Burrowing Owl (*Athene cunicularia* ssp. *hypugaea*)

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Legal Status

State of California: Species of Special Concern
Federal: Bureau of Land Management Sensitive, U.S. Fish and Wildlife Service Bird | of Conservation Concern
Other: Endangered in Canada and Minnesota; Threatened in Colorado; Mexico: "Special Protection" status.
Critical Habitat: N/A
Recovery Planning: N/A
Notes: The burrowing owl has been included on the list of California Species of Special Concern since 1978 (Remsen 1978; Gervais et al. 2008). In 2003, a petition to list the burrowing owl as threatened or endangered under the California Endangered Species Act (Center for Biological Diversity et al. 2003) was rejected by the California Fish and Game Commission (Miller 2007). Populations in California continue to decline or have been extirpated from rapid loss of farmland, changes in agricultural practices, eradication of ground squirrels, pesticide use, traffic and wind turbine-related mortality, and possibly West Nile virus (Gervais et al. 2008). Another petition could be submitted, however, that could potentially change the burrowing owl's status during the planning and implementation of the DRECP.

Taxonomy

Up to 25 subspecies have been recognized (Poulin et al. 2011), but only one subspecies (*Athene cunicularia hypugaea*) occurs in continental North America outside of Florida (Poulin et al. 2011). Descriptions of the species' physical characteristics, behavior, and distribution are provided in the most recent revision of the species account for Birds of North America revised by R. Poulin and L.D. Todd (Poulin et al. 2011).

Distribution

General

Western burrowing owl is found in non-mountainous western North America, from the Great Plains grasslands in southern portions of the western Canadian provinces south through the U.S. into Mexico (Poulin et al. 2011). Other subspecies occur in arid, open habitats in Florida, the Caribbean Basin, and South America (Poulin et al. 2011; Clark 1997) (Figure SP-B04).

In California, the burrowing owl's range extends throughout the lowlands from the northern Central Valley to the U.S./Mexico border, with about two-thirds of the population occupying the Imperial Valley, near the Salton Sea (Wilkerson and Siegel 2010). The species' distribution and abundance vary considerably throughout its range (DeSante et al. 2007; Wilkerson and Siegel 2010). Breeding burrowing owls are generally absent from the coast north of Sonoma County and from high mountain areas, such as the Sierra Nevada and the Transverse Ranges extending east from Santa Barbara County to San Bernardino County (Gervais et al. 2008).

Distribution and Occurrences within the Plan Area

Historical

Grinnell and Miller (1944) described a range in California that included most of the lowlands, although "mostly rare or wanting in coastal counties north of Marin County" with "Numbers in favorable localities large; originally common, even 'abundant'." They regarded the species as "becoming scarce in settled parts of the State" due to "roadside shooting, anti-'vermin' campaigns, elimination of ground squirrels—hence of nesting places for these owls." The increase in abundance of burrowing owls in some agricultural environments, such as the Imperial Valley, likely began when the native desert ecosystem in this region was converted to large areas of irrigated agriculture (DeSante et al. 2004). The time period for this shift was in the early 20th century as van Rossem (1911) considered the species "abundant everywhere in suitable locations" in the Imperial Valley.

Recent

The overall range of the burrowing owl in California has not drastically changed from that described by Grinnell and Miller (1944), but the species has disappeared or greatly declined as a breeding bird in many areas that were once occupied (DeSante et al. 2007; Gervais et al. 2008; Wilkerson and Siegel 2010). By one recent estimate (Miller 2007), the burrowing owl has functionally disappeared as a breeding species from 22% of its former range and continues to decline in an additional 23% of its range.

A statewide survey conducted from 1991 to 1993 found that populations had disappeared from the central coast (Marin, San Francisco, Santa Cruz, Napa, and coastal San Luis Obispo counties), Ventura County, and the Coachella Valley in Riverside County, and were nearly extirpated from Sonoma, Santa Barbara, Orange, coastal Monterey, and San Mateo counties, where only small, remnant populations remained (DeSante et al. 2007).

The most current information on the burrowing owl's breeding distribution in California comes from systematic surveys conducted in 2006-2007 across the species' mainland breeding range in the state (Wilkerson and Siegel 2010). Compared with the surveys in the early 1990s, this survey found 10.9% fewer pairs, but the overall change was not statistically significant. About 69% of California's population was found to be concentrated in agricultural areas of the Imperial Valley; secondary centers of abundance were identified in the southern Central Valley (~12% of the state total), middle Central Valley (~6% of the state total), western Mojave Desert (~6% of the state total), and Palo Verde Valley near Blythe in eastern Riverside County (~2% of the state total); approximately 5% of the state's population was scattered elsewhere.

Natural History

Habitat Requirements

Throughout their range, western burrowing owls require habitats with three basic attributes: open, well-drained terrain; short, sparse vegetation generally lacking trees; and underground burrows or burrow-like structures (e.g., culverts) (Klute et al. 2003; Gervais et al. 2008). Burrowing owls occupy grasslands, deserts, sagebrush scrub, agricultural areas (including pastures and untilled margins of cropland), earthen levees and berms, a variety of habitat types on coastal uplands (especially by over-wintering migrants) (California Natural Diversity Database 2010), and urban vacant lots, as well as the margins of airports, golf courses, residential developments, and roads (CVAG et al. 2007; Gervais et al. 2008). Burrowing owls occur on relatively flat expanses with level to gentle topography (CDFG 2012).

Several habitat characteristics may explain the species' distribution within the Plan Area: vegetation density, availability of suitable prey, availability of burrows or suitable soil, and disturbance (primarily from humans) (BLM 2005). However, Unitt (2004) notes that sites with suitable characteristics for burrowing owls may not support populations due to "high sensitivity to habitat fragmentation, proliferation of terrestrial predators, and high mortality from collisions with cars." During the breeding season, burrowing owls may need enough permanent cover and taller vegetation within their foraging range to provide them with sufficient prey, which includes large insects and small mammals (Poulin et al. 2011; Wellicome 1997). Paired males are known to line the burrow entrance and tunnel with dried mammal dung for several possible reasons including the prevention of nest predation and increasing insect presence near the nest as a source of convenient prey (Smith 2004). This behavior is obviously prominent in habitat that is regularly grazed by cows, horses or bison (Smith 2004).

Few desert areas have too much plant cover for burrowing owls; and those areas that do have high cover (e.g., palm oases) are unoccupied (e.g., Barrows 1989). Dense vegetation may not exclude burrowing owls directly, but rather indirectly through increased predation or competition with other species, or lowered hunting success for preferred prey (BLM 2005). When vegetation height is greater than 5 centimeters (2 inches), owls may prefer habitat with elevated perches to increase their horizontal visibility to detect both predators and prey (Green and Anthony 1989). Suitable habitat associations for burrowing owl are summarized in Table 1.

Human alteration of the landscape can inadvertently or intentionally create suitable habitat, but can also make potential habitat unsuitable by way of "habitat loss, associated prey reduction, and human disturbance" (Lincer and Bloom 2007) and various pesticides are known to adversely affect burrowing owls, directly or indirectly (James and Fox 1987; Haug and Oliphant 1987). Agriculture and surface irrigation systems (i.e., earthen canals and ditches) can create habitat by providing bankside burrow sites and prey in the adjacent fields (Gervais et al. 2008; Poulin et al. 2011), while urban development and the associated excessive noise or disturbance can result in habitat loss and indirect adverse effects (BLM 2005).

Table 1. Habitat Associations for Burrowing Owl

Land Cover Type	Land Cover Use	Population Density	Habitat Parameters	Supporting Information
Shortgrass-dominated grasslands and steppes	Nesting, shelter, refugia	Medium	Burrows mostly dug by other animals including the California ground squirrel	The presence of nest burrows, dug by fossorial mammals such as ground squirrels, seems to be a critical requirement for burrowing owls. Typically forage in habitats characterized by low-growing vegetation (Poulin et al. 2011). Often use unlined earthen banks along agricultural ditches as burrow sites (Poulin et al. 2011)
Agricultural	Nesting, shelter, refugia	Varies, from low to the highest known.	See above	Rosenberg and Haley 2004; DeSante et al 2007.

Land Cover Type	Land Cover Use	Population Density	Habitat Parameters	Supporting Information
Desert Shrublands	Wintering range; less often, for breeding.	Extremely Low	See above	(Longshore and Crowe 2010; Wilkerson and Siegel 2011).
Urban-Suburban	Nesting, shelter, refugia	Low	See above	See above; may use urban levees if suitable burrows are available (Poulin et al. 2011)
Rural residential	Nesting, shelter, refugia	Low	See above	See above; may use urban levees if suitable burrows are available (Poulin et al. 2011)

Foraging Requirements

Burrowing owls are opportunistic predators that prey on arthropods, small mammals, birds, amphibians, and reptiles (Karalus and Eckert 1987; Poulin et al. 2011). Burrowing owls typically forage in habitats characterized by low-growing, sparse vegetation (Poulin et al. 2011) feeding on insects during the day, especially during the summer, and small mammals at night. Thomsen (1971) found that crickets and meadow voles (*Microtus* spp.) were the most common food items. Nocturnal foraging can occur up to several kilometers away from the burrow, and burrowing owls concentrate their hunting on grassland areas, crop fields, and structurally similar habitats with an abundance of small mammals (Haug and Oliphant 1990). The majority of the burrowing owl diet can be made up of rodents or large insects depending on the region in which they are found and the time of year (Rosenburg et al. 2007; Haug and Oliphant 1990).

Reproduction

Burrowing owls reach sexual maturity within one year of age (Poulin et al. 2011). Nesting in California generally runs from February through August, with peak activity from March to July (Zeiner et al. 1990; Thomsen 1971; Gervais et al. 2008).

Nesting sites always have available perching sites, such as fences or raised rodent mounds (Johnsgard 1988). Non-nest satellite burrows are typically employed to escape from approaching predators (especially raptors and ravens), to spread out pre-fledged nestlings (in case terrestrial predators invade one of an owl family's burrows and consume the young in it), and to relocate from parasite-infested nesting and roosting burrows (Dechant et al. 2002). Burrowing owls are primarily monogamous and typically breed once per year (Poulin et al. 2011). Mate fidelity between years was found to be high in the Imperial Valley (Catlin et al. 2005) but low in Saskatchewan (Poulin et al. 2011), perhaps reflecting a behavioral difference between resident and migratory populations. Normally, one clutch of 6–12 eggs is produced per year, with 7–9 eggs in a typical clutch (Poulin et al. 2011), although in rare instances two broods may be raised in a season (Gervais and Rosenberg 1999); the largest clutch recorded was 14 eggs, all of which hatched. Rosenberg et al. (2007) found variable productivity between habitat types, with productivity 10-20% lower in urban nest sites than grassland and fragmented habitat, but lowest in agricultural sites, which only average 2.9 ± 0.6 young per nest. Considerable variability also existed within years, where, even in an overall "good" or "poor" year, outlier nests existed. Clutch size is positively correlated with prey abundance (Wellicome 1997). Incubation normally lasts 28 to 30 days, beginning before the clutch is complete (Poulin et al. 2011). The eggs hatch asynchronously, which may be an adaptation to annual variation in prey abundance, whereby more young can be raised during years when prey is plentiful (Newton 1977, 1979; Wellicome 2005).

During incubation and brooding, the female stays in the burrow almost continuously while the male does the provisioning. Young burrowing owls fledge at about 44 days. As they mature they join the adults in foraging flights at dusk (Rosenberg et al. 1998). Prior studies in California have characterized burrowing owl reproductive success as 33% per nest attempt (Thomsen 1971) and 78% over seven breeding seasons (Trulio 1994, 1997), with 2.9 to 7.8 young fledged per successful nest (Poulin et al. 2011). However, burrowing owl fecundity in the Imperial Valley agricultural landscape is only 2.0 – 3.6 young fledged per nest (Rosenberg and Haley 2004).

Table 2. Key Seasonal Periods for Burrowing Owl

	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Breeding			✓	✓	✓	✓	✓	✓				
Migration			✓	✓					✓	✓		
Winter Movements	✓										✓	✓

Source: Poulin et al. 2011

Spatial Behavior

Spatial activity includes migration by some individuals, dispersal, and home range use. Table 3 summarizes data for these activities.

California supports year-round resident burrowing owls and over-wintering migrants (Gervais et al. 2008). Many owls remain resident throughout the year in their breeding locales (especially in central and southern California) while some apparently migrate or disperse in the fall (Haug et al. 1993; Poulin et al. 2011; Coulombe 1971; Barclay 2007). Owls breeding in northern California locales and at higher elevations are believed to move south during the winter (Grinnell and Miller 1944; Haug et al. 1993; Zeiner et al. 1990). Other researchers report that burrowing owls may "wander" during the winter months, occasionally appearing and disappearing from their breeding grounds (McCaskie et al. 1988; Martin 1973).

It can be difficult to identify individual burrowing owls in mild-winter regions as being winter residents (migratory) seasonal wanderers, or permanent residents. Burrowing owl monitoring studies at Moffett Federal Airfield (Trulio 1994) and Mineta San José International Airport (Barclay 2007) show that the number of individuals observed declines from October to March. However, burrowing owls may not actually leave during this time (see banding summary below), but may just be less visible, as shown by LaFever et al. (2008) and suggested by Thomsen (1971) and Coulombe (1971) because they spend more daylight hours in their burrows. Trulio (1994) reported that the number of burrows used at Moffett Federal Airfield did not decline during the winter, suggesting owls are less visible during the winter months. In central California, burrowing owls occur only as winter visitors in some coastal areas that appear to contain suitable breeding habitat (Garrett and Dunn 1981).

Recoveries of burrowing owls banded in California are another source of information about the nature of owl migration and dispersal. U.S. Geological Survey Bird Banding Laboratory records (through August 2003) contained 106 resightings of 4,708 burrowing owls banded in California (Barclay 2007). Seventy-five (71%) of these encounters occurred in the same 10-minute block of longitude and latitude (361 kilometers^2 or 139 miles^2) where the owls were banded, and 27 (25%) occurred in the 10-minute block adjacent to where they were banded. Of the remaining four encounters of burrowing owls that were banded and recovered in California, all were less than 95 kilometers from the block where they were banded (Barclay 2007).

Burrowing owls exhibit high site-fidelity and sometimes reuse burrows year after year, although dispersal distances may be considerable and variable depending on location and the age of the owls. Distances of approximately 53–150 kilometers (33–93 miles) have been observed in California for adult and natal dispersal, respectively (Gervais et al. 2008) but are usually much shorter (Table 3). Sizes of burrowing owl territories and home ranges also vary (Table 3). For example, at the Oakland Airport in California estimated breeding territories ranged from about 0.04 to 1.1 hectares (0.1–2.8 acres) (Thomsen 1971). Male ranges can be quite large, with estimated ranges as large as 3 kilometers^2 (740 acres) (Haug and Oliphant 1987).

Table 3. Spatial Information for Burrowing Owl

Type	Distance/Area	Location of Study	Citation
	May forage over 2–3 km^2 during nesting season	California agriculture; Saskatchewan agriculture	Rosenberg and Haley 2004; Haug and Oliphant 1987
Home range (male)	114 hectares (282 acres)	Imperial Valley, farm fields	Rosenberg and Haley 2004
	476 acres	San Joaquin Valley crop-grassland mosaic	Gervais et al. 2003

Table 3. Spatial Information for Burrowing Owl

Type	Distance/Area	Location of Study	Citation
	596 acres	Saskatchewan crop-grassland mosaic	Haug and Oliphant 1990
Breeding Territory	Range: 0.04–1.1 hectares (0.1–2.8 acres).	Oakland, California	Thomsen 1971
	Minimum: 7 acres	Desert in New Mexico	
Distance between Nest Burrows	Varies from 90 m to under 14 m	Idaho, Texas	Poulin et al. 2011, references therein
Dispersal	Juveniles disperse about 0.25 km (0.4 mi) from natal burrows after fledging.	Idaho	King and Belthoff 2001
	Adults disperse an average of 3.1 km (range 0.2–53 km)	Carrizo Plain, California	Rosier et al. 2006
Migration	Highly variable, little data; Most southern California birds are year-round residents	California and elsewhere	Poulin et al. 2011; DeSante et al. 1997; Harman and Barclay 1997

km – kilometer
m – meter

Ecological Relationships

In California, burrowing owls most commonly live in burrows created by ground squirrels (*Spermophilis* spp.) (Gervais et al. 2008). Therefore, the suitability and quality of burrowing owl habitat in the Plan Area is closely and positively related to the occurrence and population health of ground squirrels. Burrowing owls on the Great Plains depend mainly on prairie dogs for suitable burrows. In Great Basin sagebrush steppe, where ground squirrels do not occur, burrowing owls may depend on badgers (*Taxidea taxus*) for nest burrow excavation, although this species is a major predator of burrowing owls (Green and Anthony 1997). Burrowing owls prefer grazed areas where livestock have reduced vegetation height (Wedgwood 1976). Green and Anthony (1989) found that nests lined with livestock dung were less prone to predation and had increased insect prey presence (Smith 2004), but uncertainty remains in the effect of grazing on burrowing owls and their habitat (Klute et al. 2003). In addition to badgers, native mammalian and avian predators include coyotes (*Canis latrans*) Swainson's hawks (*Buteo swainsoni*), ferruginous hawks (*B. regalis*), merlins (*Falco columbarius*), prairie falcons (*F. mexicanus*), peregrine falcons (*F. peregrinus*), great horned owls (*Bubo virginianus*), red-tailed hawks (*B. jamaicensis*), Cooper's hawks (*Accipiter cooperii*), and crows (*Corvus brachyrhynchos*) (Poulin et al. 2011). Non-native species, especially domestic dogs (*Canis familiaris*) and cats (*Felis domesticus*) are known predators of adult and young burrowing owls. Cannibalism has also been reported.

Population Status and Trends

Global: Stable (NatureServe 2010)
State: Declining; Priority 2 Species of Concern (Gervais et al. 2008)
Within Plan Area: Declining (Bloom 2009)

Recently published survey results based on a random sample of 860 5-kilometer[2] blocks in California in 2006–2007 yielded an estimate for the breeding-season population of burrowing owls of 9,187 pairs (±2,346 pairs) (Wilkerson and Siegel 2010). When comparing these results to 1993 results for the same survey areas using the same methods, the results indicate a population decline of approximately 10.9%, although the difference is not statistically significant. (The relatively large margin of error weakens the power of the test to show statistical differences.) Many regions in the Plan Area were not systematically surveyed prior to 2006–2007 (except for the Imperial Valley agricultural complex). Within the Plan Area agricultural development supports the highest densities of burrowing owls known in the world. However, a survey by Bloom Biological for the Imperial Irrigation District from 2007 to 2008 indicated a decline in the size of the Imperial Valley agricultural population (Bloom 2009). Population surveys are currently being conducted by the Imperial Irrigation District with results to be published in the summer of 2012 (Lovecchio, pers. comm. 2012). This will help to determine if the decline recorded in 2007–2008 is in fact a longer-term trend.

There were no surveys for burrowing owls prior to 2007 in the West Mohave Desert. Once surveyed, the results yielded an estimate of 560 (±268) pairs of burrowing owls. Due to the survey's focus on a portion of the agricultural valleys, and the subsequent extrapolation of agricultural survey results to non-agricultural desert scrub areas of the West Mojave Desert, this number may constitute either a gross over-estimate or a gross under-estimate of the true number of burrowing owls in the region (Wilkerson and Siegel 2010). Just west of the Plan Area, 53 burrowing owls were found in the Coachella Valley during the 2006–2007 surveys. However, other areas in central-western Kern County (and Rosedale west of the Plan Area) were estimated to have lost at least 95 breeding pairs, since 1993, apparently related to expanding urban development on the west side of Bakersfield (Wilkerson and Siegel 2010).

Threats and Environmental Stressors

The most immediate threats to the burrowing owl are the conversion of grassland habitat to urban other than livestock grazing and the loss of agricultural hay, grass, and alfalfa lands to development or conversion to unsuitable crops like cotton, vineyards, orchards, corn and sugarcane (Gervais et al. 2008, Wilkerson and Siegel 2010). Vehicle collisions may also be a significant cause of mortality in the Plan Area (BLM 2005). All of these factors are well-established for burrowing owls in many parts of California (Gervais et al. 2008; Poulin et al. 2011; Hamilton and Willick 1996), and can be expected to increase in desert areas as a result of continuing regional human population growth and concomitant changes in land uses.

Associated with the habitat loss and degradation is the decline of fossorial species across much of the owl's historical range that create suitable nest sites for burrowing owls, such as ground squirrels, badgers, marmots (*Marmota* spp.), skunks (*Mephitis* spp., *Spilogale putorius*), kangaroo rats (*Dipodomys spectabilis*), and desert tortoises (*Gopherus agassizii*) (Gervais et al. 2008; Poulin et al. 2011). Eradication programs that have decimated rodent populations have, in turn, decreased the abundance of key prey available for burrowing owls. Because the burrowing owl depends on other animals to dig its burrows, loss of fossorial species limits the extent of burrowing owl habitat across much of the Plan Area (Poulin et al. 2011).

Direct causes of mortality in burrowing owls include: predation by hawks, owls, badgers, coyotes foxes, domestic dogs and cats, and others (Poulin et al. 2011); vehicular collisions; wind turbines; barbed wire fences; shooting; road maintenance; tilling, pesticide application and other agricultural practices; and disease and parasites (Gervais et al. 2008; Poulin et al. 2011). Vehicular collisions, which accounted for 25 to 60% of burrowing owl mortalities in three studies (summarized in Poulin et al. 2011), are a significant cause of mortality because burrowing owls habitually perch and hunt on roadways at night (Bent 1938; Poulin et al. 2011). James and Fox (1987) were able to determine that reproductive success was directly proportional to the distance of pesticide application from burrows as a result of direct toxicity. Indirect mortality may also result from pesticide application to burrowing owl prey (James et al. 1990).

The fallowing of agricultural land in Imperial Valley as the water allocation to Imperial Valley Farms is reduced may produce less abundant habitat for rodents and invertebrates on which the burrowing owl preys. In some cases, losses to development are spurred on because of the loss of water for irrigating pastures. The robustness of the Imperial Valley burrowing owl population may be at risk if suitable agricultural habitat converts to habitat for renewable energy installations as landowners make economic decisions to shift land uses based on the potentially declining availability of irrigation water (Campbell, pers. comm. 2012).

Conservation and Management Activities

The burrowing owl is in decline across broad areas of its distribution in the United States and Canada. Several species status reviews, spanning a broad spatial scale from continental, to regional, to site- or project-specific have addressed the need for burrowing owl conservation and management. Broad-scale plan include *North American Conservation Action Plan, Western Burrowing Owl* (Commission for Environmental Cooperation 2005), *Status Assessment and Conservation Plan for the Western Burrowing Owl in* *the United States* (Klute et al. 2003), *Recovery Strategy for the Burrowing Owl (*Athene cunicularia*) in Canada* (Environment Canada 2007), *Recovery Plan for the Burrowing Owl in Canada* (Hjertaas 1997), "Effects of Management Practices on Grassland Birds: Burrowing Owl" (Dechant et al. 2002), *Sonoran Joint Venture: Bird Conservation Plan, Version 1.0* (Sonoran Joint Venture Technical Committee 2006), and *The Desert Bird Conservation Plan: A Strategy for Protecting and Managing Desert Habitats and Associated Birds in California* (Bates 2006). The State of California has issued guidance on how development projects should mitigate impacts to burrowing owls (CDFG 2012). Recently issued conservation plans within the DRECP Area and adjacent desert regions are detailed in the West Mojave Plan (BLM 2005), the Imperial Irrigation District's 2009 Annual Water Report (Imperial Irrigation District 2010), and the CVMSHCP (CVAG et al. 2007). Habitat conservation planning efforts outside the DRECP Plan Area have also addressed the burrowing owl for example: East Contra Costa County HCP/NCCP (2006), Santa Clara Valley HCP/NCCP Draft (2012), and San Joaquin County Multi-Species Habitat Conservation and Open Space Plan (2000).

In California, the Department of Fish and Game, has completed the *Staff Report on Burrowing Owl Mitigation* (2012). This document provides guiding principles for conservation, conservation goals, and mitigation methods. The report includes habitat assessment and reporting details, breeding and non-breeding season survey and reports, a mitigation management plan and vegetation management goals.

Efforts to manage burrowing owls have employed a variety of techniques to address site-specific goals and conditions. Common management activities have addressed habitat management on preserve lands (Johnson 1986; Stanton and Teresa 2007; CVAG et al. 2007); evaluation of impacts from development projects (Bendix 2007; Smith and Belthoff 2001; Trulio 2001); prevention of disturbance during the nesting season (Koshear et al. 2007; (CVAG et al. 2007); installation of artificial burrows (Collins and Landry 1977; Poulin 2000; Smith and Conway 2005; Smith et al. 2005; Wildlife Research Institute, Inc 2005; Barclay 2008); and management of burrowing owls on military installations and airfields (Barclay 2007; Garcia and Conway 2007; Rosenberg et al. 1998, 2009; Trulio 2001). Other management efforts listed by Poulin et al. (2011) include "installation of perches which provide hunting and predator observation sites; captive breeding and release; relocation of owls under immediate threat; pesticide restrictions; traffic and other warning signs; land stewardship agreements; and vegetation management through fire or grazing." Poulin et al. (2011) cites the highly successful use of artificial burrows by Olenick (1990) in Idaho.

The reintroduction of burrowing owls into vacant ranges has been done with limited success in British Columbia (Munro et al. 1984; Leupin and Low 2001), Manitoba (De Smet 1997), Minnesota (Martell et al. 2001), southwest Oregon (Green pers. comm.) and on a token, experimental scale in California (Delevoryas 1997). Because this species shows strong site fidelity to nesting areas, introducing birds to new areas is a challenge.

Management practices have also been implemented to address the unwanted occurrence of burrowing owls in some settings. These include passive relocation (Trulio 1995; Bendix 2007) and active relocation (Feeney 1997; Bloom et al. 2003) to remove burrowing owls from development project sites where impacts to occupied burrows were unavoidable and avoidance of direct take was desirable (Smith and Belthoff 2001). Management has also been carried out to address predation of burrowing owls on other special-status species (Garcia and Conway 2007). According to Lincer and Bloom (2007), burrowing owls were removed from areas between Camp Pendleton and Tijuana Slough National Wildlife Refuge (PHB) at potential California least tern and western snowy plover breeding sites.

Data Characterization

Parts of the Plan Area were randomly sampled for burrowing owl populations recently for the first time, including portions the Mojave and Sonoran deserts (Wilkerson and Siegel 2010). While this survey provides an objective statewide population estimate, and includes previously unsurveyed areas, it contains systematic sources of error and other limitations (e.g., the range in the extrapolated population estimate of 560 ±268 pairs for the western Mojave Desert is quite large). Potential sources of error include observer detection shortcomings, a lack of a detection probability assessment, untested population estimate assumptions (e.g., assuming a breeding pair when observing a single owl), and large tracts of lands that remain unsurveyed due to access restrictions (which limits the ability to conduct a truly random sample). Although these limitations preclude a precise absolute population size estimate, the methods in the Wilkerson and Siegel (2010) survey adhered to those established by DeSante et al. (2007); the method of comparison between the two studies and thus the population trend estimates can be made. The information gained from these surveys informs the background of conservation planning for the burrowing owl in the DRECP Area. However, the potential sources of error identified above and the relatively weak statistical power to precisely estimate population size from the survey methods highlight the need for further census and monitoring efforts. Due to the high demographic variability of burrowing owl populations (Wilkerson and Siegel 2010) and prior documentation of burrowing owl population model inaccuracies (Johnson 1997), uncertainties remain in assessing the effect of conservation activities.

An ongoing data-collection protocol is specified in the Imperial Irrigation District's 2010 Annual Report (Bloom 2009).

Management and Monitoring Considerations

Though populations may be stable in areas such as the Imperial Valley and the western Mojave Desert, populations elsewhere in California have declined in numbers since the 1991–1993 survey, especially where agricultural land has converted to urban development (Wilkerson and Siegel 2010). Management and monitoring can be difficult since the vast majority of burrowing owl habitat in California occurs on private agricultural lands (Wilkerson and Siegel 2010). The Imperial Valley agricultural areas in the Plan Area support the most dense burrowing owl populations known anywhere, making conservation of the species especially challenging (Gervais et al. 2008).

Wilkerson and Siegel (2010) identified several important considerations for successful burrowing owl management, such as recognizing the species association with ground squirrels and agricultural water control infrastructure, and identifying the particular conservation needs for newly surveyed populations in the western Mojave Desert. Preserving traditional nesting sites, as burrowing owls often reuse nesting sites occupied in recent years, is also an important management consideration (Dechant et al. 2002).

Pesticide use to control pest species in agricultural and urban-interface areas has clear adverse effects on burrowing owls due to direct mortality, weight loss, loss of animals that provide burrows, and loss of prey base (Poulin et al. 2011). Alternative integrated pest management strategies may be possible, though research on California ground squirrels (*Spermophilus beecheyi*) indicates that trapping and relocating is not a useful management alternative for problem ground squirrel colonies in most instances (BLM 2005; Van Vuren et al. 1997). Dechant (2002) provides recommendations for pest control that minimize negative impacts to burrowing owls, including excluding pesticide use around burrowing owl nests, restricting prairie dog control measures such as poisoning and baiting, and restricting the timing of pest control activities to avoid burrowing owl nesting, or nest selection periods.

Threats to burrowing owls associated with public land uses differ from those on private lands and, therefore, require different management considerations. On BLM-administered land, the Western Mojave Plan (2005) identified as primary short-term conservation needs reducing burrowing owl mortality from both on- and off-highway vehicle (OHV) collisions and protecting the species from shooting and harassment. In the long-term the Western Mohave Plan calls for occupied and potentially occupied habitat protection and for maintaining populations of fossorial mammals. Suggested management considerations in occupied and potential burrowing owl habitat on BLM lands included prohibiting OHV use and imposing speed limits, prohibiting certain pest control measures, educating recreational users, and requiring surveys prior to land-use changes. Livestock grazing may enhance habitat suitability by reducing vegetation height, and nests lined with livestock dung may reduce predation as well as increasing insect prey activity (Green and Anthony 1989; Smith 2004), but the effects of livestock on burrowing owls are not well documented and grazing management objectives may conflict with other habitat management objectives (e.g., managing for ground squirrel populations). The potential benefit of livestock grazing on burrowing owl habitat on public lands would need to be tested.

Much remains to be learned about the kinds of habitat alteration tolerated by burrowing owls, including noise impacts and the duration and daily timing of nearby human activities (BLM 2005). The close proximity of some burrowing owl populations to airports suggest that they are tolerant of noise and other activities, but these relationships are not well understood (e.g., are these individuals just making the best of a marginal situation). Sustained population monitoring is important to assess the success of burrowing owl management practices because population levels can be highly variable, little information exists on the lifetime reproductive success of the species, and population trends have been difficult to predict in California (Johnson 1997; Poulin et al. 2011). Wilkerson and Siegel (2010) encouraged the engagement of "citizen-scientists" in ongoing monitoring efforts to reduce cost, expand monitoring scope, and increase awareness, but future surveys should incorporate latest research (e.g., Conway et al. 2008) to increase survey accuracy and population estimation precision.

Species Modeled Habitat Distribution

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

There are 6,496,668 acres of modeled suitable habitat for burrowing owl in the Plan Area. Appendix C includes a figure showing the modeled suitable habitat in the Plan Area.

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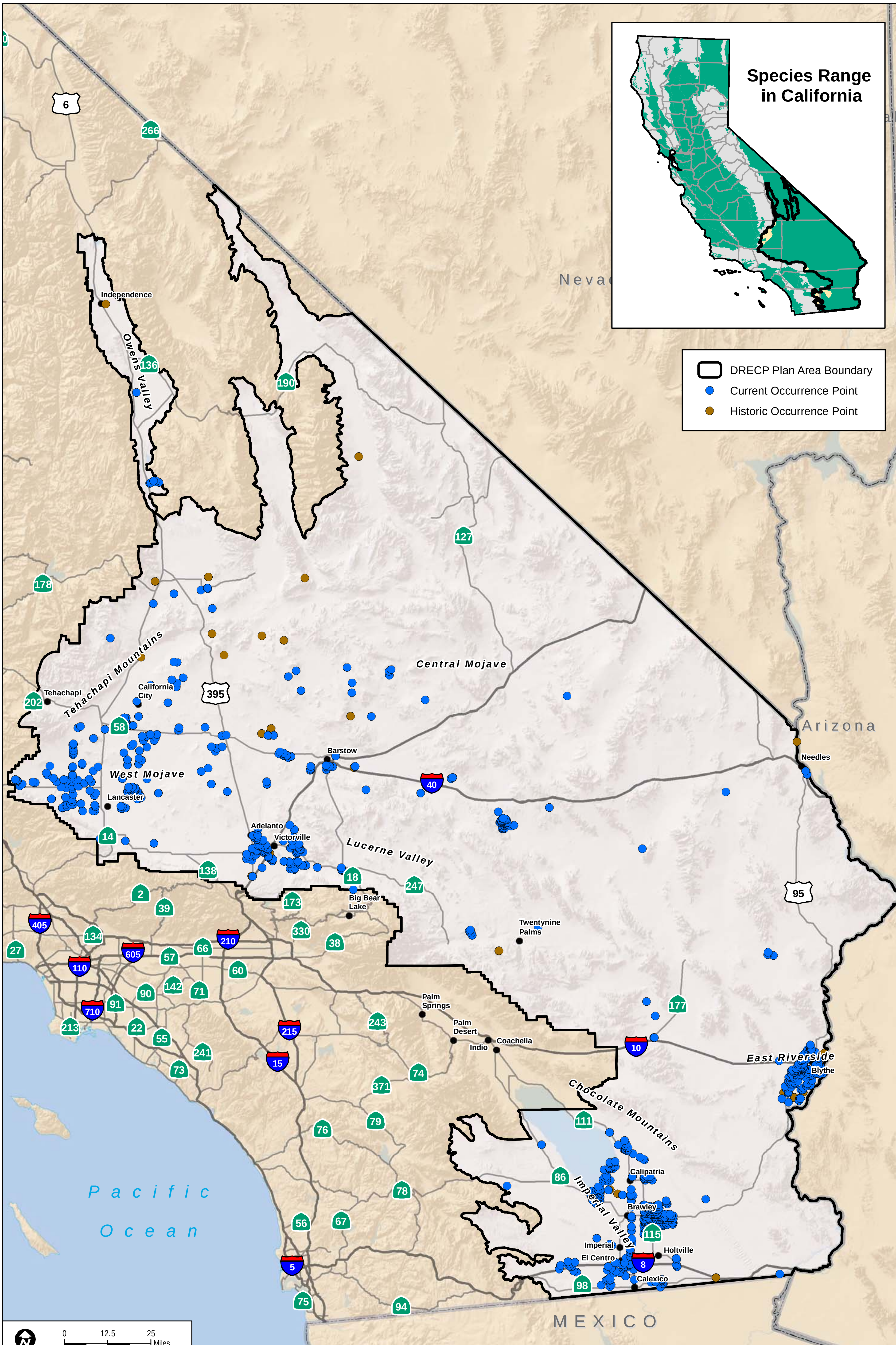

Sources: ESRI (2014); DRECP Species Occurrence Database (2013), CWHR (2008)

FIGURE SP-B03

Burrowing Owl Occurrences in the Plan Area