poop, owl finished let me get very close	3/26/2025	-120.4655	34.4590
27347	Yes		1	No owl seen, no pellets fair amount of droppings	3/26/2025	-120.4656	34.4590
27358	Yes		3		3/31/2025	-120.4615	34.4590
27377	Yes		3		3/26/2025	-120.4663	34.4590
27469	Yes		2		3/26/2025	-120.4682	34.4591
28021	Yes		2	Squirrel	5/5/2025	-120.4633	34.4593
28023	Yes		2	Squirrel colony	5/5/2025	-120.4634	34.4593
28035	Yes		2	Close to trees	3/31/2025	-120.4550	34.4593
28138	Yes		2		5/5/2025	-120.4619	34.4594
28213	Yes		2	Squirrel	5/5/2025	-120.4634	34.4594
28386	Yes		2	Squirrel	5/5/2025	-120.4632	34.4595
28417	Yes		2	Fresh	5/5/2025	-120.4640	34.4595
28425	Yes		2		5/5/2025	-120.4641	34.4595
28664	Yes		2	fresh dug, 2 burrows	3/26/2025	-120.4656	34.4596
28738	Yes		2	Squirrel	5/5/2025	-120.4630	34.4597
28744	Yes		2	Squirrel	5/5/2025	-120.4631	34.4597
28841	Yes		3		3/26/2025	-120.4655	34.4597
28908	Yes		2		3/31/2025	-120.4585	34.4598
28933	Yes		2	Smaller diameter maybe squirrel	5/5/2025	-120.4634	34.4598
29094	Yes		3	Squirrel	5/5/2025	-120.4630	34.4598
29108	Yes		2	Squirrel	5/5/2025	-120.4633	34.4599
29224	Yes		2		3/26/2025	-120.4663	34.4599

Grid ID	Burrow Presence	Owls Observed	Burrow Suitability	Notes	Monitoring Date	X	Y
29227	Yes		2		3/26/2025	-120.4664	34.4599
29305	Yes		2		3/31/2025	-120.4594	34.4599
29877	Yes		4		3/31/2025	-120.4607	34.4602
30994	Yes	1	1	Owl here, likely one of the two spooked moments earlier. Weird this seems to be its number one burrow	3/31/2025	-120.4593	34.4608
31125	Yes		2		3/26/2025	-120.4670	34.4609
31178	Yes		2	Matrix of about 5 but on fresher shallow side	3/31/2025	-120.4597	34.4609
31197	Yes		2	Close to cypress	3/31/2025	-120.4558	34.4610
31279	Yes	1	1	Owl spooked, let us get really close	3/26/2025	-120.4667	34.4610
31543	No	2		Just spooked two owls in short succession but no burrows found yet- pig damage. Excellent habitat few burrows	3/31/2025	-120.4606	34.4611
31548	Yes		3		3/31/2025	-120.4564	34.4611
31621	Yes		3	2 burrows	3/26/2025	-120.4671	34.4612
31769	Yes		3		3/26/2025	-120.4666	34.4613
32093	Yes		2		3/26/2025	-120.4668	34.4615
32106	Yes		2		3/26/2025	-120.4671	34.4615
32265	Yes		2	fresh dug, multiple burrows	3/26/2025	-120.4671	34.4616
32408	Yes		1	One pellet, lightly used only	3/26/2025	-120.4666	34.4616
32440	Yes		1		3/26/2025	-120.4675	34.4617
32571	Yes		2		3/26/2025	-120.4667	34.4617
32681	Yes		1	Partly obscured by iceplant	3/31/2025	-120.4611	34.4618
32913	Yes		2		3/26/2025	-120.4675	34.4619
33049	Yes		4	Slightly obscured by lupine	3/26/2025	-120.4670	34.4620
33203	Yes		2		3/26/2025	-120.4669	34.4621
33221	Yes		2		3/26/2025	-120.4675	34.4621
33355	Yes		1	No bird seen	3/26/2025	-120.4669	34.4622

Grid ID	Burrow Presence	Owls Observed	Burrow Suitability	Notes	Monitoring Date	X	Y
33358	Yes		3		3/26/2025	-120.4671	34.4622
33403	Yes		2		3/26/2025	-120.4683	34.4622
33486	Yes	1	1	Owl seen maybe was on this	3/31/2025	-120.4577	34.4623
33512	Yes		1		3/26/2025	-120.4671	34.4623
33544	Yes		2		3/26/2025	-120.4679	34.4623
33651	Yes		3		3/31/2025	-120.4580	34.4624
33678	Yes		2		3/26/2025	-120.4675	34.4624
33809	Yes		1		3/31/2025	-120.4582	34.4624
33820	Yes		2	Very freshly dug	3/26/2025	-120.4673	34.4625
33867	Yes		1		3/26/2025	-120.4686	34.4625
34016	Yes		2	Freshly dug	3/26/2025	-120.4686	34.4626
34148	Yes		3		3/26/2025	-120.4725	34.4627
34299	Yes		2		3/26/2025	-120.4726	34.4627
34369	Yes		2	Maybe on shallow side	3/31/2025	-120.4618	34.4628
34675	Yes		1	No owl seen	3/31/2025	-120.4622	34.4630
34692	Yes		3	Some potential droppings	3/31/2025	-120.4628	34.4630
34734	Yes		3		3/26/2025	-120.4726	34.4630
34870	Yes		2		3/26/2025	-120.4725	34.4631
35126	Yes		2		3/31/2025	-120.4630	34.4633
35270	Yes		2		3/26/2025	-120.4719	34.4634
35294	Yes		3		3/26/2025	-120.4726	34.4634
35302	Yes		3		3/26/2025	-120.4728	34.4634
35541	Yes		3		3/26/2025	-120.4718	34.4635
35658	Yes		3		3/26/2025	-120.4713	34.4636
35833	Yes		3		3/26/2025	-120.4723	34.4637
36169	Yes		2		3/26/2025	-120.4703	34.4640

Grid ID	Burrow Presence	Owls Observed	Burrow Suitability	Notes	Monitoring Date	X	Y
36186	Yes		3		3/26/2025	-120.4708	34.4640
36187	Yes		2		3/26/2025	-120.4709	34.4640
36268	Yes		2	Fresh	3/31/2025	-120.4647	34.4640
36703	Yes		1	2 pellets looks abandoned by now	3/31/2025	-120.4620	34.4643
36713	Yes		1	dropping and pellet	4/2/2025	-120.4667	34.4643
36714	Yes		3		3/31/2025	-120.4623	34.4643
36762	Yes		3		4/2/2025	-120.4726	34.4644
36911	Yes		2		3/31/2025	-120.4646	34.4645
37064	Yes		2		3/31/2025	-120.4612	34.4646
37255	Yes		2	In research plot with jangling metal tags	4/2/2025	-120.4678	34.4647
37357	Yes		3		4/2/2025	-120.4670	34.4648
37419	Yes		3		3/31/2025	-120.4604	34.4648
37513	Yes		2		4/2/2025	-120.4682	34.4649
37593	Yes		2	Possibly too shallow/ lightly obscured by iceplant	4/2/2025	-120.4710	34.4650
37728	Yes		3		4/2/2025	-120.4714	34.4651
37758	Yes		2		4/2/2025	-120.4682	34.4651
37876	Yes		2		4/2/2025	-120.4724	34.4652
37921	Yes		2		3/31/2025	-120.4652	34.4652
38001	Yes		2		4/2/2025	-120.4725	34.4653
38014	Yes		2		4/2/2025	-120.4686	34.4653
38094	Yes		2		3/31/2025	-120.4628	34.4653
38449	Yes		2	Thick Bromus and radish	3/31/2025	-120.4627	34.4656
38475	Yes		2		4/2/2025	-120.4680	34.4656
38524	Yes		2	Maybe too shallow	3/31/2025	-120.4655	34.4657
38699	Yes		2		4/2/2025	-120.4677	34.4658
38797	Yes		1	No pellets, poop, very thick bromus d and radish obscuring entrance	3/31/2025	-120.4627	34.4659

Grid ID	Burrow Presence	Owls Observed	Burrow Suitability	Notes	Monitoring Date	X	Y
39250	Yes		1	Bromus is thick here	3/31/2025	-120.4630	34.4662
41720	Yes		2		3/31/2025	-120.4710	34.4694
41755	Yes		2	2 next to each other	3/31/2025	-120.4704	34.4695
41873	Yes		2		3/31/2025	-120.4707	34.4697
41994	Yes		2	Recently dug	3/31/2025	-120.4718	34.4700
43033	Yes		2	fresh dug	3/26/2025	-120.4664	34.4593