

## THE STATUS OF THE BURROWING OWL IN SAN DIEGO COUNTY, CALIFORNIA

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*Abstract.* Burrowing Owl (*Athene cunicularia*) populations in San Diego County appear to have decreased through the early 1900s in conjunction with human population growth and concomitant habitat loss. By the late 1970s/early 1980s, there were perhaps 250-300 pairs left, but as of 2003 the population had been reduced to no more than 25-30 resident pairs (note: recent surveys revealed additional owls suggesting that there were, at most, 46 pairs in the county as of 2007). Primary threats to the remaining small Burrowing Owl population in San Diego County are: reduced habitat suitability and fragmentation of remaining suitable habitat; conflicts with management of listed species, especially the California Least Tern (*Sterna antillarum browni*) and Western Snowy Plover (*Charadrius alexandrinus nivosus*); and human disturbance (including their pets and vehicles). In addition, predators, prey abundance and availability, and colony size are likely factors influencing population dynamics, the relative importance of which are difficult to characterize. Given county owl population declines and current threats, a comprehensive management program is essential to protect remaining habitat and owls. If such a plan, or similar action, is not implemented soon, extirpation of the Burrowing Owl in San Diego County seems imminent.

*Key Words:* *Athene cunicularia*, breeding, Burrowing Owl, California, habitat loss, management, population trends, San Diego County, status.

Our effort to determine the status of the Burrowing Owl in San Diego County (Fig. 1) is part of the urgent implementation tasks associated with the San Diego Multiple Species Conservation Program (MSCP). The MSCP is a local Habitat Conservation Plan (HCP) implemented under the State's Natural Community Conservation Planning (NCCP) Program of which the city and County of San Diego, as well as several other cities, are participating members. It encompasses the southwest quadrant of the county in which the

vast majority of the county human population resides (Figs. 2-4).

Each HCP/NCCP requires a monitoring program to determine the effectiveness of that plan. The Biological Monitoring Plan for the MSCP (Ogden 1996) recommended that "All known Burrowing Owl breeding localities within the preserve should be monitored for level of occupation; thus, grassland plot delineation needs to account for the known distribution of Burrowing Owls." Clearly, the monitoring of Burrowing Owls is a critical

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FIGURE 1. Study area location in San Diego County, CA.

component of the MSCP. With the exception of Marine Corps Base Camp Pendleton (Bloom 1980) and Fallbrook Detachment (Bloom 1996), comprehensive studies of this species within the county or the MSCP were lacking prior to studies by the Wildlife Research Institute, Inc. (WRI 2002, 2003, 2004, 2005).

However, Burrowing Owl population declines had begun early in some places and they were obvious to many biologists. Grinnell and Miller (1944:202), reported, "Numbers in favorable locations large; originally common, even 'abundant.' Latterly becoming scarce in settled parts of the state." Sams and Stott (1959:21) indicated, "Resident, formerly fairly common in suitable areas." During the 1970s and early 1980s, this species was still widespread in San Diego County and colonies of 40-60 pairs could be found in Escondido and the Warner Ranch (J. Oakley, WRI, personal communication) with smaller colonies of 30-40 pairs along the coast, on Otay Mesa, and along the Mexican border (based on interviews with local biologists and birders).

The objectives of the subject project were to:

- Determine the location of historical and

remaining breeding Burrowing Owls within San Diego County;

- Identify those conditions that seemed to influence county population trends; and
- Identify needed management, including enhancement opportunities, and research needs.

## STUDY AREA

The study area included all of San Diego County (approximately 6.67 million ha) located in the southwest corner of the state (Fig. 1). It has a coastal plain, with foothills, mountains, and desert, respectively, to the east. The coastal area, where most Burrowing Owls have been located, ranged from sea level up to approximately 700 m. Precipitation ranges from approximately five to 102 cm for the county and 25 to 46 cm per year for the areas west of the foothills (T. Oberbauer, San Diego County, personal communication).

## METHODS

Information for this study came from five general sources: museum and other records; the scientific literature (Clark et al. 1997, Lincer and Clark, this volume); outdoor-oriented public; local experts; and our own fieldwork. We reviewed historical egg and skin collections at several museums (i.e., San Diego Natural History Museum, Field Museum of Natural History, National Museum of Natural History, American Museum of Natural History, Western Foundation of Vertebrate Zoology, Santa Barbara Museum of Natural History, U.C. Museum of Vertebrate Zoology, California Academy of Sciences, Carnegie Museum of Natural History, University of Minnesota Bell Museum, and UCLA Dickey Bird and Mammal Collection). We interviewed key professionals in the San Diego ornithological community (see Acknowledgements). One of the authors (PHB), within a broader study of southwestern California raptor populations, surveyed the largest patches of potential Burrowing Owl habitat in the county located on Marine Corps Base Camp Pendleton (309,000 ha) annually between 1971-2004 and adjacent Fallbrook Detachment (21,876 ha) between 1994-2004. Finally, major sources of data for this investigation came from studies within

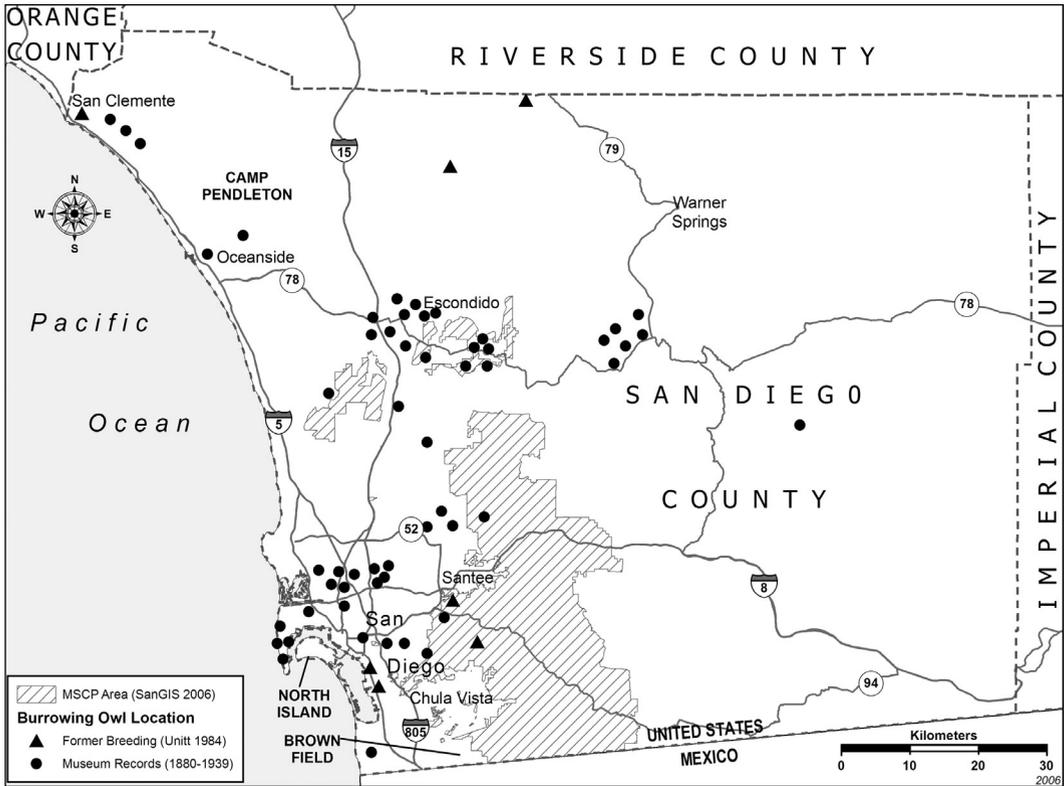


FIGURE 2. Historical locations of breeding Burrowing Owls in San Diego County, CA.

the MSCP, funded by the City of San Diego and the California Department of Fish and Game (CDFG), which addressed the status of the Burrowing Owl (WRI 2003) as well as other raptors within the MSCP (WRI 2002, 2004, 2005).

Because of patchy historical data sets for much of San Diego County, we were limited to presenting estimates of the owl’s status for three periods: late 1800s/early 1900s, the late 1970s/early 1980s, and recently (primarily 2000-2003).

## RESULTS

Museum records from 10 institutions (spanning roughly 1880 to 1939) revealed 54 Burrowing Owl egg sets and 18 birds collected during the breeding season in San Diego County (Fig. 2). Interviews with long-term resident biologists, historical checklists, and perspectives provided by authors (Garrett and Dunn 1981, Unitt 1984, and Zeiner et al. 1990) indicate that the

Burrowing Owl population was still substantially healthy during the 1970s and early 1980s (Fig. 3).

The last time period for which we have fairly comprehensive San Diego County Burrowing Owl data is 2000-2003 (Fig. 4). During this period, WRI conducted a series of raptor investigations (WRI 2002, 2003, 2004, 2005) and the San Diego Museum of Natural History conducted part of its five-year study for a County Bird Atlas (Unitt 2004). During this window, we estimate that 25-30 pairs of Burrowing Owls remained in the county (see update in Discussion).

## DISCUSSION

### HISTORICAL AND CURRENT DISTRIBUTION

Burrowing Owls have disappeared and/or populations declined in several southern California and San Francisco Bay counties and

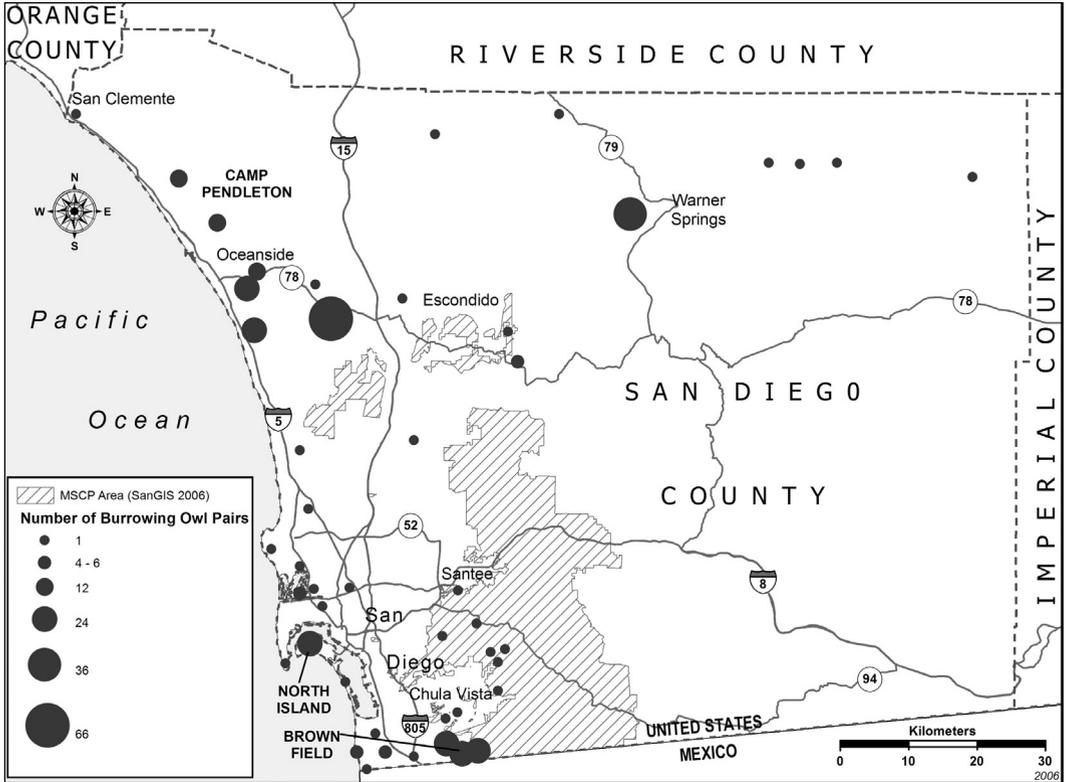


FIGURE 3. Breeding Burrowing Owl locations in San Diego County, CA in the late 1970s and early 1980s.

in coastal areas (DeSante et al. 1997, Klute et al. 2003, Kidd et al. this volume). This trend is not limited to California; as of 1992, 16 (67%) of 24 states and provinces polled reported Burrowing Owl population declines and none reported an increase (James and Espie 1997). As a result of widespread concern, this species was the subject of two recent international symposia (Lincer and Steenhof 1997, Wellicome and Holroyd 2001) as well as the 2003 California Burrowing Owl Symposium (this volume). Concern for this species is not just local or even regional; it has also declined in several large regions, most notably the northeastern Great Plains and Canada (Klute et al. 2003).

The international trend is reflected by San Diego County as a microcosm. References to “former breeding” areas by Unitt (1984:108) and Abbott (in Bent 1961:391) indicate that Burrowing Owls were widespread in this county and common, primarily from the coast and the grassy interior, during the late 1800s and early

1900s (Fig. 2). Abbott described numerous Burrowing Owls still living on scattered vacant land amongst a growing City of San Diego in 1921. This is consistent with observations of Stephens (1919:17), who stated that the owl was a “...common resident in open ground from the seashore to the higher foothills.”

However, Grinnell and Miller (1944:202) noted that it was “...becoming scarce in settled parts of the state.” Although Burrowing Owls are not common in natural deserts (D. Rosenberg, Oregon State University, personal communication), the lack of historical records from the desert may also reflect egg collector access ability. Evidence for some desert-dwelling Burrowing Owls is supported by an overview during the 1950s by Sams and Stott (1959:21), who indicated that the species “Occurs in open country both in the coastal lowlands *and the desert* (*italics added*).”

Although Unitt (1984) reported that the Burrowing Owl was still present in the 1970s in

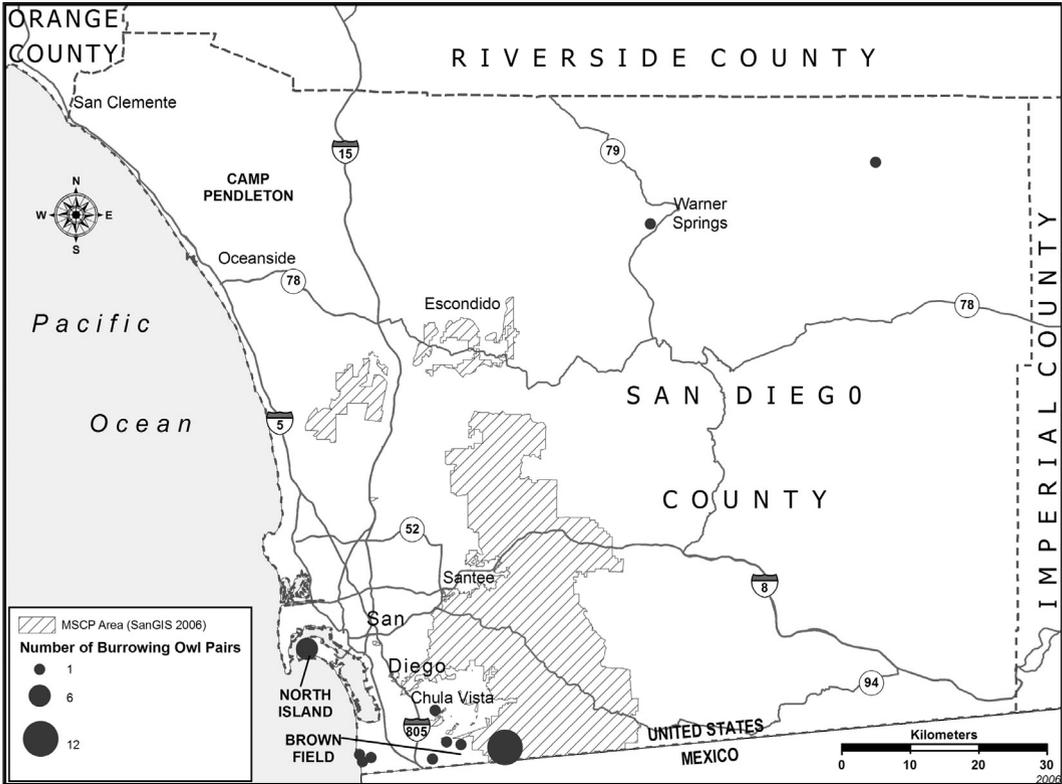


FIGURE 4. Breeding Burrowing Owl locations in San Diego County, CA during 2000-2003.

many areas, by the time he reviewed its status (1984:109), he considered it an “Uncommon and declining resident in grassland, agricultural land, and coastal dunes” and went on to say, “...urbanization has greatly restricted the extent of suitable habitat [in San Diego County].” At that time, owls were known to have bred along San Diego’s coast, in the Ramona Grasslands (Loy 1986, Bloom 1994 *in* BFMA 1997), and along a north-south line from El Cajon to just east of San Ysidro (see Map 30 of Unitt 1984).

In the late 1970s and early 1980s, we estimate there may have been 250-300 pairs well distributed in suitable habitat throughout the county, based on our review (Fig. 3). Given the documented county trends in Burrowing Owl numbers and associated owl habitat loss, there could have been substantially more owls at the turn of the century.

Burrowing owls currently occupy some historical sites (e.g., North Island, south San Diego coastal area, and Otay Mesa) (Unitt 1984)

although in much reduced numbers (Fig. 4). They are also present at some locations that were not included in Unitt’s 1984 review. Recent observations of some individuals (e.g., on Rancho Jamul [D. Lawhead, California Department of Parks and Recreation, personal communication], and Rolling Hills, where artificial burrows are showing some success [D. Mayer, California Department of Fish and Game, personal communication] may be a reflection of increased management attention and organized searching (i.e., through the County Bird Atlas and focused WRI raptor surveys). Owls were clearly absent from many developed places where they were formerly found (e.g., north-central county, coastal areas, including south of La Jolla, Point Loma, and the area around the City of San Diego).

Surprisingly, even the relatively vast and pristine habitats of Camp Pendleton currently support no breeding Burrowing Owls although a mix of wintering and migrating individuals

persist (PHB). The juxtaposed Fallbrook Detachment population presently consists only of migrants (PHB, J. W. Kidd, Kidd Biological Consulting, personal communication). These observations are consistent with those in Unitt (2004).

Burrowing Owl populations in San Diego County are experiencing the same kind of consistent declines observed throughout the northeastern Great Plains and Canada (Klute et al. 2003). In that regional decline factors vary based on specific local and regional population stressors, it is unlikely that exactly the same factors are responsible for declines in all affected populations. It is equally likely, however, that some key factors were/are common to many declining populations.

The extirpation of the Camp Pendleton breeding population is an interesting case study because it is a well documented, if poorly understood, example of part of the San Diego County population decline. Camp Pendleton and adjacent Fallbrook Detachment, at the northwestern corner of San Diego County, are large adjacent military reservations (52,000 and 3,582 ha, respectively) with huge areas of potential Burrowing Owl habitat.

E. Harrison collected two egg sets in 1931 from unknown locations on what was then Rancho Santa Margarita (E. Harrison, Western Foundation for Vertebrate Zoology, personal communication). While this property was still under private ownership and management, considerably more of it was devoted to agriculture, particularly beans, (R.J. O'Neill, Rancho Mission Viejo, personal communication). Given the propensity of some agricultural areas to support Burrowing Owls, it is likely that this breeding population was larger and more widely distributed historically than when PHB first observed it in 1971 (see below). Historical evidence of breeding Burrowing Owls is lacking for Fallbrook Detachment on Camp Pendleton's eastern boundary despite a large California ground squirrel (*Spermophilus beecheyi*) population.

PHB surveyed Camp Pendleton during the 1970s and documented approximately 15 pairs (Bloom 1980). Six of these were located in November Area at the south end of the reservation and nine widely distributed pairs were located in the X-Ray, Oscar, Kilo 1 and

mid-southern coastal zone of the Base (Bloom 1980 and PHB, unpublished data). By the early 1980s, Camp Pendleton's breeding Burrowing Owl population dropped to only two pairs in Kilo 1 and by the late 1980s only one breeding pair persisted (Fig. 2, PHB, unpublished data). A pair was last seen in 1994 (J. W. Kidd, Kidd Biological Consulting, personal communication). Appropriate Burrowing Owl nesting habitat exists on the Fallbrook Detachment but no nests have been found. If breeding Burrowing Owls did exist on Fallbrook Detachment, they disappeared prior to 1993 (Bloom 1996). Thus, it appears that in the northwest portion of the county, including Camp Pendleton and the Fallbrook Detachment, the Burrowing Owl had been extirpated as a breeding species by 1995.

In 2003, based on the authors' personal knowledge, there were 25-30 resident pairs of Burrowing Owls in San Diego County located primarily in the southern quarter of the county and on North Island, which is due west of the City of San Diego (Fig. 4). (Note: In 2006, an additional 14 owl pairs were reported for the eastern Otay Mesa area (B. Jones, HELIX Environmental Planning, personal communication) and two pairs successfully bred in the Ramona Grasslands, which were from owls bred and released from WRI (JLL). It is possible that these owls were present in an area not previously surveyed or the result of recent reproductive success because of a break in a recent drought. Regardless of the reason, there could currently (2007) be roughly 16 more owl pairs (for a total of 41-46 pairs) in the county than we previously estimated.)

Although lack of data prevented exploring the historical wintering Burrowing Owl population and trends, we can assume that all or most of the above resident pairs (and some of their surviving offspring) remain in the county during the winter, which would mean that approximately 148-168 local individuals winter in the county. These are, apparently, joined by migratory wintering birds (JLL and PHB, personal observation) and Unitt (2004) also "...noted the burrowing owl in 20 [county bird] atlas squares where it evidently no longer breeds." We estimate that 50-100 of these migrant Burrowing Owls winter in, or migrate through, Camp Pendleton and adjacent Fallbrook Detachment alone. Given the

distribution of suitable habitat and our knowledge of wintering owls, another 100 owls likely winter in San Diego County, for a total estimate of approximately 300 to 370 owls that could winter here. However, data collected for the County Bird Atlas (Unitt 2004) suggests that the wintering owl numbers may be lower.

REASONS FOR POPULATION DECLINES

Decreases in the county’s Burrowing Owl population clearly coincide with increases in the human population according to the records of the San Diego Area Governments (SANDAG, Fig. 5). San Diego County experienced a major human population increase around the City of San Diego in the late 1940s and early 1950s in response to the build-up in Navy personnel associated with World War II. The county’s human population continued to grow through the 1970s and early 1980s, coinciding with the construction of the interstate highway system. This facilitated movement into, and development of, previously inaccessible interior areas, converting easily developed grasslands into citrus groves, other agricultural uses and housing developments.

The history of several current and former owl colonies provides insight into the reason for owl population losses. To the extent that these typify the environment faced by Burrowing Owl populations, colony history may shed light on what to expect in the future and what action may need to be taken.

*North County.* — One of the authors (JLL) visited many of the former Burrowing Owl colony sites with J. Oakley, a biologist who conducted Burrowing Owl studies in the northern half of the county in the 1970s and 1980s. Several moderate size colonies (two to three dozen pairs) persisted in his study areas (Oceanside, Carlsbad, Vista, San Marcos, Warner Ranch) through the late 1970s and into the early 1980s (J. Oakley, WRI, personal communication). Many of these lingered for years in the urban vacant lots between new development. Over time, these colonies decreased in size and eventually disappeared. In some cases, the habitat had been completely replaced by urban and commercial uses, and in one case, by the expansion of the Palomar Airport runway. In other cases, the remaining habitat, although apparently viable was close to or surrounded by

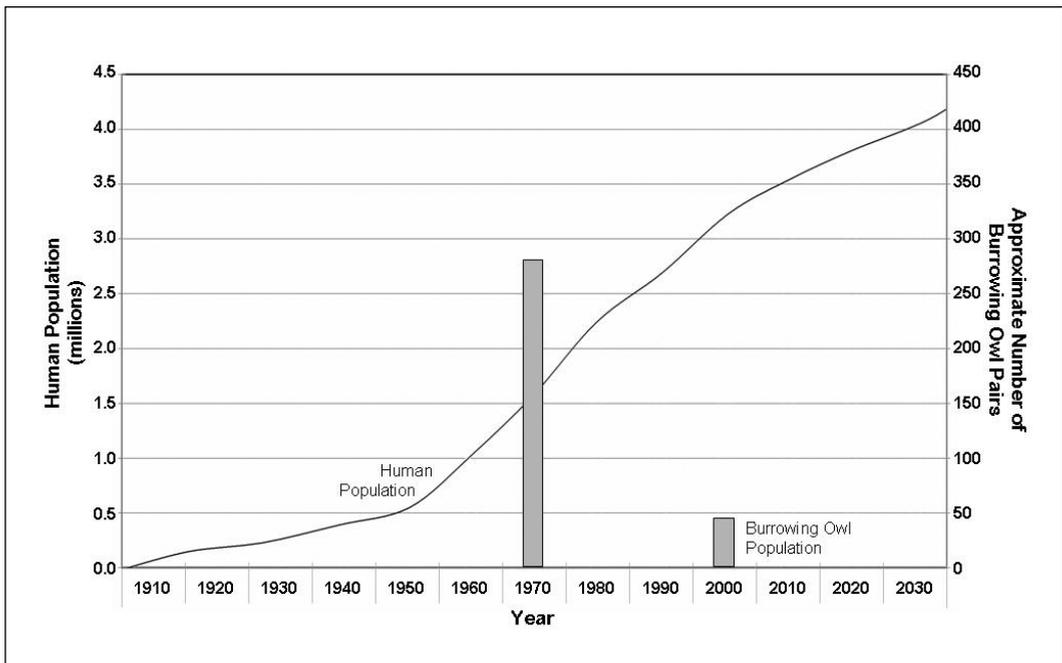


FIGURE 5. San Diego County human population growth versus Burrowing Owl population estimates (human population data from San Diego Area Governments (SANDAG), San Diego, CA).

developed areas. In these cases, we concluded that disturbance from human activity (e.g., walking, jogging, off-road activity, dog walking) and loose and feral pets (chasing and, presumably, preying upon owls) would have made the environment inhospitable for owls (Wesemann and Rowe 1985, Millsap and Bear 2000). In still other locations, like the Ramona Grasslands, where Burrowing Owls previously bred (Bloom 1994 *in* BFMA 1997, Loy 1986), habitat existing previously appears to be present but we observed no nesting owls and few fossorial mammals. In one eastern county area where Oakley had worked, the Warner Ranch, only one owl pair remained in 2003 (Fig. 4). Habitat conditions appeared unchanged from when approximately three dozen Burrowing Owl pairs were documented (Fig. 3, J. Oakley, WRI, personal communication) except there was a complete absence of ground squirrels and other fossorial mammals (JLL).

*Camp Pendleton.* — The reasons for both early and even contemporary Burrowing Owl declines on Camp Pendleton were likely in part due to direct conversion of land uses from cattle grazing and crop production to intense and localized military maneuvers, particularly in the lowlands and coastal areas. Camp Pendleton was established in 1942 and has annually conducted considerable heavy track vehicle activity, including amphibious landing vehicles and tanks that may have crushed ground squirrel and Burrowing Owl burrows and thus eliminated colonies of both species. A more subtle loss of breeding habitat may have resulted from the removal of intense cattle grazing after the military took control that probably allowed tall non-native grasses (*Avena* spp. and *Bromus* spp.) and sweet fennel (*Foeniculum vulgare*) to flourish.

Because of the introduction of exotic annual Mediterranean grasses, dry climate, and military training, Camp Pendleton probably burned more frequently than any other similar-sized parcel of land in California. Occasional fires in Burrowing Owl habitat are probably a positive event, but at too high a frequency type conversion and the effect on the prey base (especially arthropods, herpetofauna, and small mammals) is probably detrimental and may have compounded the effects of military maneuvers on the species (PHB).

*North Island and Other Military Bases.* — North Island supports one of two remaining Burrowing Owl colonies. It is located just west of the City of San Diego at the north end of a barrier peninsula that forms the western edge of San Diego Bay. This Navy base has historically supported a large Burrowing Owl population (Winchell 1994, Winchell and Pavelka 2004). During 1994–1995, at least 27 pairs were present (C. Winchell, U.S. Fish and Wildlife Service [USFWS], personal communication). According to B. Stewart (Wildlife Services, personal communication), there have been at least 14 pairs and/or active burrows in recent years. In 1999, the number was reduced to 11 breeding pairs (Winchell and Pavelka 2004), but the population has decreased since then (WRI 2003, 2005). Even more recently (March 2002), during WRI's field surveys, the maximum number of pairs, based on active burrows, was between six and eight. The causal factors responsible for this decline are not clear. However, predation by nesting Peregrine Falcons (*Falco peregrinus*) has been documented (C. Winchell, U.S. Fish and Wildlife Service, personal communication). In addition, these owls are seen as a threat by those responsible for intensively managing nearby California Least Tern and Western Snowy Plover colonies. For instance, at least two Burrowing Owl breeding pairs that nested on the Ream Field Auxiliary Naval Base (southern coastal San Diego County), but foraged on the adjacent Tijuana Slough National Wildlife Refuge, were trapped and removed because they were known predators of California Least Terns on the refuge (PHB).

Under contract by responsible federal agencies, Burrowing Owls have been captured and removed from federal lands from Camp Pendleton south to the Tijuana Slough National Wildlife Refuge (PHB). Owls were either live trapped and transported to the desert or, if untrappable, they were shot or if injured during trapping, they were euthanized. Some were held in rehabilitation facilities until the end of the breeding season and hence produced no young that year and had dubious survival potential given inadequate release techniques (PHB). No reports of numbers taken are known or have been provided by the agencies. A recent Freedom of Information Act request by the National Audubon Society for information related to the take of predators by Animal

Services at California Least Tern and Western Snowy Plover breeding sites was promised but never provided (P. DeSimone, National Audubon Society, personal communication).

Management for the California Least Tern and Western Snowy Plover (and, if continued, against the Burrowing Owl) by government agencies is likely to be a significant causative factor in the continuing decline of the Burrowing Owl on the San Diego County coastline. Even if owls are trapped from locations other than North Island (or any other breeding area), any reduction in the area's population has potentially important impacts to overall recruitment. Finally, as Navy facilities expand and human activities increase, the normal tolls of habitat loss, associated prey reduction, and human disturbance will be exacted on this dwindling population. Although the Navy may have, for many years, protected this colony from the developmental impacts that characterized the mainland (because important habitat remained undisturbed at low levels of military activity), current and future expansion may simply cause/continue a delayed negative effect.

*Otay Border Area.* — The Otay border area (several hundred ha), including Otay Mesa, supports the other remaining colony (HELIX 2001, Recon 2001, EDAW 2001, Unitt 2004, and JLL). This area abuts, and is just north of, the Mexican border fence at and to the east of the Otay Border Crossing and U.S. Customs Facility. This area on eastern Otay Mesa contained, perhaps, the largest remaining Burrowing Owl colony in San Diego County in 2003. This scrub habitat is kept sparsely vegetated by Border Patrol activities and fires (Unitt 2004). It has recently supported as many as 22 owls (JLL), representing six to seven pairs and their young. It not only supports a relatively large, and perhaps the last, Burrowing Owl "colony" in the MSCP, but also numerous other sensitive species (WRI 2003).

In the winter of 2001/2002, a relatively large number of Burrowing Owls (>12) wintered at the above site in open scrub and short grass habitat (JLL). By summer of 2002, the area had been turned into a construction site lay down area for a border culvert project (JLL). The habitat had been cleared, large equipment parked, and numerous large culverts stored on the owls' wintering and breeding site. This area is part of a County

Specific Plan, which portends additional major land use changes including the construction of a triple border fence. Without proper environmental review, lead agency action, and creative management, this large remaining Burrowing Owl population will be lost in the near future.

There are also currently several pairs of Burrowing Owls along a narrow strip of land, near the Customs Facility, which is patrolled by the Border Patrol. The owls along the border, and within a fenced and patrolled area, are surviving in this internationally protected zone but their breeding status is unknown.

Additional scattered owl pairs have breed on Otay Mesa, including on the Navy's Satellite Surveillance Station immediately north of Brown Field approximately 17 km northwest of the Custom Facility (WRI 2003). In addition, habitat loss and human disturbance, including vehicle traffic, decreases habitat values for these birds. Some owl habitat there, including a parcel owned by the City of San Diego, has been devastated by off-road vehicle activity. Plans to expand the Navy's Satellite Surveillance Station could also affect the remaining two Burrowing Owl pairs within and adjacent to the station.

## CONSERVATION IMPLICATIONS

Development and associated land use changes have been responsible for the decline of the Burrowing Owl in San Diego County. Many of these factors are also operating over a larger geographic scale (Lincer and Steenhof 1997, Klute et al. 2003).

- Major factors causing local Burrowing Owl declines include:
  - Direct loss of suitable habitat from private and public development.
  - Habitat type conversion.
  - Loss of ground squirrels and other fossorial mammals as a result of control (i.e., poisoning) efforts, habitat loss, and predation by pet and feral dogs and cats.
  - In the coastal region, conflicts with the management of listed species, like the California Least Tern and Western Snowy Plover.
  - Owl mortality and disturbance from pet and feral dogs and cats.
- Modifying factors:
  - Habitat fragmentation and loss of habitat

connectivity (James et al. 1997).

- Disturbance caused by people hiking, jogging, and walking dogs.
- Possibly important factors:
  - Vulnerability of small colonies to stochastic events (Johnson 1997).
  - Border Patrol activities may have both negative impacts (on habitat and burrows) and a positive impact through the protection provided by security fencing.
  - Altered top predator dynamics that may have led to increased populations of meso-predators: e.g., coyotes (*Canis latrans*), badgers (*Taxidea taxus*), foxes (*Urocyon cinereoargenteus*), bobcats (*Lynx rufous*) and some other species, like raccoons (*Procyon lotor*), opossums (*Didelphis marsupialis*), and skunks (*Mephitis mephitis* and *Spilogale putorius*).

The primary threats to the remaining small Burrowing Owl population in San Diego County are:

- Inadequate habitat acreage and fragmentation of remaining suitable habitat.
- Conflicts with management of listed species (i.e., the California Least Tern and Western Snowy Plover) in the coastal region.
- Disturbance by recreational vehicles and construction equipment.
- Inadequate regulatory protection and the lack of a comprehensive management plan to reverse the ongoing declines.

Unnatural levels, and kinds, of predation will continue to play a role in the demise of Burrowing Owls. Prey availability may be limiting in certain locations. Small colonies and scattered pairs will continue to be vulnerable to stochastic events.

Resource management needs include (1) understanding the status and trends of the Burrowing Owl population and (2) identifying demographic and other environmental factors that influence those trends.

We recommend the following to enhance Burrowing Owl conservation in San Diego County:

- Yearly monitoring of known Burrowing Owl locations in the county should be conducted until the current population decline is accepted as irreversible or the trend is reversed and numbers stabilize. We

recommend monitoring occupancy, nesting success and productivity of all known breeding pairs using consistent methodology (Steenhof 1987, CBOC 1997).

- Quantify the relative importance of predators, disturbance, prey base, and minimal colony size, to the success of Burrowing Owl colonies.
- Using appropriate pilot studies, develop a proactive approach to Burrowing Owl relocation. Identify important site criteria and potential receiver sites, examine likely carrying capacity, and (if necessary) augment the sites' ability to support owls before relocating owls to those locations. Potential sites include both public and private parcels. Site improvements may include habitat management and manipulation, security, the installation of artificial nest burrows, prey management, and introduction of fossorial mammals. There should be a cooperative effort involving all governmental levels and agencies (including resource agencies, the Department of Defense, Homeland Security, water authorities, and airport authorities), as well as the private sector.
- Establish a burrowing owl captive breeding and reintroduction facility. Experimental efforts at WRI (JLL) and Naval Weapons Station, Seal Beach (PHB) have demonstrated success where captive bred and released owls have produced eggs and young in artificial burrows. Although past Burrowing Owl reintroduction results have been mixed (Martell et al. 2001), success rates have been improved through careful planning and timely execution (Leupin and Low 2001). Every opportunity to increase success rates should be explored if owl population trends are to be reversed. A reintroduction program would substantially improve the chances of this species persisting in San Diego County. A breeding facility could serve numerous purposes including (1) receiving and safely holding "problem" Burrowing Owls (e.g., those trapped at California Least Tern colonies), (2) receiving/holding injured, but unreleasable, potential breeding birds, (3) public education, and (4) providing a source of young birds and/or family units

for reintroduction or augmentation of extant colonies (Barclay 1987).

- Develop alternatives to trapping and re-locating or euthanizing Burrowing Owls in order to protect least terns or other sensitive species, such as incorporating them into a captive breeding and reintroduction program.
- Develop a comprehensive and coordinated San Diego County Burrowing Owl Management and Monitoring Plan, involving all relevant parties. Public education should be incorporated into this proactive effort. Programs involving private landowners elsewhere have been successful and provide a good model (Hjertaas 1997). This could include establishing a Burrowing Owl Hotline that could quickly connect individuals with challenging management needs with those who can provide timely solutions.
- Because (a) this species has been extirpated in much of its former range, (b) it continues to decline in most areas, (c) most (>70%) of the remaining state owl population is concentrated in Imperial Valley living under man-made conditions subject to change, and (d) it appears to get limited protection from changing land uses because it is not listed under state or federal endangered species acts, some increased level of regulatory protection may be in order. One alternative may be listing in specific areas, such as San Diego County.

The San Diego County owl breeding population has decreased approximately 90 percent from what it was 25 to 30 years ago. It then numbered in the hundreds of pairs and at the time of this symposium it was reduced to no more than perhaps 25-30 resident pairs. Even with the recently observed additional East Otay Mesa and Ramona Grasslands owls, there are not likely more than 46 pairs in the county. If current threats continue and a comprehensive management program is not implemented soon, the extirpation of the Burrowing Owl in San Diego County is imminent.

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