

**Nature Reserve of Orange County Pilot Study:  
Monitoring Coastal Cactus Wren  
Reproduction, Dispersal and Survival**

Interim Report

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## **Introduction**

Southern California supports both coastal and desert populations of the Cactus Wren (*Campylorhynchus brunneicapillus*). While the desert populations are fairly abundant, populations of coastal Cactus Wren have shown dramatic declines over the last several decades (Sauer et al. 1999; Proudfoot et al. 2000; Solek and Szijj 2004; Mitrovich and Hamilton 2007), with extirpation from many locations as a result of habitat loss, habitat fragmentation, edge effects of development, and catastrophic fire. The coastal population is unique in that it occurs exclusively within the coastal sage scrub plant community, ranging from Ventura County south into northwestern Baja California.

The coastal Cactus Wren, like other Cactus Wrens, is sedentary; that is, it doesn't migrate, and adults rarely leave their breeding territories. Coastal Cactus Wrens have seldom been documented to move more than a few kilometers from their natal territories. As indicated by its name, the key habitat element for this bird is thickets of cholla or prickly-pear cactus tall enough to support and protect the birds' nest (>1 m tall). Because of its restriction to mature stands of cholla or prickly pear, this species has always had a rather patchy distribution in coastal southern California. However, it was formerly widespread and even abundant. Over the past decade, much of this coastal habitat has been lost to development or, where habitat remains, it has become fragmented to the extent that wrens may no longer be capable of effectively dispersing between habitat patches. Remnant patches of habitat are also subject to edge effects, including invasion of nonnative plant species that can replace native coastal sage scrub species that provide foraging areas for the wrens. These nonnative species can also make the habitat more flammable. Nest productivity is likely to decrease in these small patches, and because the size of the patch is limited by development, the wren population cannot increase and instead is more vulnerable to extirpation.

The fires of the last decade have exacerbated the problem, burned cactus patches can require 10, 20, or more years to regrow to a height suitable to support nesting by coastal Cactus Wrens. Thus, while fire and the availability of suitable habitat appear to be limiting factors in the current distribution of the coastal Cactus Wren, little research has been conducted on this bird to understand its population dynamics.

## **Objectives of this Study**

Conservation and management of the coastal Cactus Wren relies on a better understanding of how annual productivity, individual survivorship, and population isolation are related to population dynamics. This pilot study is intended as a first step in a comprehensive research program resulting in adaptive management actions.

The objectives of this pilot study included:

1. Monitor individual productivity and annual survival in a population of banded birds.
2. Monitor dispersal, colonization, and survivorship of fledglings.
3. Collect genetic material of coastal Cactus Wren across its range to conduct taxonomic analyses.
4. Test for exposure to West Nile Virus.

## Background

### *Taxonomic Status*

The southernmost populations of the coastal Cactus Wren in southern Orange County, San Diego County, and northern Baja California are classified as San Diego Cactus Wren (*C. b. sandiegensis*), whereas populations in Ventura and Los Angeles Counties and in deserts of California, Nevada and eastern Arizona are often classified as *C. b. anthonyi* (Rea and Weaver 1990; Proudfoot et al. 2000). It is possible that the two subspecies interbreed where they come into contact in Orange County. The San Diego Cactus Wren is designated as a Species of Special Concern by the California Department of Fish and Game (Unitt 2008). Coastal populations share song characteristics, have a similar ecology, and are isolated from desert populations, supporting designation as a distinct subpopulation (Atwood and Lerman 2007).

### *Conservation Status*

The coastal Cactus Wren is a target species for the Natural Community Conservation Planning (NCCP) program in southern California. Within the range of the coastal Cactus Wren, NCCP Plans have been completed for the Palos Verdes Peninsula in Los Angeles County, western Riverside County, central and coastal Orange County, and northern and southern San Diego County (Multiple Habitats Conservation Program and Multiple Species Conservation Program, respectively).

In the Central and Coastal Subregions of Orange County, 67.5% of 994 Cactus Wren locations documented during 1992 surveys were conserved in the Nature Reserve of Orange County (NROC) Reserve System (County of Orange 2003). Another 10.4% of locations were potentially conserved in special linkages and existing uses. Although these locations have not been developed, Cactus Wrens have disappeared from a majority of these locations because of fire and other factors.

### *NROC Population Status and Fire History*

Cactus Wrens nest in mature cactus scrub. Following wildfire, it can take many years for cactus to grow back to a size sufficient for Cactus Wren use (Proudfoot et al. 2000; Solek and Szijj 2004). In 1993, the Laguna Fire burned 75% of the ~17,000 acre Coastal Reserve. Post-fire surveys found the number of Cactus Wrens reduced to 28% of their pre-fire levels (Bontrager et al. 1995). Cactus Wren surveys and cactus scrub mapping conducted in 2006 found 58% of cactus scrub that burned in 1993 remained unoccupied (Mitrovich and Hamilton 2007). Much of this unoccupied cactus appeared too small to be suitable for Cactus Wren. An analysis of cactus scrub habitat and Cactus Wren locations indicates an 87% decline in occupied habitat in the Coastal Reserve between 1993 and 2006 (Mitrovich and Hamilton 2007). While much of this decrease is due to the Laguna Fire, there has also been a substantial decrease in Cactus Wren abundance in unburned patches of cactus scrub. Annual surveys conducted from 1999 to 2004 documented larger proportional reductions in Cactus Wren populations in the Coastal Reserve than in the ~20,000 acre Central Reserve (Hamilton 2004). Unfortunately, in fall 2007, the Santiago Fire burned 75% of the Central Reserve,

severely burning 1,059 (75%) of mapped cactus scrub (Leatherman BioConsulting 2009). Approximately 684 acres were considered potentially suitable for occupancy by Cactus Wrens and were surveyed. It was estimated that 67 territories remain in unburned and lightly burned cactus scrub, representing an 82% decline in Central Reserve territories based on 2004 estimates.

### *Reproductive Biology*

Cactus Wren populations in apparently suitable, unburned cactus scrub could be declining due to decreases in annual productivity, reduced survivorship, and increasing isolation of populations resulting in lack of colonization following local extinction.

Most information on Cactus Wren reproduction comes from studies on desert populations. Cactus Wrens tend to have a fairly long nesting cycle relative to other North American passerines (Clark and Martin 2007). The period from nest building to fledging can extend 42-55 days with another 17-25 days of post-fledging dependence on parents (Proudfoot et al. 2000). Cactus Wren have been documented producing three broods in a breeding season, although most wrens produce only one or two broods with three young per brood. Occasionally, juveniles overwinter in the natal territory until they are chased out by their parents at the beginning of the next breeding season. Cactus Wrens are sedentary, with juveniles dispersing short distances to find an available territory and mate. One study found juvenile males stayed near their natal territory while females moved farther to find mates, up to 420 m (Anderson and Anderson 1973). Studies of populations in coastal southern California have also documented short dispersal distances, although only a small proportion of banded juveniles were observed after dispersing and establishing territories (Kamada 2008 and references therein). As habitat patches become smaller and more isolated, it may be increasingly difficult for juveniles to successfully disperse and establish into a breeding population (Solek and Szijj 2004; Mitrovich and Hamilton 2007; Kamada 2008). Smaller, isolated habitat fragments may support smaller populations with increasing chance of local extinction and reduced probability of recolonization.

Food limitation and nest predation have long been considered the most important factors regulating avian productivity (e.g., Lack 1954; Martin 1987; Newton 1998). In arid and semi-arid ecosystems, such as in southern California, the timing and amount of annual rainfall influences reproductive output in birds (e.g., DeSante and Geupel 1987; Grant et al. 2000; Morrison and Bolger 2002). Rainfall in arid systems is positively correlated with available food for nesting birds. Extreme drought in southern California during 2002 led to reproductive failure of birds inhabiting coastal sage scrub and chaparral habitats and was linked to severe food limitation (Bolger et al. 2005; Preston and Rotenberry 2006a). Surveys of Cactus Wren in Orange County documented an estimated 30% decrease in numbers from 2002 to 2003, presumably due to lack of reproduction in 2002 (Hamilton 2003). Over the last decade, there have been multiple years of lower than average rainfall in southern California, with a second exceptional drought year in 2007. A study of Cactus Wren in Orange County during 2007 also found low productivity among sampled pairs (Kamada 2008). It is likely low productivity during these drought periods has contributed to the decline of Cactus Wrens. An experimental

study of a desert population of Cactus Wrens demonstrated that annual productivity was influenced by food availability during the nestling stage (Simons and Martin 1990). Food-supplemented pairs had a greater number of second broods over the two year study and higher nestling survival in one year. There are also reports of nestling starvation in another desert population (Marr and Raitt 1983). This study found that Cactus Wrens initiated nests when temperatures were high and predicted favorable temperatures and food conditions during the nestling stage. In one year, unusually cold temperatures at night resulted in most pairs abandoning nests with eggs and reduced hatching success and starvation of broods in the remaining nests.

The role of nest predation in limiting Cactus Wren productivity is unknown. Nest predation is the major cause of nest failure in passerines (Ricklefs 1969; Martin 1993). As protection against predation, Cactus Wrens build domed nests in spiny cholla and prickly pear cactus, making the nests inaccessible to many predators (Proudfoot et al. 2000). However, some avian species and snakes can still access and depredate nests. Documented nest predators include several snake species and Greater Roadrunners (*Geococcyx californianus*). Cactus Wren pairs have been observed defending nests against ground squirrels, Loggerhead Shrikes (*Lanius ludovicianus*), Western Scrub-Jays (*Aphelocoma californica*), and Northern Mockingbirds (*Mimus polyglottus*), indicating a wider range of potential nest predators (Anderson and Anderson 1963a; Proudfoot et al. 2000; Solek and Szijj 2004). In desert populations, Curve-billed Thrasher (*Toxostoma curvirostre*) often destroys wren nests, although this destruction is attributed to competition for nest sites rather than for consumption of nest contents.

Food limitation and nest predation may both be important factors regulating Cactus Wren annual productivity. While there is evidence that food limitation contributes to reduced fecundity, this doesn't rule out simultaneous effects of nest predation. For example, during the extreme 2002 southern California drought it was expected that food limitation was the primary factor limiting reproduction in songbirds (Bolger et al. 2005). However, an experimental study manipulating food and nest predation found both factors had equal and independent effects on annual fecundity of a chaparral songbird in the region (Preston and Rotenberry 2006a,b).

#### *Annual Survival*

A study of a banded desert population of Cactus Wrens documented males living an average of 2 years and females 1.4 years (Anderson and Anderson 1963b). These averages may be rather low, as the wrens were of unknown age when banded and were in an urban edge environment with high mortality from domestic cat predation. Based on Bird Banding Lab records, the oldest known banded individual was 6 years and 4 months (Gustafson and Hildenbrand 1998). One study showed survival of fledglings 3-40 days out of the nest was equivalent to less than 50% survival over a year, with survivorship increasing with age (Ricklefs and Hainsworth 1968). Causes of mortality include predation of juveniles and adults by Cooper's Hawk (*Accipiter cooperii*) and domestic cats (*Felis domesticus*).

### *Disease*

A potential emerging threat to Cactus Wren survival could be West Nile Virus. West Nile Virus was first introduced from Africa into the United States in New York City in 1999. This virus is transmitted by mosquitoes, infects wild birds, and can cause substantial mortality. It was first detected in bird populations in southern California during 2003 ([http://diseasemaps.usgs.gov/2003/us\\_bird.html](http://diseasemaps.usgs.gov/2003/us_bird.html)). West Nile Virus has spread throughout the region and the number of dead birds testing positive for the virus have increased, with record numbers recorded this year in Orange and San Diego Counties (<http://www.sdcounty.ca.gov/pests/>; <http://www.ocvcd.org/wnv1.php>). It is unknown whether West Nile Virus is adversely affecting Cactus Wren populations in southern California. Cactus Wrens have tested positive for West Nile Virus in the United States, although there is no information regarding the location or number of individuals affected ([http://www.nwhc.usgs.gov/disease\\_information/west\\_nile\\_virus/index.jsp](http://www.nwhc.usgs.gov/disease_information/west_nile_virus/index.jsp)).

## **Methodology**

### *Study Sites*

We selected seven Cactus Wren monitoring sites in NROC's Coastal and Central Reserves. The sites were selected to represent a range in population abundance and degree of isolation from other populations. Sites ranged from one pair to 13 pairs. We intended to sample at least 24 pairs evenly divided between the Coastal and Central Reserves. Study sites included the University of California Irvine (UCI) Ecological Reserve, Upper Newport Bay, Aliso/Wood Canyon, James Dilley Preserve (Sycamore Hills), Crystal Cove State Park, Southern California Edison-Viejo Conservation Easement near Aliso Creek, and El Modena Open Space Preserve.

### *Monitoring Reproductive Behavior*

We attempted to observe each pair for 30-60 minutes at least once a week from early March through the end of July to gather data on reproductive success and productivity. We relied on observations by NROC staff and volunteers to track reproductive behavior and identify nesting stages based on behavioral cues. This allowed us to reduce visits to the nest to check nesting status and which allowed us to reduce disturbance of the nest (e.g., Powell and Collier 1998; Martin and Morrison 1999). Cactus Wrens have relatively easy-to-find nests that can usually be watched from a distance. We supplemented these observations with nest checks conducted as necessary by Dana Kamada and Karly Moore, who possessed the appropriate permits to conduct nest checks. Nest checks were done only as necessary to determine the appropriate time to band nestlings, ideally around 8-9 days of age. Information gathered during nest checks also allowed us to more closely follow the reproductive status of each pair.

During our behavior observations we recorded behaviors such as nest building, nest defense, courtship and copulation, female visits to the nest to incubate and brood, male and female trips to the nest with food, removal of fecal sacs, and care of young once they fledged. Cactus Wren make a variety of vocalizations, some of which could be used as clues of reproductive status. A study of a desert population of Cactus Wren

found that females incubated 7-15 minutes and were off the nest 12-20 minutes to forage (Anderson and Anderson 1960). Males made an average of 4.3 visits/hour to the nest to feed nestlings, while females made an average of 7.3 visits/hour. Since Cactus Wren nests are fairly easy to find, we can focus our attention on suspected nests and should be able to observe behaviors indicative of nesting stage during the 30-60 minutes of observation each week.

We confirmed reproductive success by searching for and counting the number of fledglings observed during periodic visits in the post-fledging period. By monitoring reproductive behavior throughout the breeding season, we were able to record the number of broods, number of young fledged, and number of failed nesting attempts. For unsuccessful pairs, we attempted to identify the stage at which reproduction failed in most cases. We expected that there would be some nests failing during egg laying/early incubation or late incubation/early nestling period where we would be unable to determine the stage of nest failure.

Nest monitoring data is important to assessing whether productivity was a factor limiting Cactus Wren populations in 2009. We hypothesized that Cactus Wren pairs facing food limitation would delay initiating clutches, abandon nests with eggs or young, fail to renest following nest failure, and if successful, have small broods. Pairs facing high nest predation risk, but which aren't limited by food, could exhibit multiple renesting attempts, and when successful, have relatively large broods. It may not be possible to distinguish between pairs affected by both food limitation and nest predation and those pairs whose productivity is limited solely by food availability.

In addition to observing Cactus Wren reproductive behavior, we mapped the locations and color band combinations of Cactus Wren when first detected and at 10 minute intervals throughout behavioral observations. We recorded the location of intraspecific territorial disputes. We mapped potential nest predators at the location where first detected and noted if they come close to the nest. We also mapped locations of potential predators of adults and fledglings/juveniles. Potential predators include Cooper's Hawk, Western Scrub-Jay, California Thrasher (*Toxostoma redivivum*), Loggerhead Shrike, and Greater Roadrunner. We also noted snakes and potential mammal predators such as coyotes (*Canis latrans*), bobcats (*Lynx rufus*) and domestic cats. We recorded the response of the Cactus Wren to potential predators, particularly near the nest. This type of information can be used to assess whether predation may be an important factor in Cactus Wren reproduction and survival.

#### *Banding and Collection of Genetic Material*

We planned to capture and color band adults beginning in February and continuing through December. At the time of banding, we planned to collect feather and/or blood samples. During the breeding season, we planned to band nestlings and/or fledglings. The stage at which we banded depends accessibility of the nest and on how accurately we can age the nestlings from observations of reproductive behavior and nest checks.

### *Monitoring Dispersal and Annual Survival*

After banding fledglings, we planned to visit each territory every week or two during the breeding season to determine if fledglings remained in the natal territory. During the non-breeding season we planned to survey surrounding areas to see if we could determine where juveniles were dispersing to and where they would be establishing territories. Resighting banded Cactus Wren juveniles has been demonstrated to be relatively difficult in previous studies in Orange County and on the Palos Verdes Peninsula, Los Angeles County (Kamada 2008 and references therein), thus we anticipated that our dispersal sample sizes will be relatively small during this pilot study. We also monitored adults throughout the breeding season to begin compiling data on annual survival.

We planned to collect blood samples to provide to Orange County Vector Control to test for West Nile Virus. The unused portions of each blood sample could be used to analyze genetic relationships within NROC populations and relatedness to other Cactus Wren populations. We anticipated that the San Diego Zoological Society's Center for Research on Endangered Species would be able to store and eventually analyze all blood and feather samples we provided.

## **Results**

### *Field Effort*

We were able to monitor 34 territories at five sites in the Coastal and Central Reserves (Figures 1-6). Appendix Table 1 provides details on dates of field work, the names of field personnel conducting various monitoring activities and the reproductive status of birds at each site. Teams visited sites on 103 days during the breeding season (February 1 to July 31) to monitor Cactus Wrens. Generally one to three people conducted each site visit and sometimes teams would visit more than one site during a field day. We also spent 19 days surveying areas outside of the Monitoring Sites (Appendix Table 2). We had intended to include two additional sites, James Dilley Reserve and Aliso/Wood Canyons Wilderness Park, in our monitoring. Unfortunately, we were unable to find any Cactus Wrens at James Dilley and two pairs found at Aliso/Wood Canyons were not detected until late in the breeding season.

### *Color Banding and Collecting Feather/Blood Samples*

A total of 143 Cactus Wren were banded with unique color bands. Of these birds, 93 (65%) were nestlings, fledglings or juveniles born in 2009. Equal numbers of adults captured were females (24 individuals) compared to males (23 individuals). We collected feather samples from 62 of the banded birds. We did not collect feather samples from young nestlings that were just molting in their feathers. We had planned to collect blood samples to test for West Nile Virus and to use for future genetic analysis. However, after discussions with disease experts and veterinarians at the San Diego Zoological Society's Institute for Conservation Biology (formerly Center for Research on Endangered Species), we felt the risks of obtaining large enough samples

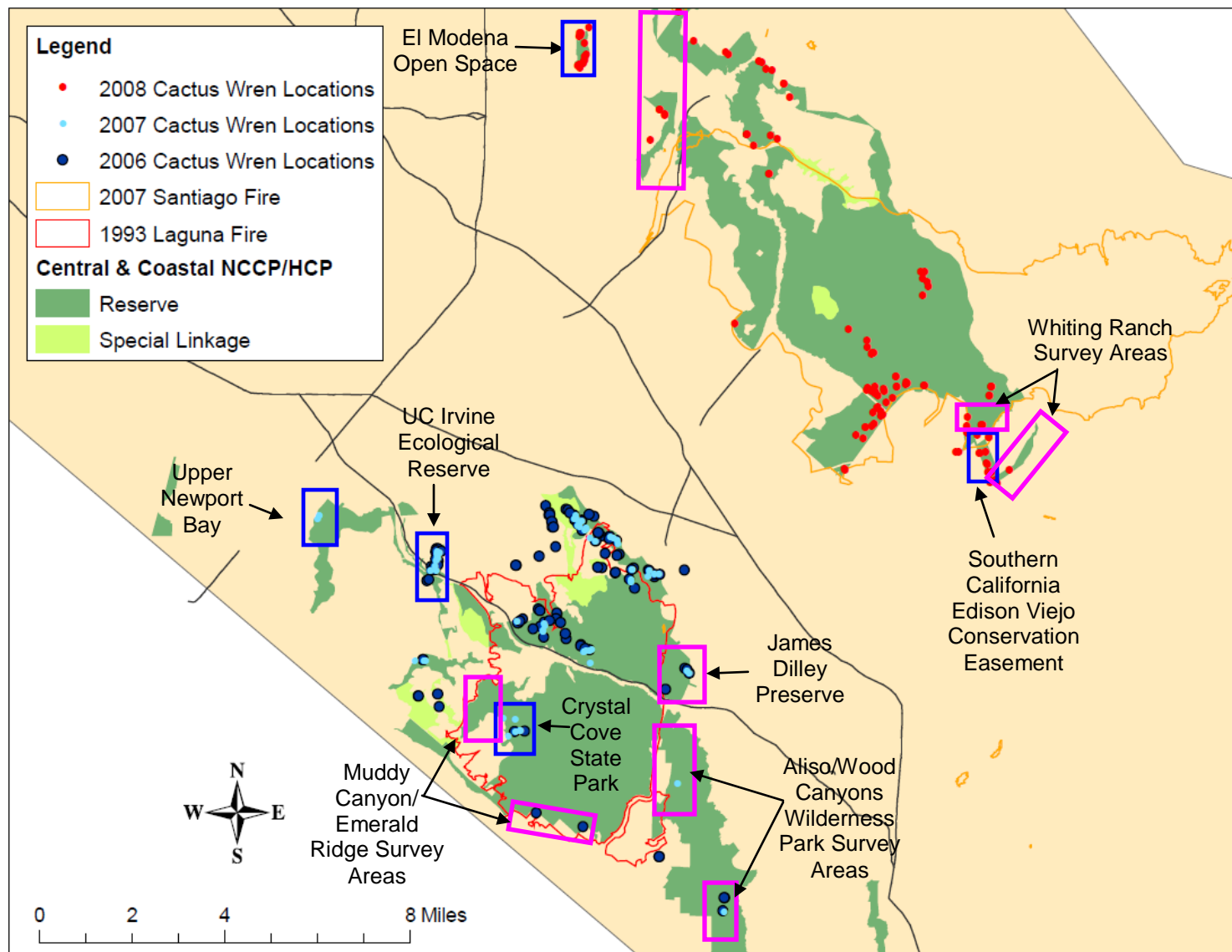
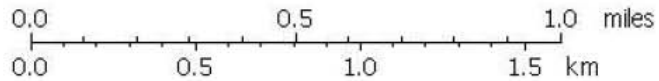
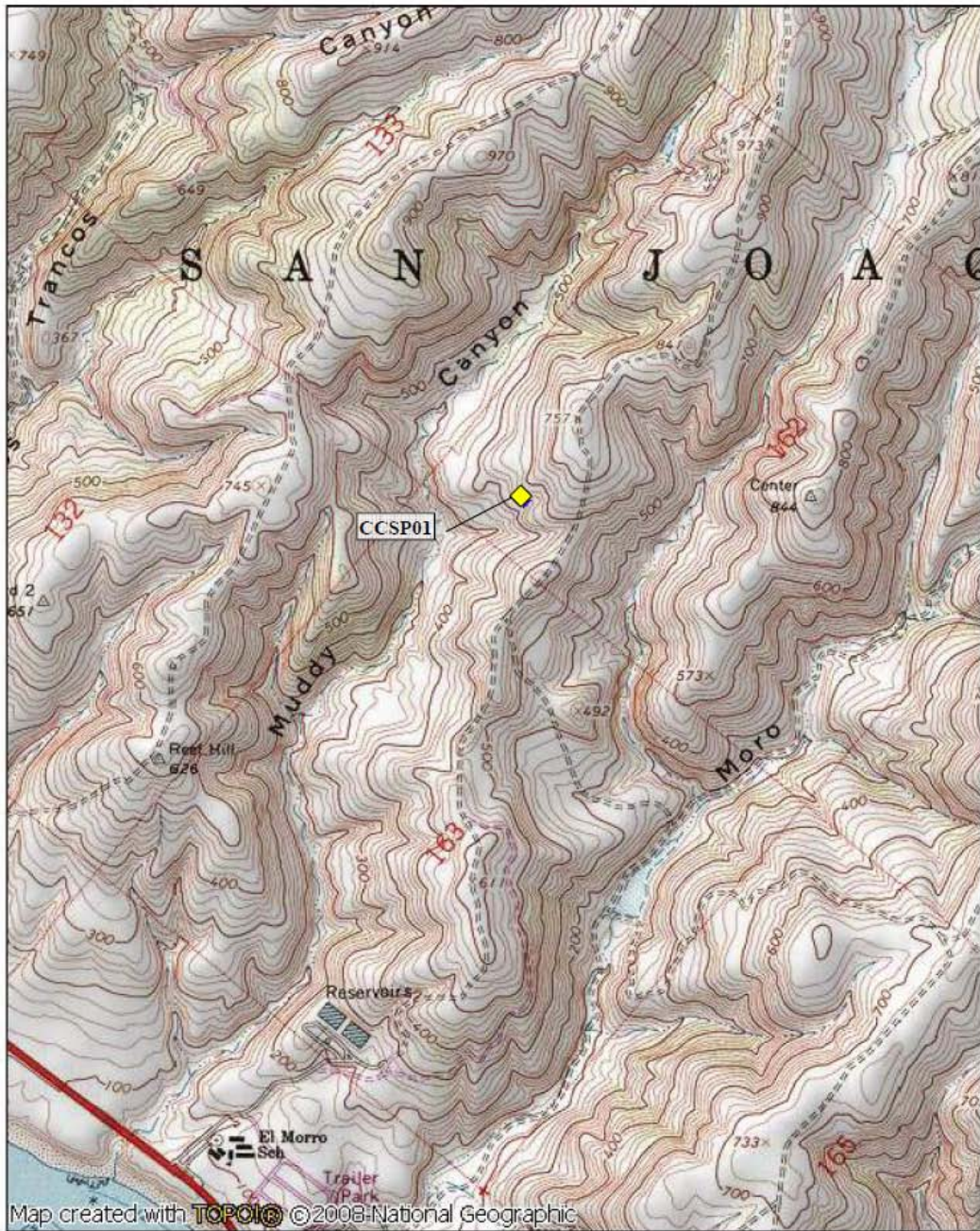


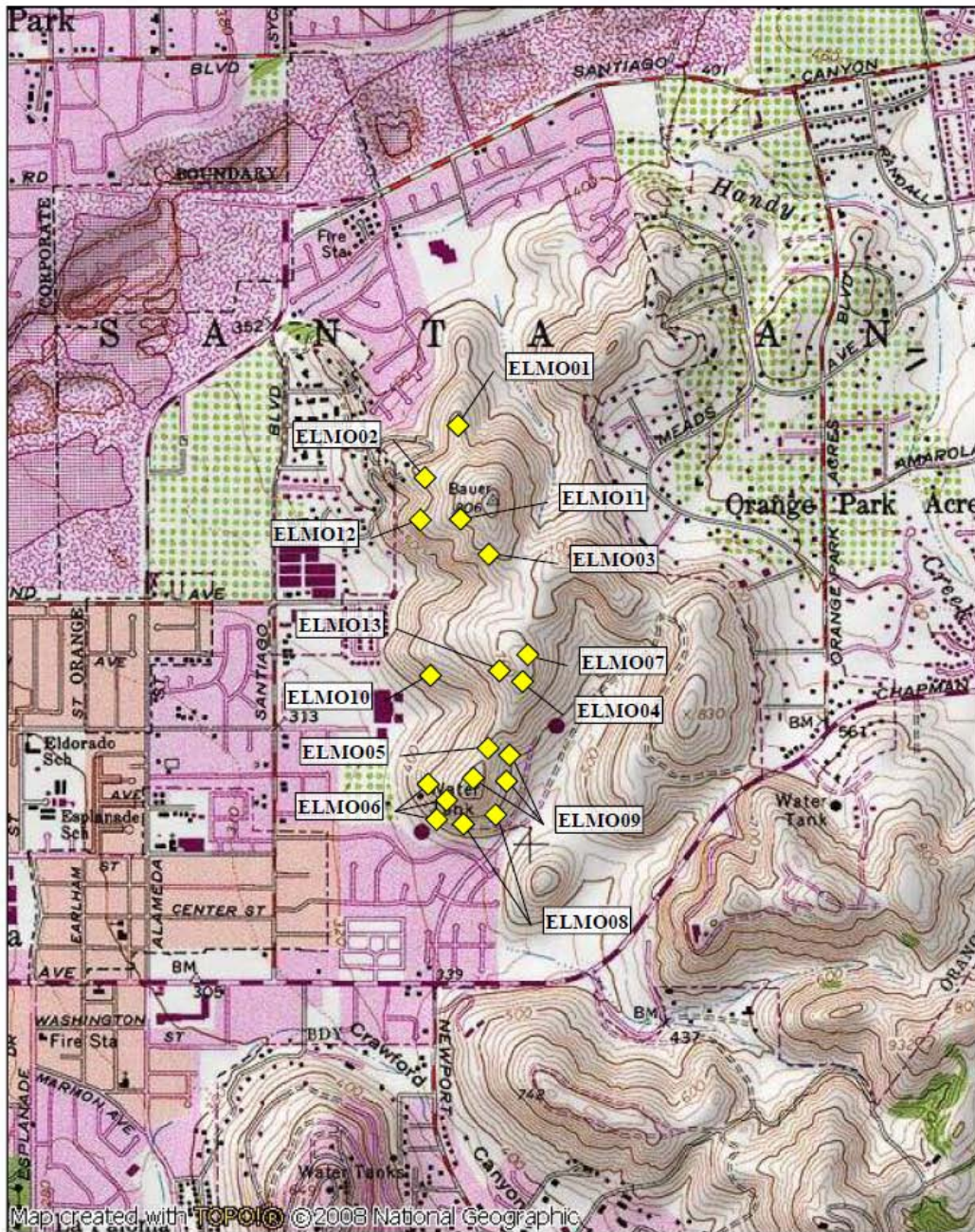
Figure 1. Cactus Wrens locations, monitoring sites (blue boxes), and survey areas (pink boxes) on NCCP/HCP lands in the Nature Reserve of Orange County's 2009 Cactus Wren Monitoring Study.



TN \* MN  
12 1/2  
11/29/09

Crystal Cove State Park: 2009 cactus wren territories. Laguna Beach 7.5' quadrangle; T7S, R9W, Sec. 9; 2 Adults, <=4 Juvs. & 2 Nests detected; Coast prickly-pear series; Field visits occurred 10 Mar. to 5 Aug. 2009.

Figure 2. Cactus Wren nests at the Crystal Cove State Park Monitoring Site.

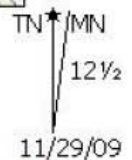
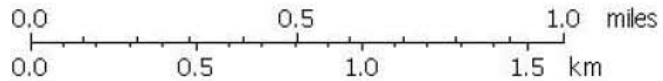
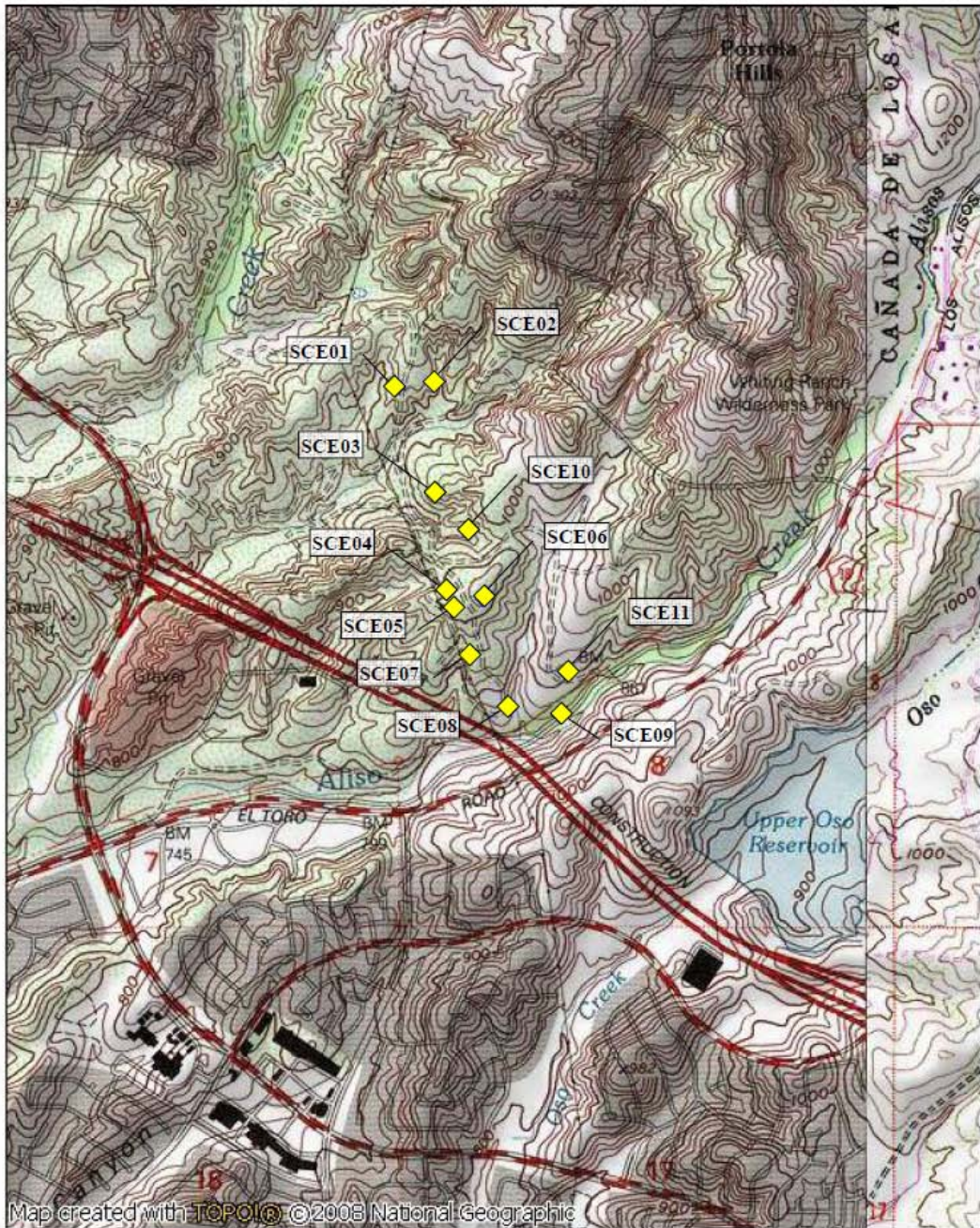


0.0 0.5 1.0 miles  
0.0 0.5 1.0 1.5 km

TN MN  
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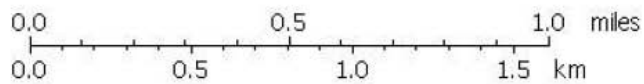
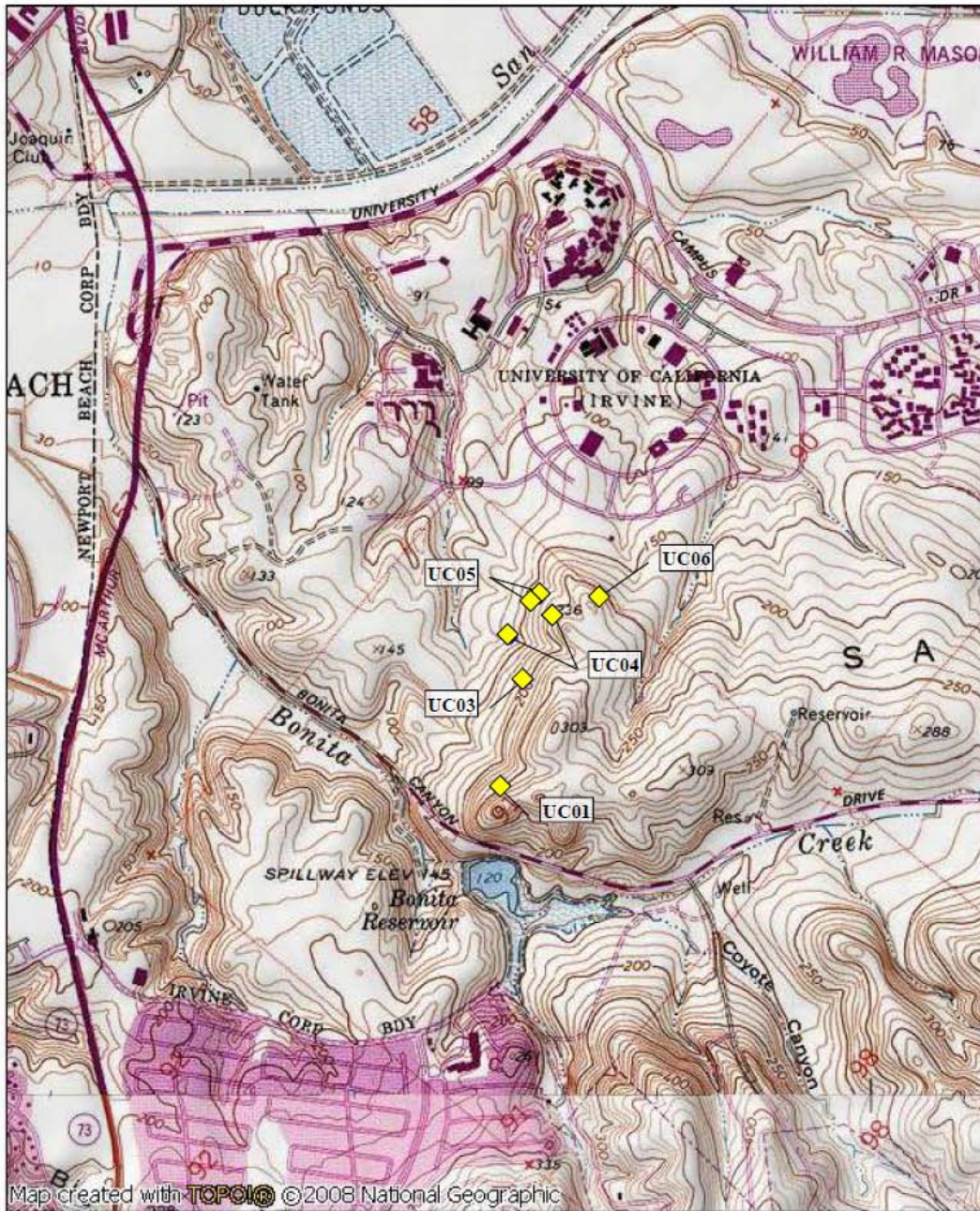
El Modena: 2009 cactus wren territories. Orange 7.5' quadrangle; T4S, R9W, Sec. 23/26; 26 Adults, 25 Juvs. & 19 Nests detected; Coast prickly-pear series; Field visits occurred 3 Mar. to 20 Jul. 2009.

Figure 3. Cactus Wren nests at the El Modena Open Space Preserve Monitoring Site.



Whiting Ranch/So. Calif. Edison: 2009 cactus wren territories. El Toro 7.5' quadrangle; T6S, R7W, Sec. 5/8; 21 Adults, 39 Juvs. & 13 Nests detected; Coast prickly-pear series; Field visits occurred 4 Mar. to 31 Jul. 2009.

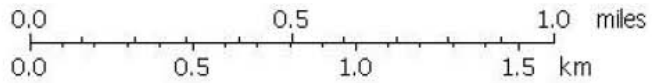
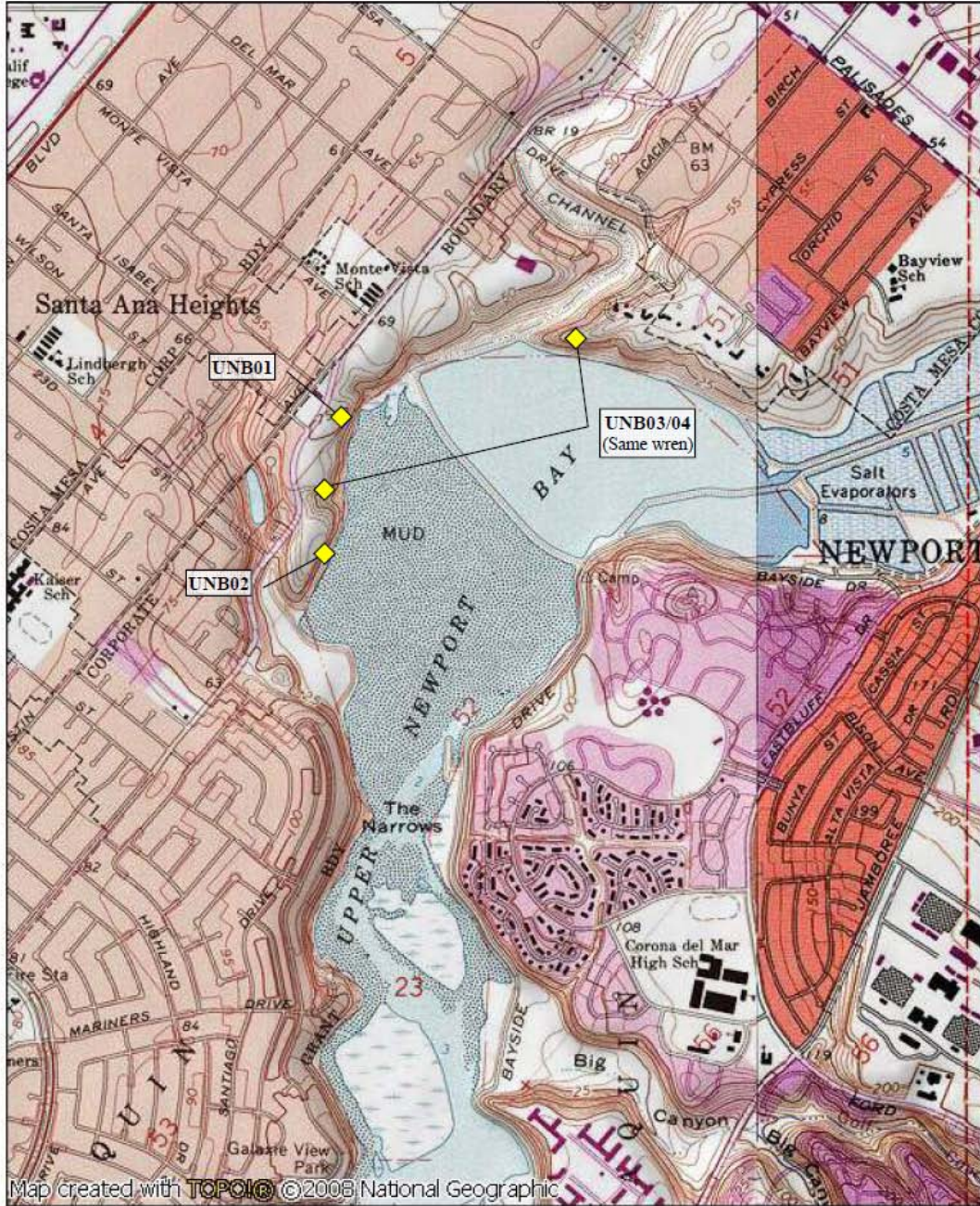
Figure 4. Cactus Wren nests at the Southern California Edison-Viejo Monitoring Site.



TN\* / MN  
12 1/2  
11/29/09

UC Irvine Site: 2009 cactus wren territories. Tustin 7.5' quadrangle; T6S, R9W, Sec. 17 & 20; 10 Adults, >=17 Juvs., & 8 Nests detected; patches of Coast prickly-pear series or cactus scrub within coastal sage scrub and grassland; Field visits occurred 19 Feb. to 30 Jul. 2009.

Figure 5. Cactus Wren nests at the UC Irvine Ecological Reserve Monitoring Site.



TN MN  
12 1/2  
11/29/09

Upper Newport Bay: 2009 cactus wren territories. Newport Beach 7.5' quadrangle; T6S, R10W, Sec. 14; 5 Adults, 7 Juvs. & 3 Nests detected; Coast prickly-pear series; Field visits occurred 5 Mar. to 6 Jul. 2009.

Figure 6. Cactus Wren nests at the Upper Newport Bay Monitoring Site.

for testing for the virus were too high. We also discovered that interpreting results of blood testing is problematic and that the most definitive method for determining if West Nile Virus is affecting the population is to collect and test dead Cactus Wrens.

### *Reproduction*

Annual productivity was fairly high in 2009, compared with 2007 which was an extreme drought year with few nesting attempts (Kamada 2008). A total of 25 pairs (73.5%) successfully produced fledglings. Four pairs (11.8%) attempted breeding and after losing two or more nests to predation failed to produce fledglings. Three pairs (8.8%) failed to breed successfully because one or both members of the pair disappeared and were not replaced by other individuals. In a fourth case, the unbanded pair disappeared following a nest failure but an unbanded pair with fledglings used the same territory later in the breeding season. We assumed this was the same pair and that we lost track of the pair after the first nest failure. One male (2.9%) at Upper Newport Bay remained single throughout the breeding season and another pair (2.9%) appeared not to nest despite building a couple of potential breeding nests. At least 80 fledglings were produced at the five sites with an average of 2.4 fledglings/territory or 3.2 fledglings/successful pair.

We observed some interested breeding interactions. One pair at El Modena that paired later in the season and could potentially have been SY birds (SCE09) attempted to nest within another pair's territory. The intruding pair had their nest destroyed by the resident pair. They constructed two more breeding nests, one of which was depredated at the egg stage after the female displayed rather negligent incubation behavior. The third nest failed after the male disappeared, it was undetermined whether eggs had been laid at this nest. There was a case of serial polyandry in which a female at the Southern California Edison site (SCE05) successfully produced one brood of young and then began nest building in an adjacent territory belonging to a single male. The female paired with this second male within two weeks, leaving her first mate to care for the first brood. She then produced a second brood with the neighboring male. In a similar case of potential serial polygyny, a nesting female at Crystal Cove State Park (CCSP01) disappeared with her nestlings prior to the expected fledging date. It was unclear whether the nest failed or the young fledged early and were moved down into a nearby drainage and cared for by the female. Two unbanded juveniles were observed interacting with the male later in the season and a partial band combination matched that of the missing female. An unbanded female quickly paired with the male and produced a brood of young in the same nest cactus as the first female.

Cactus Wrens build multiple nests including multiple potential breeding nests and roost nests for individuals to sleep in during the night. We did not include roost nests or potential breeding nests for which there was no evidence of egg laying in our analysis of nesting activity. Of the 41 breeding nests with known fates, 30 (73.2%) produced fledglings. Nine nests (22.0%) were depredated, one nest destroyed by other wrens (2.4%), and one nest was abandoned (2.4%) after the adults disappeared and were presumed to be dead. Nests were equally depredated at the egg stage (5 nests) and nestling stage (4 nests). Based on observations of Cactus Wren nest defense and the

presence and behavior of suspected nest predators, we suspect that nest predators include Western Scrub-Jay, Greater Roadrunner and snakes. There were also observations of Common Ravens dive-bombing nests. Nest predation was highest at the El Modena Open Space Preserve with 5 of 13 (38.5%) nest attempts failing due to nest predation.

### *Survival*

A total of nine adults disappeared during the 2009 breeding season. The ELMO04 pair is likely to have died as their nest with nestlings was abandoned in late April and the unbanded male and banded female were not seen again (Table 1). Similarly, the UNB02 female and ELMO09 male both disappeared in the midst of the breeding season and were presumed to have died. The unbanded ELMO07 pair disappeared after their nest was depredated at about the same time as the adjacent ELMO04 pair disappeared. However, an unbanded pair with fledglings showed up later in ELMO07's territory and was presumed to be the same pair. It is thought they nested the second time on a steep inaccessible slope out of view of observers. It is unclear whether the first female in the CCSP01 pair actually died or just moved into another area with her young (see section above). Similarly, the female of an unbanded pair at UCI Ecological Reserve (UC02) disappeared at the beginning of the breeding season but may have moved to another territory and paired with the single male (UC06). It is unclear what happened to her first mate, he was not seen again at the site and is likely to have died.

Cooper's Hawks were observed hunting for adult, fledgling, and juvenile Cactus Wrens, especially at El Modena Open Space Reserve and Upper Newport Bay. At both sites, Cooper's Hawks nested adjacent to Cactus Wren territories and were regularly observed foraging in the cactus scrub. Cooper's Hawks appeared to focus their hunting attempts on Mourning Doves (*Zenaida macroura*) and Cactus Wrens, two of the larger passerine species at these sites. We observed hawks hunt for wrens by flying low over the cactus scrub in an attempt to flush and capture individuals, particularly fledglings in family groups. At each of these sites, we lost adults during the breeding season and hypothesized this could be due to predation by Cooper's Hawks.

Five nestlings were collected from depredated/abandoned nests in 2009 and are being submitted to the San Diego Zoological Society's Institute for Conservation Biology. It is intended that their remains could be used for future genetic analysis.

### *Dispersal*

We have begun to document dispersal movements of banded juvenile Cactus Wrens. A juvenile fledged at UC05 on May 5<sup>th</sup> was observed over a mile away on July 16, having crossed the eight lane Highway 73 toll road. We also observed wrens regularly crossing four lane Cannon Road adjacent to the El Modena Open Space Reserve. In both cases, these road crossings were from slopes high above the road that afforded a clear view of the other side of the road and allowed birds to cross above traffic. We started to see juveniles wander and make movements out of their natal territories in early June (Appendix Table 1). Some juveniles also remained in or near their natal territories as late as early December.

**Future Work**

We are continuing this project for two more years to gather information that will help us determine future management actions to assist in recovery of populations in the Coastal and Central Reserves. We will be expanding to new sites in an attempt to monitor all pairs in the Coastal Reserve. We are interested in investigating annual variation in productivity and survival. We will be expanding surveys beyond the Monitoring Sites into eleven Survey Areas to document juvenile dispersal and recruitment into breeding populations. We will use nest cameras in a subset of nests to identify nest predators. Next year, we also intend to collect small samples of blood in addition to the feather samples for genetic analysis by the San Diego Zoological Society's Institute for Conservation Biology. We are also conducting measurements of vegetation at Cactus Wren nests and territories to better understand characteristics of vegetation composition and structure associated with wren occupancy.

#### 4.0 References

- Anderson, A.A. and A. Anderson. 1963a. Life history of the Cactus Wren. Pt. III: the nesting cycle. *Condor* 62:351-369.
- Anderson, A.A. and A. Anderson. 1963b. Life history of the Cactus Wren. Pt. VI: competition and survival. *Condor* 65:29-43.
- Anderson, A.A. and A. Anderson. 1973. *The Cactus Wren*. University of Arizona Press.
- Atwood, J.L. and S.B. Lerman. 2007. Geographic variation in Cactus Wren songs. *Western Birds* 38:29-46.
- Bolger, D.T., M.A. Patten, and D.C. Bostock. 2005. Avian reproductive failure in response to an extreme climatic event. *Oecologia* 142:398-406.
- Bontrager, D.R., R.A. Erickson, and R.A. Hamilton. 1995. Impacts of the October 1993 Laguna Canyon fire on California Gnatcatchers and Cactus Wrens. Pp. 69-76 in *Brushfires in California wildlands: ecology and resource management* (J.E. Keeley and T. Scott, eds.). International Association of Wildland Fire, Fairfield, WA.
- Clark, M.E. and T.E. Martin. 2007. Modeling tradeoffs in avian life history traits and consequences for population growth. *Ecological Modelling* 209:110-120.
- County of Orange. 2003. *Natural Community Conservation Plan & Habitat Conservation Plan, County of Orange, Central & Coastal Subregion, Parts I & II: NCCP/HCP*. Prepared for County of Orange Environmental Management Agency by R.J. Meaded Consulting, Inc., July 17, 1996.
- DeSante, D.F. and G.R. Geupel. 1987. Landbird productivity in central coastal California: the relationship to annual rainfall and a reproductive failure in 1986. *Condor* 89:636-653.
- Grant, P.R., B.R. Grant, L.F. Keller, and K. Petren. 2000. Effects of El Nino events on Darwin's finch productivity. *Ecology* 81:2422-2457.
- Gustafson, M.E. and J. Hildenbrand. 1998. Bird Banding Laboratory Homepage. U.S.G.S. Patuxent Wildlife Research Center, Laurel, MD.
- Hamilton, R.A. 2003. *Target bird monitoring study: Nature reserve of Orange County, 2003*. Prepared for the Nature Reserve of Orange County, December 2, 2003. 53 pp + Appendices.
- Hamilton, R.A. 2004. *Target bird monitoring study: Nature Reserve of Orange County, 2004*. Prepared for the Nature Reserve of Orange County, November 3, 2004. 62 pp. + Appendices.

Kamada, D. 2008. *Final Report: Cactus Wren (Campylorhynchus brunneicapillus) 2007 Telemetry Study and the 2007 Monitoring Results of the 2006 Cactus Wren Translocation Study in Orange County, California*. Report prepared for the California Department of Fish and Game and the Nature Reserve of Orange County. February.

Lack, D. 1954. *The Natural Regulation of Animal Numbers*. Oxford University Press, Oxford, U.K.

Leatherman Bioconsulting. 2009. *Central Reserve Cactus Wren Habitat Assessment and Survey, 2008*. Report prepared for the Nature Reserve of Orange County. February. 27 pp.

Martin, J.A. and M.L. Morrison. 1999. Distribution, abundance, and habitat characteristics of the Buff-breasted Flycatcher in Arizona. *Condor* 101:272-281.

Martin, T.E. 1987. Food as a limiting factor on breeding birds: a life history perspective. *Annual Review of Ecology and Systematics* 18:453-487.

Martin, T.E. 1993. Nest predation among vegetation layers and habitat types: revising the dogmas. *American Naturalist* 141:897-913.

Marr, T.G. and R.J. Raitt. 1983. Annual variations in patterns of reproduction of the Cactus Wren (*Campylorhynchus brunneicapillus*). *Southwestern Naturalist* 28:149-156.

Mitrovich, M.J. and R.A. Hamilton. 2007. *Status of the Cactus Wren (Campylorhynchus brunneicapillus) within the Coastal Subregion of Orange County, California*. Report prepared for the Nature Reserve of Orange County, May 2007. 18 pp.

Morrison, S.A. and D.T. Bolger. 2002. Variation in a sparrow's reproductive success with rainfall: food and predator-mediated processes. *Oecologia* 133:315-324.

Newton, I. 1998. *Population Limitation in Birds*. Academic Press, San Diego, California, USA.

Newton, I. 1998. *Population Limitation in Birds*. Academic Press, San Diego, California, USA.

Powell, A.N. and C.L. Collier. 1998. Reproductive success of Belding's Savannah Sparrows in a highly fragmented landscape. *Auk* 115:508-513.

Preston, K.L. and J.T. Rotenberry. 2006a. Independent effects of food and predator-mediated processes on annual fecundity in a songbird. *Ecology* 87:160-168.

Preston, K.L. and J.T. Rotenberry. 2006b. The role of food, nest predation, and climate in timing of Wrentit reproductive activities. *Condor* 108:832-841.

Proudfoot, G.A., D.A. Sherry, and S. Johnson. 2000. Cactus Wren (*Campylorhynchus brunneicapillus*). In *the Birds of North America, No. 558* (A. Poole and G. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Rea, A.M. and K.L. Weaver. 1990. The taxonomy, distribution, and status of coastal California Cactus Wrens. *Western Birds* 21:81-126.

Ricklefs, R.E. 1969. An analysis of nesting mortality in birds. *Smithsonian Contributions to Zoology* 9:1-48.

Ricklefs, R.E. and F.R. Hainsworth. 1968. Temperature regulation in nestling Cactus Wrens: development of homeothermy. *Condor* 70:121-127.

Sauer, J.R., J.E. Hines, I. Thomas, J. Fallon, and G. Gough. 1999. *The North American Breeding Bird Survey, results and analysis 1966-1998*. Version 98.1, U.S. Geol. Surv. Patuxent Wildl. Res. Center, Laurel, MD.

Simons, L.S., and T.E. Martin. 1990. Food limitation of avian reproduction: an experiment with the Cactus Wren. *Ecology* 71:869-876.

Solek, C. and L. Szijj. 2004. Cactus Wren (*Campylorhynchus brunneicapillus*). In *The Coastal Scrub and Chaparral Bird Conservation Plan: a strategy for protecting and managing coastal sage scrub and chaparral habitats and associated birds in California*. California Partners in Flight. <http://www.prbo.org/calpif/html/docs/scrub.html>.

Unitt, P. 2008. San Diego Cactus Wren. In *California Bird Species of Special Concern: A Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Immediate Conservation Concern in California*. W.D. Shuford and T. Gardali, Editors. Studies of Western Birds No. 1. Published by Western Field Ornithologists and California Department of Fish and Game.

Vickery, P.D., M.L. Hunter, Jr., and J.V. Wells. 1992. Use of a new reproductive index to evaluate relationship between habitat quality and breeding success. *Auk* 109:697-705.

Zink, R.M. 2004. The role of subspecies in obscuring avian biological diversity and misleading conservation policy. *Proceedings Royal Society London B* 271:561-564.

Appendix Table 1. Dates of field work, names of field personnel, type of field work conducted, and breeding status of Cactus Wrens at Nature Reserve of Orange County 2009 Monitoring Sites.

Date	Personnel	Crystal Cove State Park (CCSP) 1 Territory	El Modena (ELMO) 13 Territories	SCE- Viejo Conservation Easement (SCE) 11 Territories	UC Irvine Ecological Reserve (UC) 5 Territories	Upper Newport Bay (UNB) 3 Territories
2/19/2009	DK				SV, NA, NB	
2/20/2009	DK, KM				SV, BU, NA, NB	
2/21/2009	DK				BA	
2/25/2009	KP, DP, MC, DH, SM, EB	O, NA				
2/28/2009	DK				BA	
3/2/2009	KP, EB, SM				O, NA, NB	
3/3/2009	KP		S, O, NA, E?			
3/5/2009	KP, KY					S, O, NA, NB
3/9/2009	KP		S, O, NB			
3/10/2009	DK		BA			
3/10/2009	KP, DP, MC, DH, STM	O, NA				
3/11/2009	EB, SM				O, NA	
3/12/2009	DK, KM, KP		BA, E?			
3/16/2009	DK		BA, E?			
3/17/2009	DK, KM, KP		BA, O, NB, E?			
3/20/2009	DK					SV, O, NA, E?
3/23/2009	DK					BA, NA, E?
3/24/2009	KP, TS		S, NA			
3/26/2009	KP		S, O, NB, E			
3/27/2009	DK	BA, NA				
3/31/2009	DK, KP		O, NB, E			
4/1/2009	DH	O, C?				
4/1/2009	SM, DC				O, E?	
4/2/2009	DK, KP		BA, O, E			
4/3/2009	DK, KM				BN, NA, NB, E, N	
4/3/2009	DK					S, E
4/6/2009	KP, SM				O, N	
4/7/2009	KM		SV, NA, NB			
4/8/2009	DH, MC	O, NA				
4/8/2009	KP		O, E?, N			

Appendix Table 1 continued.

Date	Personnel	Crystal Cove State Park (CCSP) 1 Territory	El Modena (ELMO) 13 Territories	SCE- Viejo Conservation Easement (SCE) 11 Territories	UC Irvine Ecological Reserve (UC) 5 Territories	Upper Newport Bay (UNB) 3 Territories
4/9/2009	DK, KM, KP		O, E, N			
4/9/2009	DK					O, N
4/10/2009	DK				BN, E, N	
4/13/2009	KP				O, NB, E?, N, NP	
4/14/2009	KP		O, NB, E?, N			
4/15/2009	DK		BN, E, N			
4/16/2009	DH, MC	O, NBF				
4/16/2009	KM		BN, NB, N, NP			
4/20/2009	MC	O, NA				
4/21/2009	DK, KM, KP, TS		BN, O, E, N, F			
4/21/2009	DK				S, E, NP	O, NB, F, NP
4/22/2009	KP, MC, STM	O, E?				
4/22/2009	KP, KY					O, NB, F, MA
4/22/2009	SM, DC				O, N	
4/24/2009	DK	S, E				
4/26/2009	DK					S, NB, F
4/26/2009	KM		S, NB, E, F, NAN, MA			
4/27/2009	DK		BA, BFJ, F, NP			BFJ, F
4/28/2009	DK, KM, KP, TS		BN, BU, O, E, N, F			
4/28/2009	DK				S, N	S, NA
4/29/2009	DK, MC	O, E				
4/29/2009	DK, KM		BJF, F			
4/29/2009	SM, EB				O, E, N	
4/30/2009	KM		S, N, F, NP			
5/4/2009	KP			O, E?, N		
5/5/2009	DK			S, N	BN, N, F	S, NB, NA
5/5/2009	KP, TS		O, E?, N, F			
5/6/2009	DK			BN, NB, E, N		
5/6/2009	SM, EB				O, N	
5/9/2009	DK				S, E, N, F	
5/11/2009	DK, KM		S, NB, N, NP	BA, BN, N		S, E, F

Appendix Table 1 continued.

Date	Personnel	Crystal Cove State Park (CCSP) 1 Territory	El Modena (ELMO) 13 Territories	SCE- Viejo Conservation Easement (SCE) 11 Territories	UC Irvine Ecological Reserve (UC) 5 Territories	Upper Newport Bay (UNB) 3 Territories
5/12/2009	MC	O, E				
5/12/2009	DK, KM			BA, BN, N		
5/12/2009	KP		O, NB, N, F			
5/13/2009	DK			BN, N		
5/14/2009	KM		S, NB, N?, F			
5/14/2009	SM				O, NB, N	
5/16/2009	DK				BN, N	
5/18/2009	MC	O, N				
5/18/2009	DK, KP, ST			BN, N, F, NP		
5/19/2009	DK, ST			BA, BN, N		
5/19/2009	KP		O, F			
5/20/2009	DK	S, N			S, N, F	
5/20/2009	DK, KM					S, N, NA
5/21/2009	DK				BN, N	BN, N
5/21/2009	KM		S, NB, N, F			
5/21/2009	KP				O, N, F	
5/22/2009	EB				O, E?	
5/25/2009	DK, KM			BA, BN, NB, N		
5/26/2009	DK, KM		S, F, NP			
5/27/2009	DK, KM		S, F		S, E	
5/27/2009	DK	NP, MA?				
5/27/2009	KP		O, N?, F			
5/28/2009	KM		S, N?, F			
5/28/2009	KP			O, NB, F		
5/29/2009	EB				O, NB	
6/1/2009	DK		S, NP		S, NB, N, F, NP	SV, NBF
6/2/2009	DK, KP		S, O, F, J, JD			
6/3/2009	MC	O, ?				
6/3/2009	DK	S, NB			S, E, F, NP	
6/3/2009	KP, TS			O, F		
6/3/2009	KY					O, N
6/4/2009	DK		BA, NB			
6/4/2009	MC	O, NB				

Appendix Table 1 continued.

Date	Personnel	Crystal Cove State Park (CCSP) 1 Territory	El Modena (ELMO) 13 Territories	SCE- Viejo Conservation Easement (SCE) 11 Territories	UC Irvine Ecological Reserve (UC) 5 Territories	Upper Newport Bay (UNB) 3 Territories
6/4/2009	KY					O, F, NA
6/5/2009	SM, EB				O, NB, F	
6/8/2009	DK, KM, KP				BFJ, E, N, F	
6/8/2009	DK			S, NBF		
6/9/2009	DK		S, NB, E, J, JD			
6/9/2009	KP			O, F, J, JD		
6/9/2009	KM		S, F			
6/10/2009	DK, KM, KP				O, S, E, F	
6/10/2009	DK	S, E				
6/11/2009	SM, EB				O, N, F	
6/12/2009	STM	O, E				
6/15/2009	DK		S, E, F, J, JD			
6/15/2009	KP			S, N, F		
6/16/2009	MC, MG	O, E				
6/16/2009	DK			S, NB, E, F		
6/16/2009	KP		S, NB, F, J, JD			
6/17/2009	DK	S, E				S, F
6/17/2009	DK, KM				S, N, F	
6/19/2009	SM, EB				O, F	
6/22/2009	DK		BN, NB, N, F, J, JD			
6/22/2009	KM		N, NB, F, J, JD, NP			
6/23/2009	DK, KP, DL			O, E, F		
6/23/2009	KM		S, NB, F			
6/24/2009	DK	S, E		S, NB, N, F		S, F, NA
6/24/2009	KM				S, NB, F	
6/25/2009	MC	O, E				
6/25/2009	SM, DC				O, N	
6/25/2009	DK, KM		BA, N, F, J, JD			
6/25/2009	DK			BN, N, F		
6/27/2009	DK		S, NB, J	S, N, F		
6/29/2009	DK		S, NB, N, F, J, JD			
6/29/2009	KP, DL				O, NB, N, F	

Appendix Table 1 continued.

Date	Personnel	Crystal Cove State Park (CCSP) 1 Territory	El Modena (ELMO) 13 Territories	SCE- Viejo Conservation Easement (SCE) 11 Territories	UC Irvine Ecological Reserve (UC) 5 Territories	Upper Newport Bay (UNB) 3 Territories
6/30/2009	KM		S, F			
6/30/2009	KP, DL			O, E, N, F, J		
7/1/2009	DK		BA, BJ, N, J	S, E, F		
7/2/2009	DK	S, N, J				
7/2/2009	SM, DC				O, F, J, JD	
7/6/2009	DK	S, FN			S, F, J	
7/6/2009	KP, DL, GG					S, F, NA
7/7/2009	DK			S, N, F		
7/8/2009	DK	BN, N	BU			
7/9/2009	DK		BJ, J	BN, N, F, J, JD		
7/9/2009	MG	O, N, F?				
7/9/2009	SM				O, F, J	
7/10/2009	KM		S, F, J			
7/13/2009	KP, DL				S, NB, F, J	
7/14/2009	KP, DL			S, F, J, JD		
7/15/2009	MG	O, N				
7/15/2009	DK			BA, BF, F		
7/16/2009	DK, KM	BA, N				
7/16/2009	KP, TS				S, J, JD	
7/17/2009	DK, KM			BA, BJ, J		
7/20/2009	MG	O, N				
7/20/2009	EB				O, F, J, JD	
7/20/2009	DK		S, F, J, JD			
7/21/2009	KP, TS				MV, S, F, J, JD	
7/22/2009	DK	S, F				
7/23/2009	DK, MG	S, F				
7/23/2009	KP			S, NB, F		
7/24/2009	DK			S, F		
7/30/2009	KP, TS, DL				MV, S, F, J, JD	
7/31/2009	DK			BF, F		
7/31/2009	MG	O, F?				
8/17/2009	KP, TS, DL			MV, NA		
10/17/2009	KP, TS			MV, NB, J, NA		

Appendix Table 1 continued.

Date	Personnel	Crystal Cove State Park (CCSP) 1 Territory	El Modena (ELMO) 13 Territories	SCE- Viejo Conservation Easement (SCE) 11 Territories	UC Irvine Ecological Reserve (UC) 5 Territories	Upper Newport Bay (UNB) 3 Territories
10/17/2009	DK, ST			SV, J, JD, NA		
10/18/2009	DK, KM		SV, NB, J, JD, NA			
10/23/2009	DK, KM			BA, J, NA		
10/24/2009	DK, KM			BA, J, NA		
10/27/2009	DK, KM			SV, NB, J, JD, NA		
10/28/2009	DK		SV, J, JD, NA			
11/14/2009	DK, KM			SV, NB, J, JD, NA		
11/15/2009	DK, KM, ST, WR		SV, J, JD, NA			
12/5/2009	DK		SV, J, JD			

Personnel Codes

BN = Barbara Norton  
 DC = Deana Collins  
 DH = Dominic Herrera  
 DK = Dana Kamada  
 DL = Dana Lee  
 DP = David Pryor  
 EB = Elizabeth Brown  
 GG= Gail Gutierrez  
 JV = Jacky Velasquez  
 KM = Karly Moore  
 KP = Kristine Preston  
 KY = Kathy Young  
 LC = Laura Cohen  
 MC = Maria Carrillo  
 MG = Mayra Garcia  
 PA = Portia Arutunian  
 MC = Maria Carrillo  
 MG = Mayra Garcia  
 SM = Sally Menzel  
 SR = Shirley Reynolds  
 ST = Scott Taylor  
 STM = Steve Manee  
 TS = Trish Smith  
 WR = William Rodriguez

Personnel Activity & Nesting Status Codes

*Personnel Activity Codes*

BA = Band adult  
 BFJ = Band fledgling or juvenile  
 BN = Band nestling  
 BU = Mist netting and banding attempt unsuccessful  
 MV = Measure vegetation  
 O = Observe & collect behavioral data  
 S = Look for wrens and check breeding status  
 SV = Focused surveys using taped vocalizations

*Nesting Status Codes*

C = Copulation  
 E = At least one nest at site observed or checked with eggs (egg laying/incubation)  
 F = At least one pair at site observed with fledglings  
 J = At least one juvenile independent of adults observed during visit  
 JD = Juvenile movements outside natal territory/dispersal to new site  
 N = At least one nest at site observed or checked with nestlings  
 NA = Nonbreeding single adult or pair detected  
 NAE = Nest with eggs found abandoned at site during visit  
 NAN = Nest with nestlings found abandoned at site during visit  
 NAE = Nest with eggs found abandoned at site during visit  
 NB = Nest build (roost and breeding)  
 NBF = No birds found  
 NP - At least one nest found depredated at site during visit  
 MA = At least one adult missing & not detected again, presumed mortality

Appendix Table 2. Dates of surveys, names of field personnel, and status of Cactus Wrens at Nature Reserve of Orange County 2009 Survey Areas.

Date	Personnel	Aliso-Wood Canyons Wilderness Park (AWC)	James Dilley Preserve (JDP)	Muddy Canyon/ Emerald Ridge	Whiting Ranch/EI Toro Road	Newport Back Bay	Caspers Regional Park
3/7/2009	KP, ST, PA, SR	S, NBF					
3/10/2009	KP, DP, MC, DH, STM			S, NBF			
3/16/2009	KP		S, NBF				
3/23/2009	KP, PA	S, NBF					
3/27/2009	KP, BN, LC, JV		S, NBF				
3/27/2009	DK						BA
6/16/2009	DK				SV, J, NA		
7/1/2009	DK	SV, NBF					
7/13/2009	DK		SV, NBF				
7/14/2009	DK		SV, NBF				
7/21/2009	DK			SV, NBF			
7/23/2009	DK			SV, NBF			
7/23/2009	KP				SV, J, NA		
7/28/2009	DK, SR	SV, NBF					
7/29/2009	DK, ST	SV, J					
7/30/2009	DK, ST	SV, NA					
10/17/2009	DK, ST				SV, J, JD		
10/27/2009	DK, KM				SV, NB, NA		
11/14/2009	DK, KM				SV, J, JD, NA		
11/16/2009	KM					SV, NBF	
12/4/2009	DK, WR				SV, NA		

Personnel Codes

BN = Barbara Norton  
 DH = Dominic Herrera  
 DK = Dana Kamada  
 DP = David Pryor  
 JV = Jacky Velasquez  
 KM = Karly Moore  
 KP = Kristine Preston  
 LC = Laura Cohen  
 MC = Maria Carrillo  
 PA = Portia Arutunian  
 SR = Shirley Reynolds  
 ST = Scott Taylor  
 STM = Steve Manee  
 WR = William Rodriguez

Personnel Activity Codes and/or Nesting Status at Site

*Personnel Activity Codes*

BA = Band adult  
 S = Look for wrens and check breeding status  
 SV = Focused surveys using taped vocalizations

*Cactus Wren Status Codes*

J = At least one juvenile independent of adults observed during visit  
 JD = Juvenile movements outside natal territory/dispersal to new site  
 NA = Nonbreeding single adult or pair detected  
 NBF = No birds found

