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

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Cover photographs by Robb Hamilton: Left photo is of a cactus wren pair at Upper Newport Bay (UNB), Orange County, CA; taken on 3 August 2007. The female in the lower left corner of the photo was relocated to UNB 17 June 2006 and the male in the upper right corner was relocated to UNB 18 July 2006. The male moved 0.7 km to pair up with the female in 2007 and produced the fledgling in the photograph on the right (also taken 3 August 2007).

EXECUTIVE SUMMARY

This report documents the 2007 Nature Reserve of Orange County funded study to outfit fledgling cactus wrens with radio transmitters and to use a hand-held receiver and antenna to relocate the juvenile wrens as they attempted to disperse from their natal territories. It was initially planned to radio mark up to 14 juvenile wrens from several study sites located throughout the reserve system. However, the lack of nesting attempts and low productivity, likely due to low precipitation during the previous rainy season, provided few fledglings to radio mark. We radio tracked 7 fledglings and 3 adult males for 3 to 48 days. We also monitored a pair of banded wrens that were relocated to Upper Newport Bay in 2006.

We tracked two hatch-year wrens for more than 45 days. One moved away from its natal territory (area where the parents were located) and roamed the study site, but did not leave it, and the other was not observed to have left its natal territory. Three other young wrens' signals were lost after 14 to 24 days and another lost its transmitter after 10 days. None were ever relocated during the season. Another young wren's partially eaten remains were found after three days of tracking. Two radio marked adult male parents were followed until the batteries failed and a third lost its transmitter after 21 days, but was resighted up to 48 days later. A banded male that was relocated to Upper Newport Back Bay in 2006 made a 0.7 km breeding dispersal and mated with a relocated female producing one fledgling in 2007.

In this report, the wren radio tracking observations from this study are compared to movement records from two multi-year cactus wren banding studies conducted in coastal Southern California. Cactus wrens near or at their adult size initially appear to be robust enough to tolerate having a small radio transmitter temporarily placed on them. They also appear to tolerate the translocation procedure and initially appear to quickly adjust to their new location. These activities do expose the wrens to an increased risk of injury and mortality and it is unknown what the impacts are on their long term survival and reproductive success; they should be used and conducted judiciously. It is important to understand cactus wren dispersal patterns in a fragmented landscape in order to manage and conserve their populations in the region and further study is encouraged. However, cactus wren habitat and populations in the reserve appear to continue to decline toward critical levels. Action leading towards conservation, protection and enhancement of existing habitat and populations should take priority.

INTRODUCTION

The San Diego cactus wren (*Campylorhynchus brunneicapillus sandiegensis*) is a Species of Special Concern in California and a target species for conservation in the Natural Communities Conservation Plan/Habitat Conservation Plan (NCCP) for Orange County, California. Past and recent work has shown significant declines of the species throughout the region, with areas of coastal Orange County sustaining post-1993 Laguna Fire reductions in abundance reaching 90% (Bontrager 1994, Bontrager *et al.* 1995, Mitrovich and Hamilton 2007). Development, agricultural displacement, and high frequency of wildfires have lead to substantial habitat loss for the species and severely isolated remaining natural areas supporting cactus wren populations (Mitrovich and Hamilton, 2007). The Nature Reserve of Orange County (NROC) has the challenge of managing the remaining cactus wren populations in the central and coastal areas of Orange County and requires information on the following issues as identified by Atwood *et al.* (1998): 1) factors that influence patterns of movement and ultimately dispersal by cactus wrens, 2) factors that influence annual fluctuations in cactus wren numbers, and 3) factors that influence consistent differences in cactus wren population densities, and what habitat characteristics determine whether an area acts as a population source versus a sink. Information on factors influencing the frequency of wildfire at natural areas in different locations, methods to restore habitat at degraded cactus wren areas, and methods that would allow cactus wrens seeking a territory and/or mate to move between populations may be of immediate concern.

Bontrager and Gorospe (1995) and Atwood *et al.* (1998) emphasized the importance of understanding dispersal patterns of the California gnatcatcher and cactus wren in order to sustain and conserve viable populations and that more focused and detailed demographic studies were needed on these species' biology in coastal southern California. Over a 4 year period (1991 to 1994) Bontrager and Gorospe (1995) color banded 607 cactus wrens from habitat sites in and around the San Joaquin Hills in Orange County, California. They accumulated 36 records of cactus wren dispersals from their surveys of selected study sites and from other biologists working in the area. Atwood *et al.* (1998) color banded 437 wrens over a 6 year period (1992 to 1997) at the Palos Verdes Peninsula in Los Angeles County, California. They had 71 records of juveniles that were resighted ≥ 150 days after banding. Bontrager and Atwood did not attempt to predict the most likely route taken by a resighted cactus wren, but used the straight line distances between banding and the resighting location(s) as the distance dispersed.

Although color banding is a well established and proven method for studying the biology of avian species, Atwood *et al.* (1998) described acquiring data on cactus wren (and gnatcatcher) dispersal behavior as a "difficult and labor-intensive process." In addition to experienced individuals nest monitoring and banding the wrens, the study site and surrounding areas need to be surveyed subsequent years. It is necessary to conduct the banding study and surveys for several years, because the likelihood of resighting banded nestlings and juveniles in the following years is very low. A base population of banded wrens needs to be built up, juvenile survival is typically low, juveniles may disperse into areas that are rarely visited, and Atwood found that 2 to 3 years after fledging, non-

territorial wrens can be secretive and difficult to detect. Finally, most resightings of banded wren dispersals only imply what route was taken from the banding location to the place where it would potentially reproduce. So with few direct observations, it is difficult to determine what elements of the landscape act as barriers or corridors for wrens and what proportion of wrens attempting to move across roads or through residential areas successfully find a habitat fragment, survive, find a mate, and reproduce (Bontrager and Gorospe 1995).

This report documents the NROC funded study to outfit fledgling cactus wrens with commercially available radio transmitters and to use hand-held receivers and antennae in an attempt to relocate the juvenile wrens as they dispersed from their natal territories during the summer of 2007. We initially intended to gather information on the movements of 12 to 14 juvenile wrens. However, the low number of nesting attempts and low productivity of the wrens in 2007, likely due to the extremely low amount of precipitation the previous winter and spring, provided few opportunities to capture and radio mark fledglings. The shortage of personnel to maintain the required vigilance for detecting when juveniles make a dispersal attempt, and restricted access to some areas, were also considerations for limiting the number of wrens that were radio marked. In the end, 7 fledglings and 3 adults were radio marked. The cactus wren pair that was relocated to Upper Newport Bay in 2006 was initially nest monitored in 2007 in order to radio mark the fledgling. However, it was decided not to attempt to radio mark the fledgling. The 2007 Upper Newport Bay monitoring results and the description of the radio tracking activities are documented in this report.

METHODS

We conducted the telemetry and monitoring of cactus wrens from May to September 2007 (Appendix 1). The telemetry study involved three phases: 1) Site surveys and monitoring for the breeding status of cactus wren pairs, 2) Capture and radio marking, and 3) Monitoring the location of the marked wrens. We surveyed the 2006 relocation site at Upper Newport Bay for remaining translocated cactus wrens and monitored their breeding status.

Study sites – The study sites are located in the Orange County Central and Coastal NCCP areas (Figure 1). We conducted pre-capture nest monitoring and telemetry at Sycamore Hills (SH) within the Laguna Coast Wilderness Park, Ridgeline Drive (RL), the University of California Irvine Ecological Preserve (UC), and the former El Toro Marine Corps Air Station Conservation Area (ET). No nest monitoring was conducted at Buck Gully (BG) in Newport Beach, but telemetry was conducted after Robb Hamilton found a cactus wren pair with fledglings while surveying the coastal reserve. Mr. Hamilton also found a wren pair with a fledgling on Bommer/Shady Ridge (BSR) in the Laguna Coast Wilderness Park, but we were only able to capture the adult female and not the fledgling. So we only banded the female and did not conduct radio telemetry. In 2007, we monitored a pair of cactus wrens that were relocated to Upper Newport Bay Nature Preserve (UNB) in 2006 for breeding attempts. Cactus typically was not the dominant vegetation at these sites; wrens were often observed using multiple dense to open stands

of mature cactus or even isolated cactus shrubs within a coastal sage scrub and/or grassland matrix.

The sites vary in their degree of habitat fragmentation and apparent isolation from other sites with cactus wrens. Sycamore Hills is at the eastern edge of the Laguna Coast Wilderness Park and offers an extensive area of native plant communities for a juvenile cactus wren to disperse, but it would need to wander at least 5.5 km west or north before encountering cactus known to be occupied by cactus wrens (Mitrovich and Hamitlon 2007) (Figures 1 and 2a). The Bommer/Shady Ridge cactus wren site is centrally located within the Laguna Coast Wilderness Park and is just north of the San Joaquin Hills Corridor, which bisects the San Joaquin Hills into north-south sections (Figures 1 and 2f). The El Toro site is a relatively extensive area that did contain areas of cactus scrub occupied by cactus wrens prior to the 22 October 2007 Santiago wildfire. The site is bordered by industrial, former military, and agricultural areas with the Foothill Corridor (241) bordering the north side (Figures 1 and 2d). Areas of cactus scrub did occur on the slopes north of the Foothill Corridor. Same areas near the El Toro site are slated for housing developments. The Ridgeline Drive site is west of Ridgeline and south of University Drives. The formerly extensive area of coastal sage scrub is fragmented by roads, gated communities and golf courses (Figures 1 and 2b). If a cactus wren juvenile were able to negotiate through the labyrinth of roads and housing it would be able to find areas of cactus scrub occupied by other cactus wrens. The UC Irvine and Buck Gully sites are fragments of habitat that appear to be more isolated than the Ridgeline Drive site (Figures 1, 2c and e). A wren would need to cross a number of major roads, housing tracts, and/or landscaping in order to find cactus scrub that could be occupied with wrens. At Upper Newport Bay areas of cactus scrub occur along the bluff slopes; however, a wren would need to wander east to cross under or over four major roads and move south along the re-vegetated slopes of the San Joaquin Hills Corridor before encountering an area of cactus, south of UC Irvine, known to be occupied by wrens (Figure 1).

Site surveys, nest searching, and monitoring – Site surveys for cactus wren pairs at Sycamore Hills, Ridgeline Drive, UC Irvine, El Toro, and Upper Newport Bay began during May 2007 (Appendix 1). If I encountered an accessible territory that was occupied by a pair of wrens, then I would monitor the territory to determine their breeding status.

Cactus wrens use dry grass to build football shaped nest chambers as roosts throughout the year; behavioral clues often help to determine if a particular nest is being used as a breeding nest. In general, the male and female appear to take more interest in the breeding nest during the day than a roost nest. Often, the male and female are involved with building the breeding nest and the male usually builds a roost nest in the general vicinity of the breeding nest. Once the breeding nest is completed both birds visit the nest, but the male, who may look into it, does not typically enter all the way into the nest chamber. The female continues to add lining to the nest all through egg laying, incubation and brooding. During egg laying, incubation, and the first day or two of brooding the female is in the nest for approximately 10 to 40 minute intervals. The female leaves after each interval to forage nearby and usually returns to the nest carrying

fluffy material to add to the nest lining. When the nestlings can raise their heads the female and male begin to bring food to the nest. As soon as the nestlings can self-regulate their body temperature, the female roosts in another nest for the night. It is not unusual for the breeding nest to be used as a roost nest after the nestlings have fledged.

If a monitored nest was accessible and the nestling(s) survived to 7 or 8 days after hatching, each wren nestling was then banded with a uniquely numbered U. S. Fish and Wildlife Service (FWS) band and immediately returned to the nest. This was to help verify that the juveniles captured after fledging belonged to a particular territory and clutch and to determine the hatch date of the fledglings.

Capture and marking – We attempted capturing the fledglings when they were 40 to 50 days post-hatching (over 20 to 30 days after fledgling). In Arizona, Anderson and Anderson (1973) found that fledglings approached their adult mass 38-50 days after hatching. Fledglings exhibited parental dependency 17-25 days after hatching (Proudfoot, *et al.*, 2000). Even though juveniles exhibited begging behavior, Anderson and Anderson (1962) found they were self-reliant at 50 days and 75% of their banded nestlings had dispersed by 45 days after fledging (ca. 65 days post-hatching) (Anderson and Anderson, 1963). So I estimated it would be optimal to capture and mark fledglings at 40 to 50 days post-hatching since they should be at or approaching their adult mass and becoming less reliant on parental care, but were not likely to have attempted to disperse from their natal territories.

Cactus wrens were either captured with mist nets or by hand from their nests. If feasible, nets were placed in an area of the wren's territory where they usually traversed during the early mornings and the wrens were guided to the net location with gentle herding and/or call playback recordings. Another method was to place nets around a cactus where they roosted for the night. The following morning the nets were quietly opened prior to dawn and the wren(s) were flushed from their nests just prior to or at sunrise by giving the nest a gentle shake. If the nest opening was easily accessible, then the wren was captured from the nest. The adult wrens were marked with a unique combination of a metal FWS band and two plastic color bands. The fledglings were marked with a unique combination of a metal FWS band and one plastic color band that has two colors (split-band) (Table 1). If the captured wrens did not appear stressed and weather conditions were mild we measured mass, wing chord, level of skull pneumaticization, level of development of the cloacal protuberance and brood patch, level of fat, presence of body and flight feather molt, level of flight feather wear, and juvenal plumage. Age class and sex were determined for the adults, but we were not able to determine the sexes of nestlings or fledglings. Transmitters were placed on fledglings. Transmitters were also placed on a few selected adults (preferably the male, since they usually were slightly heavier than the female) from monitored territories. This was done in order to compare the adult use area with the movements of the developing fledgling.

Radio transmitters were attached to the wrens with 12-lb (5.4-kg) braided Dacron line using a leg-harness design similar to Rappole and Tipton (1991). Using this method of transmitter attachment, Powell *et al.* (1998) did not find overtly negative impacts on

Table 1: Summary of cactus wren banding and telemetry information: Site name, Fish and Wildlife Service band number, color band combination, transmitter frequency, age category, sex, capture location coordinates, date wren was outfitted with a transmitter, number of days the wren could be radio tracked, age of fledging at last observation based on estimated hatch date, and likely fate of the wren.

Site	FWS Band No.	Color Bands*	Frequency Mhz	Age	Sex+	Capture Location UTM, WGS84, 11S East meters	Capture Location UTM, WGS84, 11S North meters	Date Radio Marked	Days Radio Tracked	Last Sighting Age (no. days)	Presumed Fate
Sycamore Hills	168187718	WM-R	151.0600	Adult	M	430179	3718619	12-Jul-07	45	---	Present at final visit 29 Aug 07
	168187723	M-r/w	151.3400	Fledgling	U	430203	3718502	12-Jul-07	3	51	Predated at site 15 Jul 07
	168187722	OM-O	---	Adult	F	430203	3718502	---	---	---	Present at final visit 29 Aug 07
Ridgeline Drive	168187715	bk/w-M	151.3600	Fledgling	U	425558	3723407	15-Jul-07	24	64	Last detection 9 Aug 07; Likely predation or dispersal
	168187724	PM-LG	---	Adult	F	425572	3723419	15-Jul-07	1	---	Present at final visit 16 Aug 07
	---	UB	---	Adult	M	---	---	---	---	---	Present at final visit 16 Aug 07
UC Irvine	168187719	LGM-LG	151.0790	Adult	M	421384	3721840	20-Jul-07	48	---	Present at final visit 9 Sep 07
	168187714	M-db/p	151.1180	Fledgling	U	421301	3721852	20-Jul-07	46	165	Last seen near site 16 Nov 07
	168187712	M-g/y	151.3800	Fledgling	U	421301	3721852	20-Jul-07	10	59	Last seen 28 Jul 07, found transmitter; Likely predation or dispersal possible
	168187713	x-M	---	Fledgling	U	---	---	---	---	---	Last seen 3 Jul 07, presumed dead
	168187720	OM-P	---	Adult	F	421301	3721852	---	---	---	Last observation 2 Sep 07, wary
El Toro†	168187725	LGM-R	151.4790	Adult	M	436721	3727086	24-Jul-07	21	---	Present at final visit 13 Sep 07
	168187717	w/bk-M	151.1700	Fledgling	U	436698	3727006	24-Jul-07	48	89	Present at final visit 13 Sep 07
	168187716	M-o/y	151.4380	Fledgling	U	436698	3727006	24-Jul-07	14	54	Last detection 8 Aug 07; Likely predation or dispersal possible
	168187726	MO-W	---	Adult	F	436633	3727080	---	---	---	Last observation 25 Aug 07, wary
Buck Gully	168187728	r/w-M	151.2120	Fledgling	U	421248	3718733	27-Jul-07	19	---	Last observed 16 Aug 07; Likely predation, dispersal, or transmitter dysfunction
	168187727	PM-P	---	Adult	M	421188	3718706	---	---	---	Present at final visit 4 Sep 07
	---	UB	---	Adult	F	---	---	---	---	---	Present at final visit 4 Sep 07
	---	UB	---	Fledgling	U	---	---	---	---	---	Last seen 20 Aug 07
Bommer/Shady Ridge	168187729	PM-W	---	Adult	F	426759	3719167	---	---	---	Present at final visit 4 Aug 07
	---	UB	---	Adult	M	---	---	---	---	---	Last seen 28 Jul 07
	---	UB	---	Fledgling	U	---	---	---	---	---	Last seen 28 Jul 07
Upper Newport Backbay	168187706	OM-LG	---	Adult	M	435075	3728245	---	---	---	Present at final visit 29 Aug 07
	168187704	M-WO	---	Adult	F	434068	3727316	---	---	---	Present at final visit 29 Aug 07
	168187721	x-M	---	Fledgling	U	417458	3723775	---	---	56	Present at final visit 29 Aug 07

*Bands read (Right Leg)-(Left Leg) and legs with two bands, the top band comes first followed by bottom band second. M=Fish & Wildlife Service band, x=No bands on the leg, UB=Unbanded bird, R=Red, , O=Orange, LG=Light Green, W=White, LB=Light Blue, P=Purple, W=White; Split bands have two colors on one band: r/w=red over white, bk/w= black over white, db/p=dark blue over purple, g/y=green over yellow, w/bk=white over black, o/y=orange over yellow

+ U=Sex Unknown, F=Female, M=Male; † The El Toro site burned 22 October 2007.

migratory Wood Thrush (*Hylocichla mustilina*) compared to banded-only thrushes. Powell *et al.* (1998) also found that 5-kg braided Dacron line (as opposed to 9-kg line) was sufficient for keeping the transmitter on through the breeding season, but appeared to decompose before 9 months. Due to relatively short thighs (femur) and some variability in girth between cactus wrens, the leg-loops of the harness were made to be adjustable in order to custom fit the size of each wren. Once the transmitter was secured to the back of the wren and the leg-loops adjusted to the proper size, the ends of the loop were tied off around the transmitter, the knot glued, and the excess line clipped. The radio transmitters weighed 0.85-.90 g (Model BD-2, Holohil Systems Ltd., Carp, Ontario) with a battery life normally of 42 days. The mass of the radio marked cactus wrens ranged from 38-45 g, so the transmitter weighed <2.4% of the lightest wren.

Monitoring marked cactus wrens – I monitored the transmitters from the ground using a hand-held Yagi antenna and a Communications Specialists, Inc. R-1000 receiver (Communications Specialists, Inc., Orange, California). Visits to territories with radio marked fledglings occurred at 1-3 day intervals, usually during the morning. If there was only a radio marked adult remaining at a territory, it was visited less frequently at 2-4 day intervals. The radio marked wrens were located with the receiver and Yagi antenna and, if possible, their color bands and antenna visually identified; repeating until they either died, lost their transmitter, the transmitter or battery failed, or could no longer be detected. If a wren was seen killed, its remains were located, its transmitter was found with marks suggesting predation, or the fledgling was missing when it was too young to have left its natal territory and it was not observed since the time of its disappearance, then the wren was regarded as dead. If a transmitter was recovered or a signal was lost from an adult or fledgling too young to have dispersed, the study site was thoroughly searched. If the wren was found and an antenna was still seen on the banded wren, but no signal could be detected, the battery was considered to have failed or the transmitter broken. The fate of a missing bird was considered unknown if it could not be considered dead, was old enough to have moved out of the study area, and the bird was not observed since the day it was last detected. When a transmitter signal was lost at the natal study site and the fate of the bird was unknown, accessible locations of the study area and an area within 3 to 5 km of the natal site was thoroughly searched, sometimes with the help of volunteers. Frequencies of birds of unknown fate that may still have had functional transmitters were scanned for throughout the potential life of the battery (42 days), but none of the missing birds were found during 2007.

A hand-held Garmin GPSmap 60C (Garmin International, Inc., Olathe, Kansas) Global Positioning System (GPS) was used to record the location where wrens were first detected each day. Bird locations were recorded in Universal Transverse Mercator (UTM) coordinates using a WGS84 datum and horizontal error was +/- 2 to 4 meters. The birds were within a 10-m radius of a GPS reading. Since the wrens would often move in response to my presence, their location at first detection was recorded. Behavioral information and habitat type were recorded for each located wren. If seen, the color band combination, the presence of the antenna, and the condition of the wren was also recorded.

Qualitative vegetation description – The percent cover of the dominant plant species were visually estimated at each of cactus wren sites that were known to have attempted nesting (Appendix 2). Plant cover estimates for the El Toro wren locaitons were estimated for conditions prior to the 22 October 2007 Santiago wildfire. Digital photos were taken of each site (Appendix 3). All but one of the photos of the El Toro site were taken after the 22 October fire. Vegetation community type was classified according to Sawyer and Keeler-Wolf (1995).

RESULTS

Surveys and nest monitoring – Up to 26 cactus wren locations were detected at all the study sites during the initial survey. Only one pair was found at Sycamore Hills, two or three pairs at Ridgeline Drive, and three pairs and a single male at UC Irvine. There were over 15 sighting locations at the El Toro site, but some of the sightings are suspected to be the same wrens (Figure 3). I observed a pair move over 300-m during a single observation period and had a pair of wrens disappear after a nest failed, later finding a pair appear 500-m away in an area where wrens were not detected during prior visits. It would be difficult to determine an accurate count of cactus wrens at the El Toro site without a color banding program. Robb Hamilton and I only observed one wren pair with fledglings at Buck Gully. I saw up to two wren locations at Bommer/Shady Ridge during our efforts to capture the fledgling. Robb Hamilton conducted cactus wren surveys of the coastal sub-region of the NCCP in 2006 and 2007 for the Nature Reserve of Orange County and will be reporting his results.

At the five monitored study sites (SH, RL, UC, ET, and UNB), I encountered ten pairs of cactus wrens that each made a single breeding attempt during the 2007 study season. Only five of the ten pairs (one pair at each monitored site) successfully produced fledglings (Figures 2a-d, g & Table 1). The other five nests were predated and none of the ten monitored pairs appeared to have made further attempts at breeding after their first try.

The wren pair at Sycamore Hills made one nesting attempt that fledged a chick (Figure 2a-i). Two pairs at Ridgeline Drive each made one nesting attempt. Pair RL01 produced one fledgling and pair RL02's nest was predated during the early nestling stage (Figure 2b-i). Two pairs at UC Irvine made breeding attempts. UC01's was predated during the early nestling stage and UC3/4 fledged three chicks, but one was missing a week later (Figure 2c-i). Sycamore Hills and UC3/4 were the earliest pairs found to be breeding and were the first to fledge chicks (Appendix 1). At least four pairs of wrens were found attempting to reproduce at the El Toro site (Figure 2d-i). ET07 had two fledglings and the other three nests were predated during the egg stage.

Mr. Hamilton encountered these and other cactus wren pairs with fledglings during his surveys of the coastal sub-region and he told me of the fledglings at Buck Gully and Bommer/Shady Ridge, so I would be able to include them in the telemetry study (Figures 2e, f & Table 1). The Buck Gully pair was found feeding up to two fledglings and the Bommer/Shady Ridge pair was found feeding one fledgling (Figures 2e and f). Of the

seven pairs I encountered that successfully bred in 2007 (including the Upper Newport Bay pair), 4 pairs produced 1 fledgling, 2 pairs produced 2 fledglings, and 1 pair produced 3 fledglings (Table 1).

Capture and marking – During 2007, a total of 18 cactus wrens were captured, and at least given a FWS band. Four were banded as adult males, 5 adult females, 7 nestlings, and 2 fledglings (Table 1). This does not include the adult wrens at Upper Newport Bay that were banded in 2006 during the translocation study. Of the 18 wrens banded in 2007, 16 were color banded. Of these, 9 adults and 2 fledglings were given color bands at the time they received FWS bands and 5 nestlings were recaptured later as fledglings and color banded. From the color banded group, a total of 10 wrens received radio transmitters during July 2007. So, 3 adult males and 7 fledglings were radio tracked for up to 48 days, until the last two transmitters' batteries failed in mid-September 2007. All the marked wrens appeared uninjured during and following their release near their capture sites and did not appear to show overtly altered behaviors due to the transmitters during the tracking period.

Radio tracking – Radio tracking started as soon as transmitters were attached to the wrens during July 2007 and occurred at the following sites: Sycamore Hills, Ridgeline Drive, UC Irvine, El Toro, and Buck Gully (Table 1 and Appendix 1). Wrens with functional transmitters were tracked from 1 to 48 days.

Sycamore Hills: We placed transmitters on the adult male and ca. 48 day old fledgling cactus wren at the Sycamore Hills site in Laguna Canyon on 12 July 2007 (Table 1). The adult male was tracked over a 45 day period until the transmitter battery failed at the end of August. The fledgling was tracked over three days until its transmitter and remains were found on the ground under a prickly pear cactus (*Opuntia littoralis*) about 150-m south of the breeding nest site. With only the thorax and leg remaining, the fledgling had clearly been eaten. The transmitter appeared to have bite marks and the plastic covering of the antenna wire had been bitten through to the metal wire in three places. After the fledgling was released and when it was relocated the following day it appeared to be active and behaving as it did prior to receiving the transmitter. On 6 July, a Cooper's hawk (*Accipiter cooperii*) was watching the family group of wrens near its perch. The fledgling was active, chattering and visibly perching on top of a shrub. It gave an alarm call and then flew towards the hawk and into a prickly pear just down slope of the hawk's perch. This may suggest the fledgling was predated, but it was not conclusive whether it was predated or scavenged and whether or not the transmitter contributed directly or indirectly to its death. In any case, we reviewed our capture and marking methodology after each session and continued to make refinements all through the season that would minimize the risk of negative impacts to the birds.

The adults and fledgling were observed moving throughout the area demarcated by the orange dashed line (ca. 21.5 acres) in Figure 2a-i prior to and after banding and radio marking. Randy Nagel of the FWS conducted a minimum convex polygon analysis (MCP) of GPS points taken at the location of first detection during a site visit (Figure 2a-ii). The Adult MCP area was 18.1 acres and the fledgling MCP area was 4.0 acres. The

apparently smaller area of the fledgling is due in part to its mortality at a relatively young age. Not as many points were collected for the fledgling, tracked for only 3 days, as for the adult male, which was followed for 45 days. Also, just prior to capture, even though the fledgling was easily able to fly and peck at things, it continued making begging displays and wandered about within calling distance of the adults. A week and half after the chick fledged, the family group was mostly seen in the southern two-thirds of the area demarcated by the orange dashed line. Later, after the fledgling died, the male and female each built roost nests in prickly pear cactus 30-m WSW of the circular pad near the center of the demarcated area. From personal observations, the demarcated area in Figure 2a-i partially overlaps up to four cactus wren territories that were present during 1995 to 2000.

Ridgeline Drive: We initially placed transmitters on the adult female and 40 day old fledgling cactus wren at the RL01 pair location of the Ridgeline Drive site on 15 July 2007 (Table 1). When the female was relocated a day later her transmitter was found on the ground below a roost nest. The transmitter was collected and re-used at another study site. At this time, the male and female were foraging and the fledgling was moving about making chatter calls and begging displays towards the parents. The fledging appeared to be unhindered by the transmitter and seemed to be behaving normally all through the tracking period. It was tracked at its natal site over a 24 day period until 9 August when only a faint signal was detected 20 to 30-m west of the breeding nest (Figure 2b-i). Neither the signal nor the bird was detected after 9 August. The juvenile was 64 days old the last day it was detected, which is old enough to be able to move away from its natal site. Volunteers and I searched the study site and surrounding area including: Sand Canyon Reservoir, Quail Hill, Mason Regional Park along University Drive, Turtle Rock, Lower Shady Canyon, and Bommer Canyon, but we did not detect the bird nor its signal. The fate of the wren is unknown, but it is likely that it moved away from its natal site, either by its own volition or by a predator.

The adults and fledgling were seen moving throughout the area indicated by the orange dashed line (ca. 21.5 acres) in Figure 2b-i, but they were found within a 3.8 acre core area centered on an east-west ravine for over 70% of the site visits. The cluster of points in Figure 2b-ii reflects this observation. The breeding nest and all their known roost nests were located in this core area. The size and shape of the MCP areas in Figure 2b-ii for the adults and chick appear to be similar and seem small relative to the other sites.

UC Irvine: We attached transmitters to an adult male and two 48 day old fledgling cactus wrens at the UC3/4 location of the UC Irvine site on 20 July 2007 (Table 1). The adult male was tracked at his territory over a 48 day period until the transmitter battery failed one week into September. For the first ten days following marking, the fledgling with the M-g/y band combination was observed with the female or male or the entire family group within the adult territory (Figure 2c). On the tenth day and afterwards, only a stationary signal was detected within the adult territory and the M-g/y wren was not seen after the tenth day. The functioning transmitter was found later and did not show obvious marks that would indicate the wren was attacked by a predator. M-g/y was 57-59 days old and nearly independent enough to be able to leave the natal site. Its sibling, M-db/p, was last

seen associated with its parents as a fledgling only two or three days later. Likely fates of the M-g/y wren would be that it lost its transmitter just prior to leaving the study site; the transmitter fell off during predation; or the bird still was on site, but it evaded observation. The M-db/p wren was radio tracked for 46 days until the battery failed. For the first 13 days following marking, the M-db/p fledgling was seen with either or both parents. On the 13th day the juvenile (61 days old) was foraging on its own in the north section of the adult territory (Figure 2c-i). It no longer was closely associated with the adults and the adults were sometimes seen chasing the juvenile away. During visits on 16 and 25 August M-db/p was wandering over nearly the entire study site (Figure 2c). When at the UC01 location, M-db/p would forage surreptitiously while the UC01 pair would follow and chase the juvenile. On 25 August, the UC01 wren was seen chasing the juvenile south for half the length of the study site. The juvenile returned to where it was found most often, either near or foraging in the irrigated landscaping west of the UC3/4 adult territory (Appendix 3: photo 8) or at the northern periphery the territory. The juvenile was last seen at this location on 16 November in this location (165 days post-hatching). A transmitter antenna was not seen on the bird during this last sighting. Although the UC3/4 wrens foraged along the north edge of the San Joaquin Hills Corridor (73), they were not detected south of the 73 where there was cactus habitat occupied by wren(s) (Mitrovich and Hamilton, 2007).

El Toro: At the ET07 El Toro wren location we placed transmitters on the adult male and two 40 day old fledglings on 24 July 2007 (Table 1). The adult male was radio tracked on its territory for 21 days until it lost the transmitter, which was found on the ground below a roost nest. The male was seen with the remaining chick during subsequent visits until the second week in September. The fledgling with M-o/y bands was tracked for 14 days until its transmitter signal was lost. The wren was 54 days old at last sighting and has not been detected since the signal was lost. The signal from its transmitter was weak two days before the last sighting even though I could see the wren only five meters away. During the last sightings, the fledgling was still associated with the family group. The El Toro site and surrounding area was searched but no signal was detected. The transmitter signals from the adult male and chick with w/bk-M bands were detected from certain high vantage points at 800 to 1000 meters away. The M-o/y was still associated with its parents and relatively young when its signal was lost and it was not re-sighted, so it most likely was predated. The w/bk-M chick was radio tracked for 48 days until the battery on the transmitter failed. As a juvenile w/bk-M was not observed to have moved away from its natal site, even though it was radio tracked until it was 89 days old. It was not unusual to find the juvenile foraging with one of the adults; this was the case during the last sighting. So, the shape and size of the MCP areas for the chicks and adults are similar (Figure 2d-ii). The El Toro site burned during the 22 October 2007 Santiago wildfire (Appendix 3: photos 13-17).

Buck Gully: On 27 July 2007, a transmitter was placed on a fledgling that was estimated to be 40-45 days old (Table 1). It was detected for 19 days until the signal was lost. The entire Buck Gully site and surrounding habitat fragments were searched and visited until the end of the season, but no signal was detected. A week prior to losing the signal a Cooper's hawk was seen perched near the family group. It made an unsuccessful attack

either on a northern mockingbird (*Mimus polyglottos*) or wren and perched nearby. All four wrens were seen a week later, but the signal was lost after this last observation. The wren was estimated at 60-65 days old when the signal was lost, which is old enough for the wren to move away from its natal area. So the fate of the wren is unknown, predation, dispersal, and/or transmitter failure are likely scenarios.

Access to the wren area on the slopes below the gated communities off San Joaquin Hills Road (west side) was limited due to the thick riparian undergrowth at the base and the residents restricting access to the upper slopes (Figure 2c, Appendix 3: photo18). The wren area east of the gated communities (east side) was accessible and the wrens could be approached close enough for visual identification and location coordinates read with a GPS. On the west side the radio marked wren was located and identified primarily by its signal and the other wrens were located by their calls and lack of a transmitter signal. When the wrens were detected on the west side, location coordinates were derived using digital aerial images from a navigation software (Terrain Navigator Pro 8.0, Maptech, Inc., Amesbury, MA). The unmarked chick and adults could not be positively discerned when they were in the upper west slope area near the housing. The adult wrens were present on the upper slope since there were observations of three or more wrens interacting in this area. The MCP areas for the chicks and adults in Figure 2e-ii should both include the upper slope on the west side and therefore be of similar size and shape instead of the chick's MCP area (20.7 acres) being larger than the adult's MCP area (13.6 acres).

Monitoring Upper Newport Bay – One wren pair was detected at Upper Newport Bay. Both adults were color banded and relocated to different sites at Upper Newport Bay in 2006 (Kamada and Mitrovich 2006). The female was relocated with a different male and two fledglings to release site UNB1 on 17 June 2006 (Figure 2g). The male and two fledglings eventually were missing after 30 and 23 days, respectively, leaving the female alone at site 1. Thirty-three days later, the female was seen being harassed to the margins of site 1 by a third pair that was translocated to a third site at Upper Newport Bay on 18 July 2006. During the last 2006 monitoring visit on 23 September 2006, the female and the third pair were foraging together at site 1. The site 1 (UNB1) female's new 2007 partner was an unpaired male at its donor site and was relocated as a single male to Upper Newport Bay site 2 on 15 July 2006. On 15 May 2007, the male from site 2 was observed foraging with the female at UNB1 (Figure 2g). Site 2 is approximately 700-m away from UNB1, but it is likely the single male could have heard wren calls from UNB1 during quiet early mornings prior to the start of passenger jet take-offs from John Wayne Airport. The third wren pair was not detected during the entire 2007 season.

The newly formed pair of relocated wrens at Upper Newport Bay laid three eggs in 2007. Only one egg hatched and the nestling successfully fledged (Table 1). It was the last monitored pair to start nesting and the last to fledge young (Appendix 1). The 56 day old chick was still with its parents on 29 August. All of the 2007 sighting locations of the UNB1 wrens were within a 4.1 acre area (Figure 2g), which is similar to the area where the relocated 2006 family group sightings occurred.

Vegetative community types – In general, the plant community types at the study sites were coastal sage scrub and/or grassland with cactus occurring as scattered isolated shrubs to dense stands in areas with some degree of southern exposure and xeric soils. Cactus wrens were often seen using multiple stands of cactus for cover, foraging (when the cactus was flowering or had ripe fruit) and nesting. They frequently were seen using selected Mexican elderberry (*Sambucus mexicana*) trees as perches for mid-day roosts, preening, observation points, territorial calling and for foraging, particularly during late summer when some if the trees were in fruit. The following are descriptions of the vegetative communities of the cactus wren areas at each site:

Sycamore Hills: The plant communities at the cactus wren location in Sycamore Hills were composed of areas of Coast prickly-pear series within a matrix of Mixed sage series (Appendix 3: photos 1-4). Prickly pear (*Opuntia littoralis*) was present on southeast to southwest facing slopes. While coastal sage (*Artemisia californica*), California buckwheat (*Eriogonum fasciculatum*), and black sage (*Salvia mellifera*) occured in mixed and conspecific clusters, they were present in similar amounts throughout the wren area (Appendix 2). Stands of California scrub oak (*Quercus berberidifoila*) occurred on steep north facing slopes of draws that tend to get less direct sun light. A south facing draw had stands of lemonade berry (*Rhus integrifolia*) along its lower slopes and base. Mexican elderberry (*Sambucus mexicana*) was noticeably uncommon at the study site and nearly absent in the wren area.

Ridgeline Drive: California sagebrush series was the dominant plant community type at the Ridgeline Drive site. On some south facing slopes, prickly pear (*Opuntia littoralis*) would occur at high enough densities to be classified as Coast prickly-pear series (Appendix 3: photos 5 and 6). Coastal cholla (*Cylindropuntia prolifera*) was also present but much less common then prickly pear. The RL02 wrens built their breeding nest in cholla. Coastal sage (*Artemisia californica*) was the most common shrub species (Appendix 2). California buckwheat (*Eriogonum fasciculatum*), and black sage (*Salvia mellifera*) were present in lesser amounts. California encelia (*Encelia californica*) may have been present, but the encelia did not develop and flower at all the sites (other than in irrigated landscaping) due to the lack of rain in 2007. It was difficult to determine how much encelia was present when it did not occur as a dense stand of shrubs, but was mixed in with other shrub species. Prickly pear, Mexican elderberry (*Sambucus mexicana*), and coastal sage were dominant elements in the draw where the RL01 wrens were most frequently observed (Figure 2b).

UC Irvine: The vegetation communities at the UC Irvine site consisted of Coast prickly-pear series and California buckwheat series occurring within a disturbed Needle grass series/ruderal matrix (Appendix 3: photos 7-12). California encelia (*Encelia californica*) was present in noticeable amounts, but essentially remained dormant and did not flower during 2007 (Appendix 2). There were areas of prickly pear (*Opuntia littoralis*) that grew as relatively low sprawling mats. The wrens did not use these areas to place their nests, but placed them in cactus and cholla that were at least a meter in height.

El Toro: Prior to the Santiago wildfire that burned the site on 22 October 2007, the plant community at the El Toro site consisted of areas of Coast prickly-pear series and Mixed sage series vegetation types within a matrix of California annual grassland series (Appendix 3: photos 13-17). There were isolated cactus shrubs and emerging California buckwheat (*Eriogonum fasciculatum*) present in the grassland. Charcoal remains of shrub stems in the ET07 and ET11 wren areas prior to the 2007 fire suggest that the site had been recovering from a previous fire. Although there was a diversity of shrubs species, grassland and bare ground were the dominant cover types at the site (Appendix 2).

Buck Gully: The vegetation community at the Buck Gully cactus wren location appears to be composed of patches of Coast prickly-pear series within a California sagebrush series matrix, but the area appears not to have burned for a long period of time. So lemonade berry (*Rhus integrifolia*) has been growing and becoming the dominant plant cover in the habitat (Appendix 3: photo 18). Irrigation run-off from housing sub-divisions provides a continuous flow of surface water at the base of the slope allowing a dense stand of willows to exist.

Bommer/Shady Ridge: A band of the Coast prickly-pear series vegetation type occurred along the northern boundary of a Foothill or Purple needlegrass series grassland (Figure 2f, Appendix 3: photo 19). Prickly pear (*Opuntia littoralis*) was dense at the edge of the grassland and became more scattered as one moved further into it. California buckwheat (*Eriogonum fasciculatum*), coyote brush (*Baccharis pilularis*), laurel sumac (*Malosma laurina*), and other coastal sage scrub shrubs also were present among the cactus (Appendix 2).

Upper Newport Bay: The plant communities at Upper Newport Bay site 1 is similar to 2006 with the Coast prickly-pear series vegetation confined to the bluff slope, ruderal vegetation above on the mesa and disturbed saltgrass series and pickleweed series below (Appendix 3: photo 20). Along with prickly pear (*Opuntia littoralis*) and coastal cholla (*Cylindropuntia prolifera*), Mexican elderberry (*Sambucus mexicana*), coastal sage (*Artemisia californica*), California buckwheat (*Eriogonum fasciculatum*), black sage (*Salvia mellifera*), and lemonade berry (*Rhus integrifolia*) were also vegetative elements (Appendix 2). The major difference between 2006 and 2007 was drier conditions in 2007. The black mustard (*Brassica nigra*) did not grow above the cactus and coastal sage scrub and the stands of California encelia (*Encelia californica*) only grew a sparse cover of leaves and did not flower during the spring. The habitat appeared more open thus allowing people to walk through and create trails.

DISCUSSION AND CONCLUSIONS

In 2007, the ten monitored wren pairs only attempted one clutch each, even if the nest failed during the egg laying stage. In Arizona 2 to 3 clutches/year were most common (Anderson and Anderson 1973) and wrens were observed with second broods in Orange County during 1991 to 1994 (Bontrager and Gorospe 1995). In our study, the average number of fledglings per pair of the ten monitored wren pairs was only 0.8 with a range

of 0 to 3 fledglings/pair. The average number of fledglings per pair for each year from 1993 to 1997 at the Palos Verdes Peninsula ranged from 3.00 to 3.63 and ranged from 0 to 9 fledglings/pair (Atwood *et al.* 1998). In our 2007 study, cactus wren productivity appears to have been lower than earlier studies in the same region.

It is likely that the low number of offspring produced by the cactus wrens at the study sites in 2007 was influenced by the extremely low amount of rainfall during the 2006-2007 rainy season (Figure 4). Arthropods are the primary prey items taken by cactus wrens with amphibians and reptiles rarely taken (I did see a small fence lizard tail dangling out of a nestlings mouth during banding) (Beal 1907, Storer 1920). Arthropod diversity and abundance in fragmented areas of coastal sage scrub in San Diego were found to be lowest after a period of drought and rebounded after a period of rainfall (Bolger *et al.* 2000). Female birds acquire energy for egg production from increased daily intake, reduced activity, and fat reserves (Blem 1990). Scarcity of food can delay or limit egg production and therefore clutch size (King 1973; Ricklefs 1974). Variation in annual mean clutch size of the Great Tit (*Parus major*) was directly related to the amount of food intake of available food (Perrins 1965). Factors affecting the net energy intake of a breeding cactus wren female during nesting season could affect clutch size or the ability to even initiate a clutch.

The low number of fledglings available for telemetry in effect reduced the ability to draw general conclusions about juvenile cactus wren dispersal patterns. So I will compare our telemetry observations with results from Bontrager and Gorospes's (1995) cactus wren (and California gnatcatcher) banding study in the San Joaquin Hills during 1991 to 1994 and Atwood et al.'s (1998) cactus wren banding study on the Palos Verdes Peninsula during 1993 to 1997.

Timing of natal dispersal – The timing of dispersal of juvenile cactus wrens from their natal territories in the San Joaquin Hills was wide ranging. Bontrager and Gorospe (1995) had young cactus wrens leaving their natal territories within several weeks of fledgling (which is consistent with Anderson and Anderson's (1963) observations in Arizona) to observing young wrens staying with their parents for 6 or 7 months. They had seven recordings of banded juveniles inheriting their natal territory after the parents disappeared. In our study, four radio marked wrens were last detected at ages ranging from 54 to 64 days since hatching (about 35 to 45 days post-fledging). The younger wren at El Toro was more likely to have disappeared for other reasons than suddenly dispersing out of detectable range of the receiver, which was detecting transmitters several hundred meters away from various high points. Another young wren at the UCI site was less associated with its parents at 61 days post-hatching and was foraging and calling at the margins of the area the parents tended to occupy. This juvenile was tracked wandering the entire length of the UCI site, but would return to the area near its parent's territory. A juvenile at the El Toro site was observed associated with its parents all through the tracking period. It was last seen at 89 days of age foraging in the vicinity of its male parent. The timing of disappearances and movements of the wrens in our study appear to be consistent with the other studies.

Dispersal distance – Bontrager and Gorospe (1995) recorded juvenile movement distances ranging from 0.0 to 5.6 km from their natal territories, but the mean was only 1.3 km (S.D. = 2.0, n=23) and 30.4% of the wrens did not disperse from their natal territories. Atwood *et al*. (1998) observed juvenile movements ranging from 0 to 10 km from their natal sites, but their mean was only 1.59 km (S.D. = 2.28, n=71) and nearly 65% were resighted within 1 km of their natal territories after 150 or more days since banding. In Arizona, Anderson and Anderson (1973) documented dispersal distances of male nestlings from their hatch nest to their first breeding nest that was in a new territory ranging from 54.6 meters to 223.4 meters with an average of 112.8 meters (n=21). Six (22.2%) additional male wrens did not disperse from their natal territories. There was not enough complete data on immature females to merit determination of ranges and averages. The cactus wren density at the Anderson and Anderson (1973) 49 acre (19.6 ha) study area was apparently high (and the habitat less patchy and/or fragmented than in our study), because, over a six year period, they banded 297 out of an estimated total of 424 nestlings (in our study the non-relocated wren pair use areas alone ranged from 17.7 to 24 acres). The wren density and the size and focus of effort on their study area may have weighted their data towards shorter dispersal distance ranges and averages.

In our study, only the one radio marked juvenile wren at UCI was tracked wandering away from its natal territory. By making short flights and skulking through the shrubs it easily moved up and back the one km length of the site within a morning. Cactus wrens do not typically make prolonged flights; most flights I have observed were short movements between shrubs and trees. A flight of a dozen meters or more involved flapping their wings in short bursts and then gliding, in a manner similar to a greater roadrunner. Longer flights were often initiated from relatively elevated perches. Dispersal routes may be dictated by what a juvenile wren perceives as a corridor or obstacle; this perception may be partly influenced by a wren's limited ability or unwillingness to make long sustained flights.

Roads and residential areas – At a time when Laguna Canyon Road was just a single two lane highway, Bontrager and Gorospe (1995) recorded four cactus wren resightings at locations where they would have had to disperse across the road. They also recorded three wrens having moved across Ridgeline Drive. This was before Strawberry Farm's Golf Course was built, and at the time the Sand Canyon Wash had more areas of dense coastal sage scrub. They found two banded wrens in the Turtle Rock Fragments (north of Bommer Canyon) requiring the birds to have crossed Turtle Rock Drive, smaller residential streets and housing. They cautioned that this was a small number of observations, only two out of 488 hatch-year and nestling wrens banded over a four year period and that the likelihood of wrens attempting these kinds of movements and successfully completing a successful dispersal is unknown. In this study, only the juvenile wren at UCI was tracked wandering away from its natal territory. It was frequently relocated calling and foraging northwest of its parent's territory and from there it was observed foraging near the edge of the preserve in the mulch of the irrigated landscaping planted with native shrubs (Figure 2c). When it was being tracked wandering around the preserve it stayed within the habitat on the preserve. The bird was not detected to have crossed any roads or moved within any housing or construction

areas. However, except for the short foraging sessions in the landscaping near its roost site, it appeared to be reluctant to stray far from the cover that the habitat on the preserve provided. It may be that what a juvenile wren perceives as available safe cover is part of what would constitute a movement corridor for this species. Bontrager and Gorospe (1995) have recorded banded hatch-year wrens with their parents as late as January. The UCI wren was only tracked until the beginning of September and last seen in November. It may not as yet have attempted to disperse from the UCI study site.

Without sufficient data about the routes immature wrens use to disperse through landscapes with varying degrees of habitat fragmentation, one can only speculate from observations of wren biology and behavior on what impedes or facilitates the movement of wrens in fragmented habitats. Some aspects of cactus wren biology and behavior that could affect their dispersal in fragmented areas include: reluctance to make sustained flights; the need for evening roost nests; the need for cover and forage during the day; and the need for cues such as the sight and/or sound of calling wrens in distant habitat before attempting to cross "gaps".

In Arizona, Anderson and Anderson (1973) thought the male cactus wrens' most consistent dispersal pattern was:

"Whenever possible, the male Cactus Wren remained in the immediate vicinity of the place in which he had been hatched; he dispersed only so far as he was forced to go."

They suggested the reasons for an immature wren's attachment to its natal site were readily available roost nests and a familiar resource base. Parental hostility, intraspecific competition, and repeated disruption of roosting were considered the repulsive "forces". In the case of immature female dispersal pattern, they thought their limited data suggests females tended to disperse farther than males. The repulsive forces were again parental hostility and intraspecific competition and the presence of single male wrens encouraged emigration. They also observed wandering immature wrens temporarily making use of roost nests until the resident adult evicted them. The cactus wrens in our study appeared highly motivated to be in their roost nests by dusk.

Given the sedentary tendencies of the cactus wren, it may be advantageous to initiate restoration of degraded/ruderal areas that are adjacent to habitat currently occupied by cactus wrens. As the restored habitat develops, immature or unpaired wrens without territories (floaters) may be able to use these less favorable restored habitat areas until an established territory opens up. This would help buffer the population from demographic fluctuations and; ideally, the restored area would later develop into favorable habitat that would support breeding wrens.

Adult breeding dispersal at Upper Newport Bay – Adult wrens with territories tend to stay with their territories and do not move from them as frequently as juveniles. Bontrager and Gorospe (1995) observed three established adult cactus wrens move to new territories that were 0.3 km away from their previous locations. In 2006 a single male wren was color banded and relocated to Upper Newport Bay and it remained at its release site for the entire 69 day monitoring period (Kamada and Mitrovich 2006). The

male wren moved 0.7 km to another relocation site and, in 2007, was found paired with a banded adult female that was also had been relocated to UNB. The pair produced one fledgling. Given that the male was relocated, it is not clear whether it could have been considered an established bird. However, the behavior appears to be that of an adult making a breeding dispersal.

Cactus wren telemetry – If care is taken, cactus wren adults and fledglings that are nearly their adult size appear to tolerate having a radio transmitter temporarily placed on them. With the exception of the fledgling that was apparently predated three days after attaching the transmitter, the other 9 wrens were robust and seemed to be behaving normally throughout the observation period. For at least four of the wrens, the transmitters fell or were preened off by the wrens after 1, 10, 21, and between 46 and 165 days.

Young cactus wrens vary widely in the timing of their natal dispersal (Bontrager and Gorospe 1995). They may leave within several weeks or stay for several months or even inherit their natal territory. This makes it difficult to predict when to attach a transmitter to a fledgling wren in order to attempt to track its dispersal. The average BD-2 transmitter battery life is only 42 days. Chance events can narrow this 42 day tracking window, such as the battery running down prematurely, low survival rate of first year birds, or the transmitter detaching from the bird. If enough young wrens in their natal territories are radio marked and enough personnel are available to consistently monitor each one, then it would be possible to catch some of them dispersing. Access to fragmented habitat within residential areas can be limited and the reaction of residents in gated communities to someone radio tracking a bird can vary from benign curiosity to hostile suspicion. Being able to track wrens through areas that are limited to access would probably require the development of commercially available micro-satellite transmitters.

Cactus wren translocation – Adult cactus wrens appear to tolerate the translocation process well. They are physically and behaviorally robust enough to bear being captured, banded, and transported in a comfortably ventilated vehicle (Kamada and Mitrovich 2006). Four of the 5 adults that were relocated to Upper Newport Bay were resighted 66 to 97 days until the end of the monitoring period on 23 September 2006. The fifth, which was a paired adult male, was missing after 30 days. Two of the adults remained at Upper Newport Bay to 2007, forming a new pair and producing a fledgling that was last resighted at 56 days post-hatching. The relocated fledglings, which had recently fledged, were still mostly dependent on their parents. They were resighted for 0 to 23 days after relocation. Hypothesizing that the adults would be more likely to initially remain at a site if they had dependent young, we translocated the family group soon after fledgling. However, a single adult male that was relocated to UNB remained at the site to the following year, found a mate and reproduced. So, if there is suitable habitat and a mate, a relocated adult wren is likely to remain without the presence of dependent young. Young cactus wrens are more likely to adjust to a new site if they are relocated at an age when they are more self-reliant, which is about 50 or more days post-hatching (Anderson and Anderson 1962).

One of the most important aspects for a successful translocation is the quality of the relocation site. Some characteristics of a high quality relocation site would be a large area with a generally south facing aspect and a mosaic of naturally occurring coastal sage scrub, grassland, and mature cactus scrub (Wheeler 1997) that is "under" occupied by wrens. Some areas of openly spaced cactus over a meter tall and not covered or shaded by vegetation would be essential (Flaagan 1999). Elements such as prickly pear cactus (*Opuntia littoralis*) and Mexican elderberry (*Sambucus mexicana*) that flower and fruit regularly and a diverse community of coastal sage scrub would help provide forage and cover throughout the year. It is not unusual to see cactus wrens running, dust bathing, and foraging on the ground between shrub openings. This behavior makes them vulnerable to domestic cats (*Felis domesticus*) and in suburban locations Anderson and Anderson (1963) observed cats killing many adult wrens. So an area free of domestic cats or has a healthy coyote population may provide a safer location for the wrens (Soulé *et al*. 1988, Crooks and Soulé 1999).

Relocation of wrens to a fragmented area composed mostly of restored habitat would not be recommended, since it is unknown whether it will provide the essential elements necessary for the wrens to survive throughout the year and reproduce. However, a location that has core areas of existing high quality cactus wren habitat with adjacent areas of sufficiently restored habitat may provide potential relocation sites.

Relocation of cactus wrens is a potential tool for conservation and management of the species; however, it should be carefully planned and executed and not conducted too frequently at this time. It is still a relatively untested method and we do not know the optimal conditions for translocation or the proportion of wrens that would survive to successfully reproduce after relocation to a site. Also, high quality cactus scrub habitat that is "under" or not occupied by cactus wrens is needed for translocation to function as a conservation tool. Therefore, translocation would be inappropriate as a mitigation measure and should not be a substitute for conserving existing habitat.

Concluding remarks – It is important for us to understand the degree to which habitat/population fragments are acting as "sources" or "sinks" and the degree to which they are genetically linked in order to manage and conserve a species. For example, how much effective cactus wren dispersal occurs between Sand Canyon Reservoir, Ridgeline Drive, Turtle Rock Fragments, Bommer/Shady Canyon, UC Irvine, Bonita Canyon, and Laguna Canyon populations? Which of the sites are consistently acting as population "sources" and which as "sinks". Where do we focus our efforts in creating genetic movement between populations and how would we go about doing it? Can sites with disturbed ruderal areas be enhanced using habitat restoration? How well is a site protected from wildfire events?

Although monitoring, color banding, and radio telemetry can be used to provide information concerning population dynamics, these methods of gathering data are, as Atwood *et al.* (1998) described, "difficult and labor-intensive" processes. A decade of consistent effort would probably be required to accumulate enough data from a small and

fragmented population in order to make useful and significantly reliable conclusions and to test population models for running management scenarios.

Mitrovich and Hamilton (2007) have found that the cactus wren population and habitat in the region has declined even further since the 1993 Laguna Fire. Small isolated groups of cactus wrens are vulnerable to local demographic extinction events and the few remaining populations with more than a half dozen pairs are vulnerable to either persistent low level habitat degradation or catastrophic events such as wildfire. The time remaining for further studies and information gathering appears to be growing short. Developing such proactive methods such as ways of growing, restoring and enhancing cactus wren habitat and approaches to managing the risk of wildfire may need to be given priority. Surveys would be required to monitor how the wren population might be responding to management actions. And, if enough funding and resources remain, reproductive monitoring and banding could provide more detailed information over the long term. In order to preserve the presence of the cactus wren within the Nature Reserve, we may be required to gather our collective judgment in order to develop and execute a management plan, even before we have sufficient information.

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REFERENCES

Anderson, A. A., and A. Anderson. 1962. Life history of the Cactus Wren. Pt. V: fledgling to independence. Condor 64:199-212.

Anderson, A. A., and A. Anderson. 1963. 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. The University of Arizona Press. Tucson, AZ.

Atwood, J.L., D.R. Bontrager, M. Fugagli, R. Hirsch, D. Kamada, M. Madden, C. Reynolds, S. Tsai, and P.A. Bowler. 1998. Population dynamics, dispersal, and demography of California gnatcatchers and cactus wrens in coastal southern California (1997 progress report). Unpublished report, Manomet Center for Conservation Sciences, Manomet, Massachusetts and University of California, Irvine, Irvine, California.

Beal, F. E. L. 1907. Birds of California in relation to the fruit industry. USDA, Biological Survey Bulletin 30.

Blem, C. R. 1990. Avian energy storage. Current Ornithology 7:59-114.

Bolger, D.T., A.V. Suarez, K.R. Crooks, S.A. Morrison, and T.J. Case. 2000. Arthropods in urban habitat fragments in southern California: Area, Age, and Edge effects. Ecological Applications 10(4):1230-1248.

Bontrager, D. R. 1994. A preliminary assesment of the effects of the October 1993 Laguna Beach fire on California gnatcatcher and cactus wren populations in the Orange County Superpark. Unpublished technical report prepared for Ed Almanza & Associates, Laguna Beach, California. 7 pp. + maps.

Bontrager, D. R., R. A. Erickson, and R. A. Hamilton. 1995. Impacts of the October 1993 Laguna fire on California gnatcatchers and cactus wrens. Pp. 69-76 *in* Brushfires in California wildlands: ecology and resource management (J. E. Keeley and T. A. Scott, eds). International Association of Wildland Fire, Fairfield, WA.

Bontrager, David R. and A. M. Gorospe. 1995. Movement and dispersal of California gnatcatchers and cactus wrens in the San Joaquin Hills, Orange County, California. January 1995. Unpublished report prepared for Ed Almanza & Associates, Laguna Beach, CA.

Crooks, K. R., and M. E. Soulé. 1999. Mesopredator release and avifaunal extinctions in a fragmented system. Nature 400:563-566.

Flaagan, K. J. 1999. Nest-site selection of the coastal cactus wren, *Campylorhynchus brunneicapillus*, in Chico Hills State Park, California. Unpublished M.S. Thesis, California State University, Fullerton.

Jones and Stokes Associates. 1993. Methods used to survey the vegetation of Orange County parks and open space areas and The Irvine Company property. Report JSA 92-032. Sacramento, CA.

Kamada, D. and M. J. Mitrovich. 2006. Results of the 2006 cactus wren (*Campylorhynchus brunneicapillus*) translocation study in Orange County, California. Unpublished report for Lyann A. Cormack at South Coast Region, Dept. of Fish and Game, San Diego, CA.

King, J. R. 1973. Energetics of reproduction in birds, pp. 78-107. Proceedings of XV International Ornithological Congress. (K.H. Voous, Ed.). Leiden: E.J. Brill.

Mitrovich, Milan J. and R. A. Hamilton. 2007. Status of the cactus wren (*Campylorhynchus brunneicapillus*) within the coastal subregion of Orange County, California. May 2007. Unpublished report prepared for the Nature Reserve of Orange County, Irvine, California.

Powell, L. A., D. G. Krementz, J. D. Lang, and M. J. Conroy. 1998. Effects of radio transmitters on migrating Wood Thrushes. 69(2):306-315.

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 F. Gill, eds.). The Birds of North America, Inc., Philadelphia PA.

Rappole, J. H., and A. R. Tipton. 1991. New harness design for attachment of radio transmitters to small passerines. Journal of Field Ornithology 62(3):335-337.

Ricklefs, R. E. 1974. Energetics of reproduction in birds, pp.152-292. Avian Energetics (R.A. Paynter, Ed.) Nuttal Ornithological Society, No. 15.

Sawyer, J. O. and T. Keeler-Wolf. 1995. A Manual of California Vegetation. California Native Plant Society. Sacramento, CA.

Soulé, M. E., D. T. Bolger, A. C. Alberts, R. S. Sauvajot, J. Wright, M. Sorice, and S. Hill. 1988. Reconstructed dynamics of rapid extinction of chaparral-requiring birds in urban habitat islands. Conservation Biology 2:75-92.

Storer, T. L. 1920. Lizard eaten by Cactus Wren. Condor 22:159.

Wheeler, T. R. 1997. Habitat requirements of the coastal Cactus Wren, *Campylorhynchus brunneicapillus*, in eastern Los Angeles County, Senior Thesis in Biology, Joint Sciences Department of the Claremont Colleges.

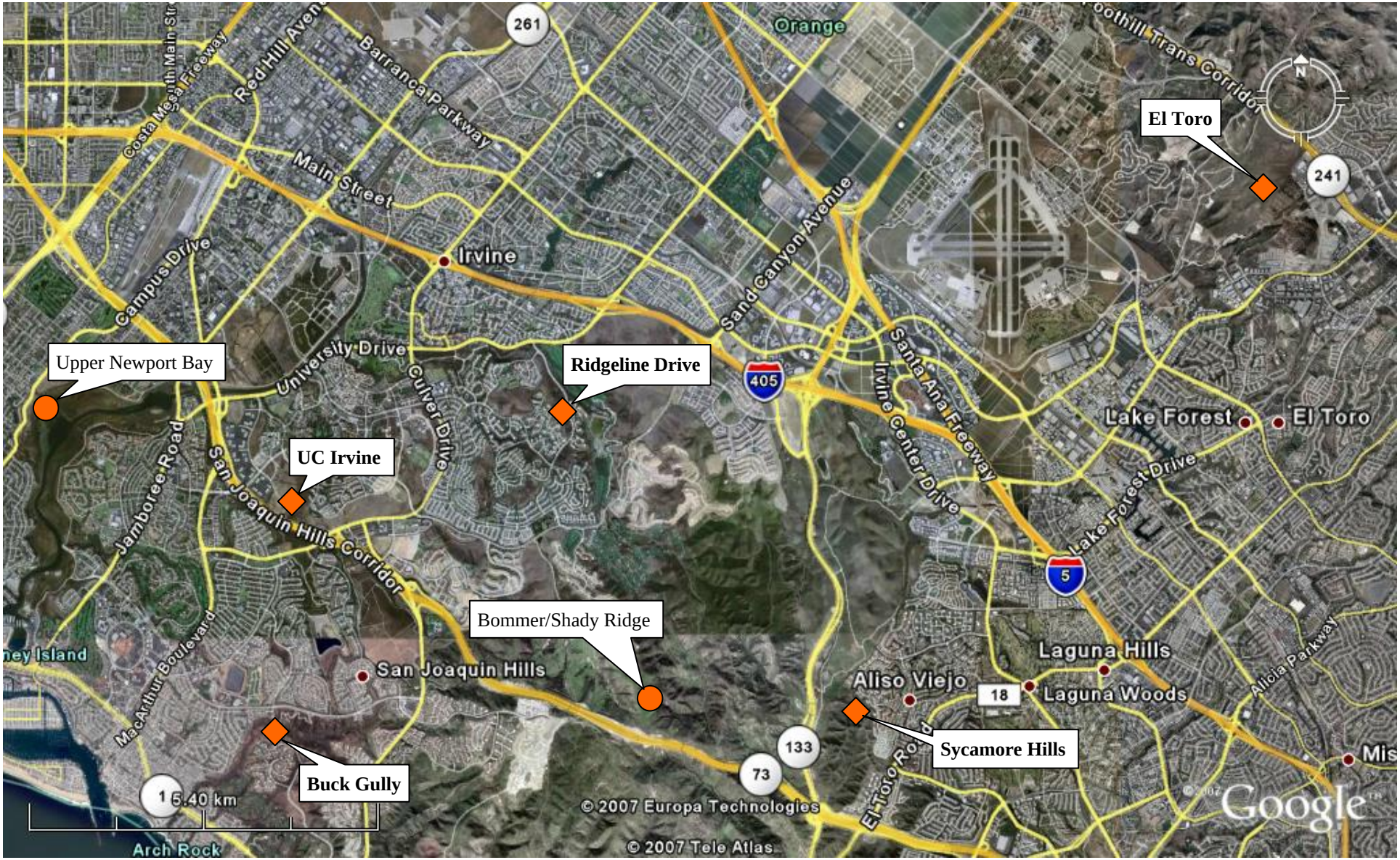

Figure 1: Vicinities of the 2007 cactus wren telemetry study sites in Orange County, California. Diamonds and bold text indicate sites where wrens were outfitted with transmitters and circles and regular text indicate sites where wrens were banded only. The El Toro site burned during the Santiago wildfire on 22 October 2007.

Figure 2a-i: Sycamore Hills cactus wren telemetry site (SH03) where the adult male and fledgling were radio marked and banded. The female was color banded only. The orange dashed line indicates the area where the wrens were commonly found during observation [Area~8.5ha (21.5ac)]. Nest UTM: 11S 430073mE, 3718658mN (WGS84), el.: 160m; Laguna Beach 7.5' quadrangle; T6S, R8W, SW¼; Laguna Beach, Orange Co., CA.

Figure 2a-ii: Minimum convex polygon (MCP) GIS analysis of the Sycamore Hills adults (red line and gold stars) and chick (fledgling) (blue line and dots) GPS points based on first detection locations for each site visit only. The area estimate of 21.5 acres in 2a-i is based on sightings of any of the three wrens and their movements.

Figure 2b-i: Ridgeline Drive cactus wren telemetry site (RL01) where the fledgling was radio marked and banded. The female was banded and male unbanded. Orange dashed line indicates area where the wrens were observed [Area~7.1ha (17.7ac)]. White dotted line indicates the area where the wrens were detected on most site visits [White dot Area~1.5ha (3.8ac)]. RL01 Nest UTM: 11S 425565mE, 3723400mN (WGS84), el.: 100m; RL02 Nest UTM 425543mE, 3723628mN, el.: 85m; Tustin 7.5' quadrangle; T6S, R9W, NE¼; Irvine, Orange Co., CA.

Figure 2b-ii: Minimum convex polygon (MCP) GIS analysis of the Ridgeline Drive (RL01) adults (red line and gold stars) and chick (blue line and dots) GPS points based on first detection locations of a site visit only. The area estimate of 17.7 acres in 2b-i is based on sightings of any of the three wrens and their movements.

Figure 2c-i: UC Irvine cactus wren telemetry site (UC3/4) where the adult male and 2 fledglings were radio marked and banded. The female was only banded. Orange dashed line indicates area where the adults and 3 younger fledglings were observed [Area~7.4ha (18.6ac)]. White dotted line indicates area where the surviving juvenile (M-db/p) was observed [Area~19.1ha (47.8ac)]. UC01 Nest UTM: 11S 421608mE, 3722661mN (WGS84), el.: 50m; UC3/4 Nest UTM: 421413mE, 3721848mN, el.: 82m; Tustin 7.5' quadrangle; T6S, R9W, SW¼; Irvine, Orange Co., CA.

Figure 2c-ii: Minimum convex polygon (MCP) GIS analysis of the UC Irvine (UC3/4) adults (red line and gold stars) and 3 chicks (blue line and dots) GPS points based on first detection locations of the day (except the blue dots outside the red polygon which include multiple locations of a the surviving juvenile during a day). The blue dots within the red polygon could be any of the three fledglings, but the blue dots outside the red polygon is the sole surviving chick, M-db/p. The area estimate of 18.6 acres in 2c-i is based on sightings of the adult wrens and their movements.

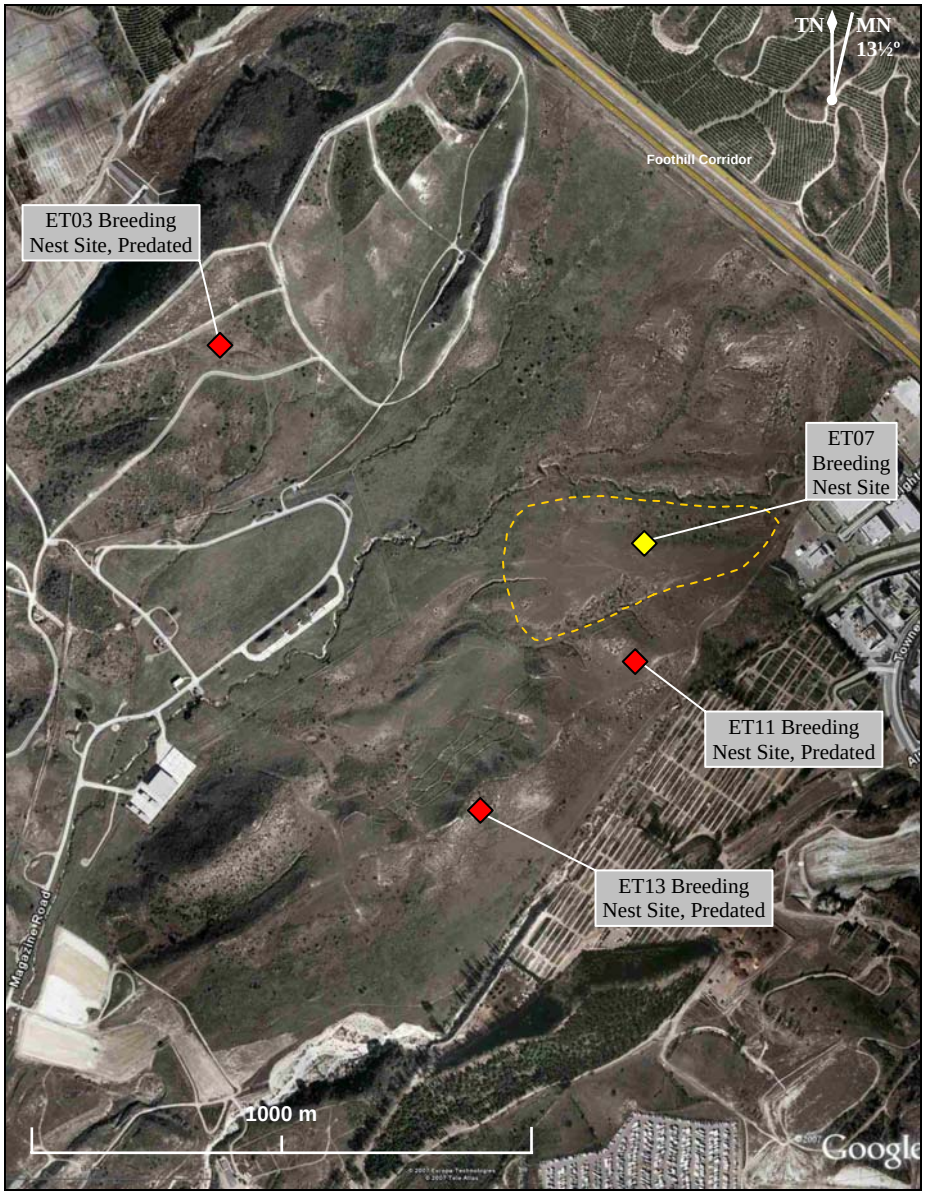

Figure 2d-i: El Toro cactus wren telemetry site (ET07) where the adult male and 2 fledglings were radio marked. The female was only banded. Orange dashed line indicates area where the adults and fledglings were observed [Area~9.6ha (23.9ac)]. ET03 Nest UTM: 11S 435774mE, 3727504mN (WGS84), el.: 200m, ET07 Nest UTM: 436698mE, 3727066mN, el.: 209m, ET11 Nest UTM: 436615mE, 3726849mN, el.: 208m, ET13 Nest UTM: 436285mE, 3726548mN, el.: 200m; El Toro 7.5' quadrangle; T6S, R8W, NE¼; El Toro, Orange Co., CA.

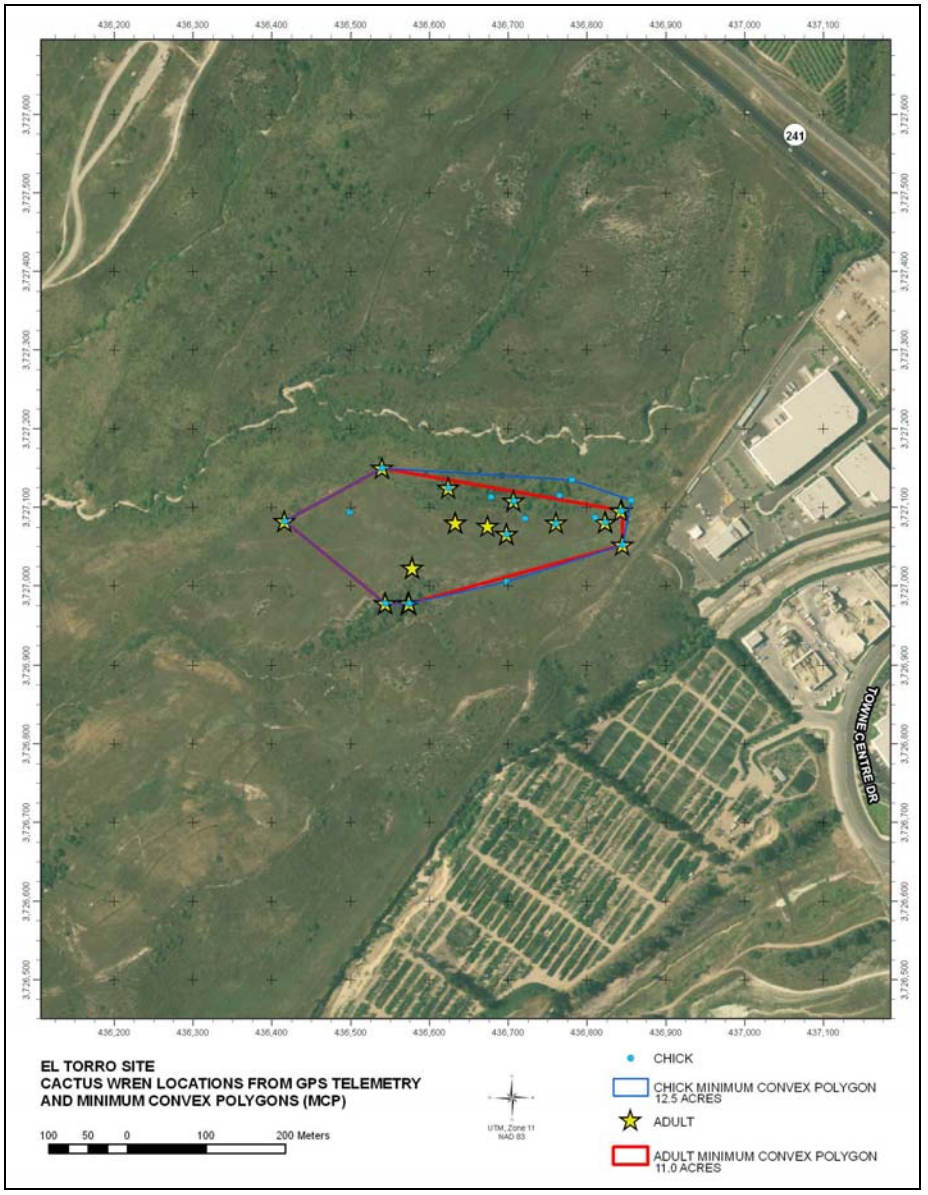

Figure 2d-ii: Minimum convex polygon (MCP) GIS analysis of the El Toro (ET07) adults (red line and gold stars) and chicks (blue line and dots) GPS points based on first detection locations of the day only. The area estimate of 23.9 acres in 2d-i is based on sightings of any of the four wrens and their movements.

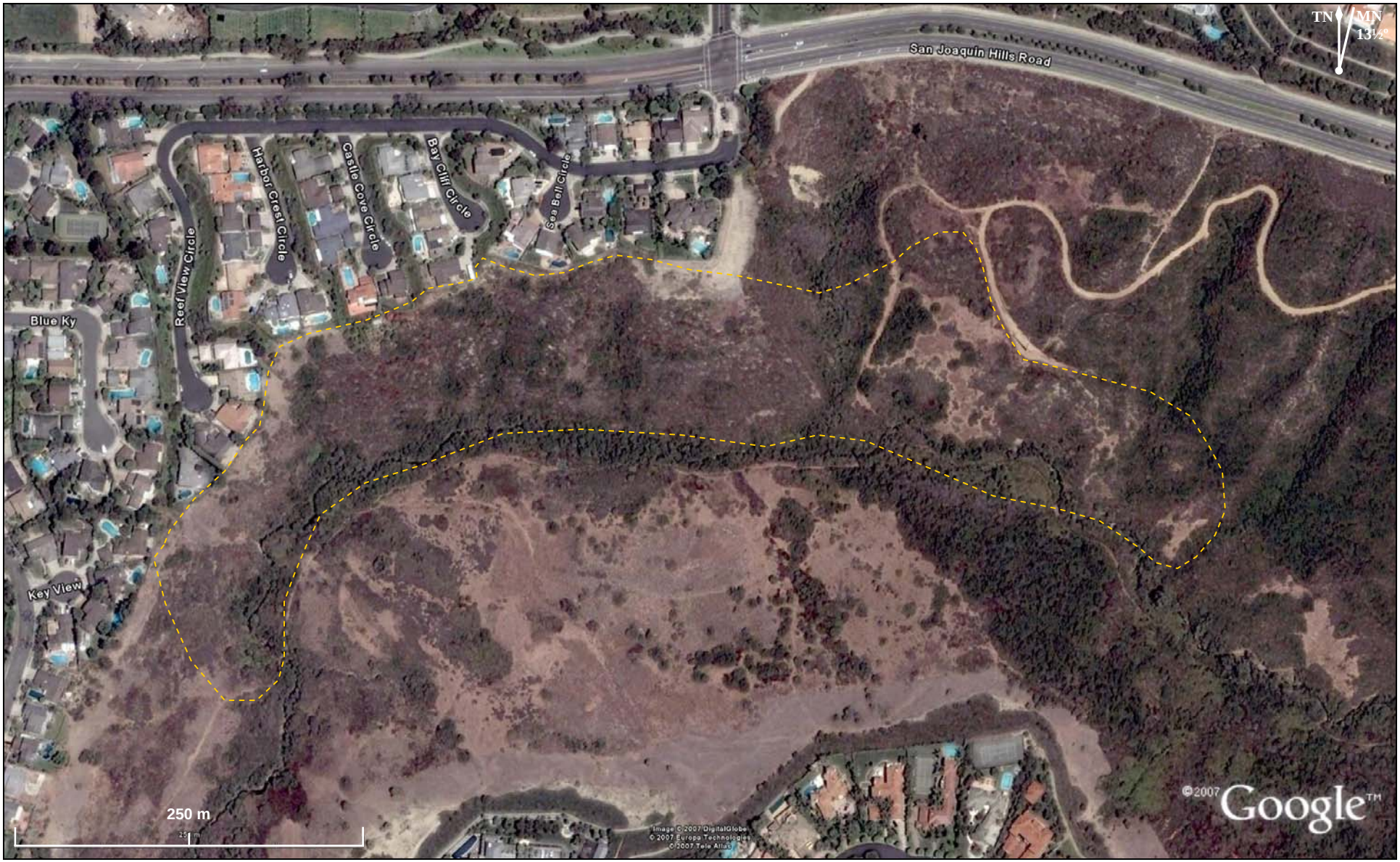

Figure 2e-ii: Buck Gully cactus wren telemetry site (BG01) where the fledgling was radio marked. The adult male was only banded and the female and other fledgling were unbanded. Orange dashed line indicates area where the wrens were observed [Area~9.6ha (24ac)]. Breeding nest location was not found, BG01 Site UTM: 11S 421084mE, 3718729mN (WGS84), el.: 100m; Laguna Beach 7.5' quadrangle; T6S, R9W, SW¼; Newport Beach, Orange Co., CA.

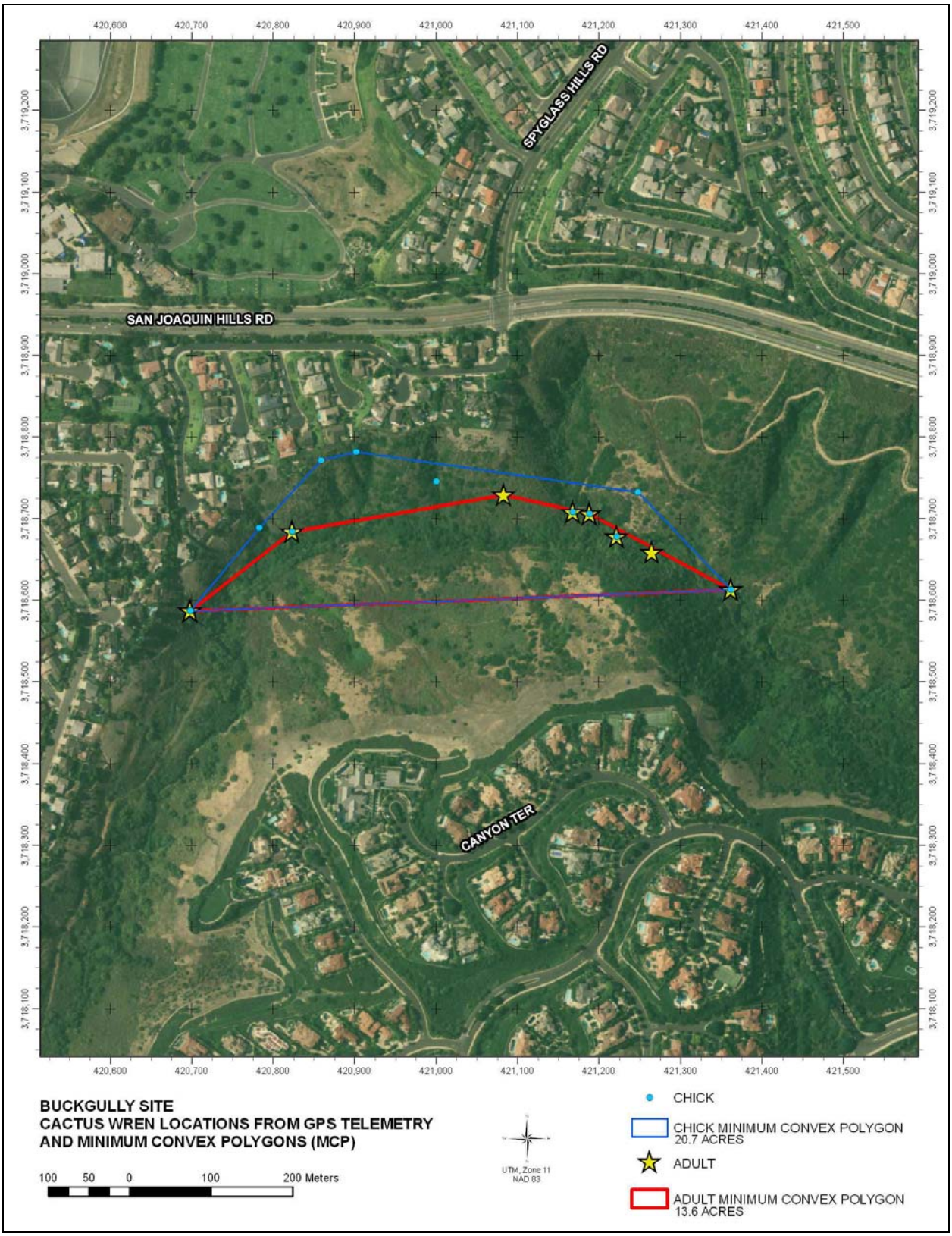

Figure 2e-ii: Minimum convex polygon (MCP) GIS analysis of the Buck Gully (BG01) adults (red line and gold stars) and chicks (blue line and dots) GPS points based on first detection locations of the day only. The area estimate of 24 acres in 2e-i is based on sightings of any of the four wrens and their movements. Due to inability to regularly access the upper slope I was only able to determine if the radio marked chick was at the upper slope, but was not able to distinguish whether the adults or un-marked chick were at the top of the slope, hence the lack of adult point locations along the upper slope (Appendix 3: Photo 18).

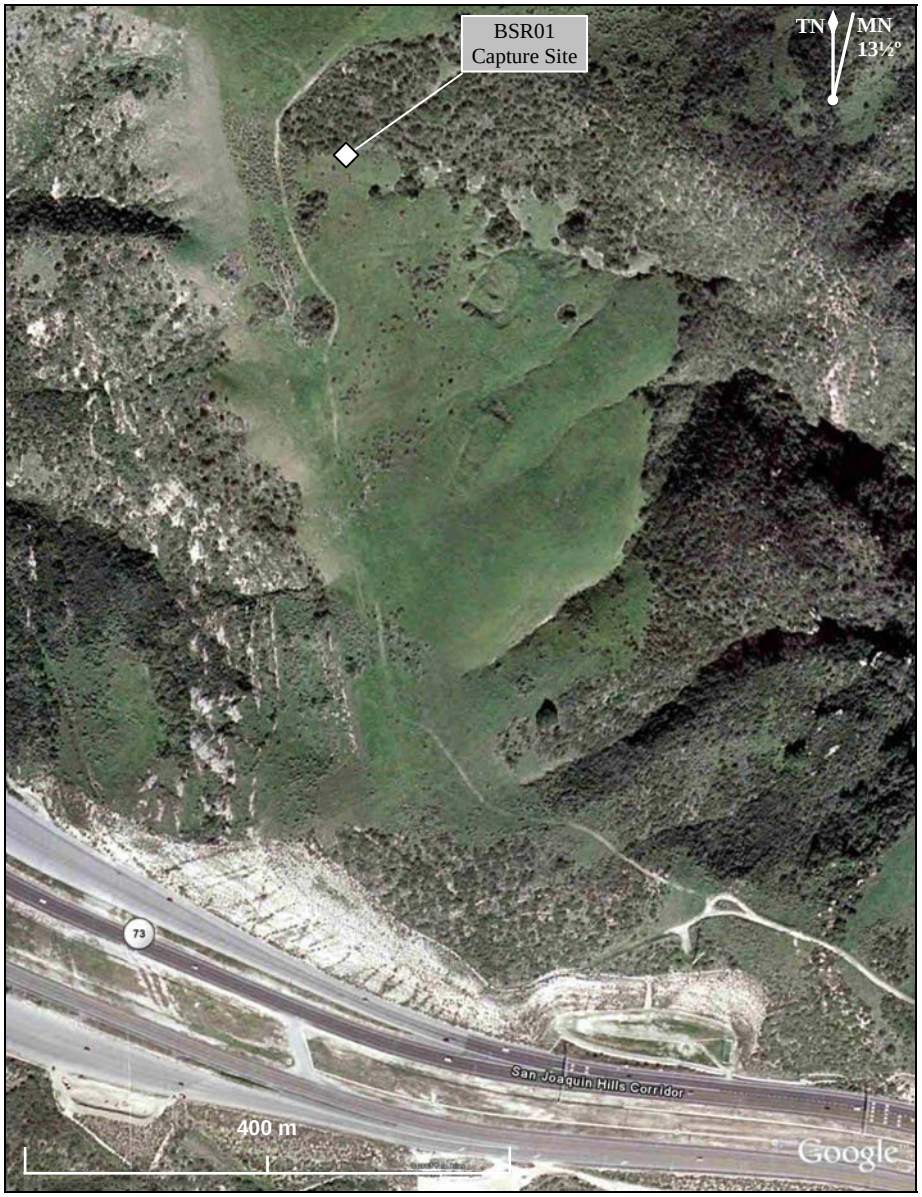

Figure 2f: Bommer/Shady Ridge where a female cactus wren was color banded, but the fledgling and male eluded capture. No telemetry was conducted at this location. BSR01 capture and roost area UTM 11S 426759mE, 3719167mN (WGS84), el.: 115m; Laguna Beach 7.5' quadrangle; T6S, R8W, SW¼; Laguna Beach, Orange Co., CA.

Figure 2g: Upper Newport Bay where 2 family groups of cactus wrens and a single male from east Irvine area were relocated in 2006. In 2007, the single male was paired with the female at site 1 and they produced a fledgling. No other wrens were detected. No telemetry was conducted at this location. Orange dashed line indicates where the wrens were observed in 2007 [Area~1.6ha (4.1ac)]. UNB1 Nest UTM 417458mE, 3723775mN (WGS84), el.: 85m; Newport Beach 7.5' quadrangle; T6S, R10W, NE¼; Newport Beach, Orange Co., CA.

Figure 3: Cactus wren sightings during the pre-telemetry study survey at the Former MCAS El Toro Conservation Area in May 2007. Red circles indicate known pair sightings and yellow circles indicate single or unknown mate status. At least two pairs of sightings are suspected to be the same birds. Entry into Site 1 at the north corner was restricted and not surveyed. Cactus habitat was present and Dr. Jeff Lincer of Wildlife Resources Institute (WRI) said that there is at least one cactus wren pair at Site 1. (Base map with legend and vegetation areas are by Earth Tech and WRI).

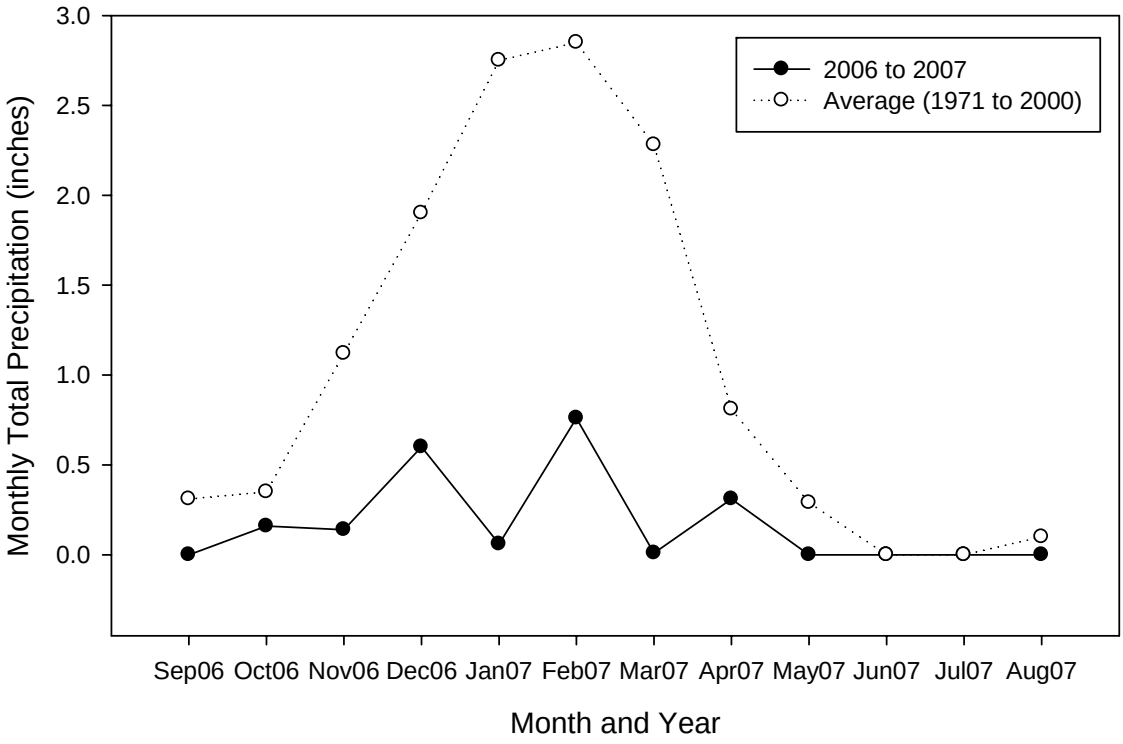

Figure 4: Monthly total inches of precipitation for September 2006 through August 2007 at John Wayne Airport, Orange County, California (http://www.weather.gov/climate/index.php?wfo=sgx). Average annual total is 12.76 inches and September 2006 to August 2007 annual total is 2.04 inches.

Appenidix 1: Field Work Dates, Personnel, and Observations or Activity

Field Personnel:

DK – Dana Kamada
KM – Karly Moore
MC – Mike Couffer
PA – Portia Arutunian
BN – Barry Nerhus
MS – Molly Stallcup
MT – Matthew Teutimez
CZ – Christina Zdenek

Cactus Wren Sites:

Bands read (Right Leg)-(Left Leg) and legs with two bands, the top band comes first followed by bottom band second.

BG – Buck Gully, Newport Beach
BSR – Bommer/Shady Ridge, Irvine
ET – El Toro Panhandle, Irvine
RL – Ridgeline Drive, Irvine
SH – Sycamore Hills, Laguna Beach
UC – U.C. Irvine Ecological Reserve
UNB – Upper Newport Bay

Letter Code Definitions of Activity and/or Observations made during a Site Visit:

Activity Codes

B – Banding
R – Applying transmitter(s) &/or color bands
T – Telemetry tracking
V – Site survey or monitoring visit

Nesting Stage Codes

E – Nest with egg(s)
N – Nest with nestling(s)
F – Fledgling(s)

Observation Codes

L – Wren lost transmitter
P - Predation
Tx – Telemetry tracking, but no signal detected

Cactus Wren Sites Monitored for Nesting Attempts During 2007													
		Buck Gully (BG)	**Bommer/ Shady Ridge (BSR)**	**El Toro (ET)**				**Ridgeline Drive (RL)**		**Sycamore Hills (SH)**	**UC Irvine (UC)**		**Upper Newport Bay**
Date	**Workers**	**01**	01	03	**07**	11	13	**01**	02	**03**	01	**3/4**	01
5/2/07	DK			V									
5/3/07	DK				V								
5/8/07	DK			V									
5/9/07	DK				V								
5/14/07	DK			V	V								
5/15/07	DK				V						V	**E**	V
5/16/07	DK							V			V		
5/21/07	DK			V	V								
5/22/07	DK									V	V	**E**	V
5/23/07	DK							V	V				
5/26/07	DK			V	**E**	**E**							
5/27/07	DK										V	**E**	V
5/28/07	DK							**E**	V				
5/29/07	DK			V						V			
6/2/07	DK							**E**	**E**				
6/3/07	DK										V	**N**	
6/5/07	DK									V	V		V
6/6/07	DK			V	**E**	**P**	**E**			V			
6/9/07	DK							**N**	**E**				
6/10/07	DK										**E**	**NB**	
6/13/07	DK												V
6/14/07	DK									**N**			

Appenidix 1: Field Work Dates, Personnel, and Observations or Activity

Cactus Wren Sites Monitored for Nesting Attempts During 2007													
		Buck Gully (BG)	**Bommer/ Shady Ridge (BSR)**	**El Toro (ET)**				**Ridgeline Drive (RL)**		**Sycamore Hills (SH)**	**UC Irvine (UC)**		**Upper Newport Bay**
Date	**Workers**	**01**	01	03	**07**	11	13	**01**	02	**03**	01	**3/4**	01
6/15/07	DK			**E**	**N**	V	**E**	**NB**					
6/16/07	DK							**N**	**E**		**E**	**N**	
6/19/07	DK									**F**			**E**
6/20/07	DK							**N**		**F**	**N**		
6/21/07	DK							**N**	**E**				**E**
6/22/07	DK			**E**	**NB**	V	**P**						
6/23/07	DK								**E**			**F**	
6/26/07	DK							**F**		**F**			**E**
6/27/07	DK			**P**	**N**	V							
6/28/07	DK							**F**	**E**	**F**	**P**		
6/29/07	DK									**FB**			
6/30/07	DK									**F**			
7/1/07	DK									**F**			
7/3/07	DK									**F**	V	**F**	
7/4/07	DK			V	**N**	V				**F**			
7/5/07	DK							**F**	**N**	**F**		**F**	**N**
7/6/07	DK									**F**		**F**	
7/7/07	DK									V		V	
7/8/07	DK, MC											**B**	
7/9/07	DK									**F**	V	**F**	
7/10/07	DK, MC			V	**N**					**F**		F	**NB**
7/11/07	DK				**N**			**F**	**P**				
7/12/07	DK, KM									**R**			
7/13/07	DK							**F**		**T**		**F**	
7/14/07	DK							**F**				**F**	
7/15/07	DK, KM							**R**		**TP**			
7/16/07	DK							**T**					
7/17/07	DK							**T**	V		V	**F**	
7/18/07	DK							**T**	V	**T**			**N**
7/19/07	DK			V	V							**F**	
7/20/07	DK, KM, MT, BN, CZ											**R**	
7/21/07	DK	**F**			**F**						V	**T**	
7/23/07	DK		**F**					**T**	V	**T**		**T**	
7/24/07	DK, KM				**R**								**F**
7/25/07	DK	**F**						**T**			V	**T**	
7/26/07	DK				**T**	V				**T**			
7/27/07	DK, KM, BN	**R**	V										
7/28/07	DK	**T**	**F**					**T**				**T**	
7/30/07	DK				**T**			**T**				**TP**	
7/31/07	DK	**T**	V							**T**	V	**T**	**F**
8/1/07	DK		**F**		**T**			**T**	V				
8/2/07	DK	**T**						**T**				**T**	

Appenidix 1: Field Work Dates, Personnel, and Observations or Activity

Cactus Wren Sites Monitored for Nesting Attempts During 2007													
		Buck Gully (BG)	**Bommer/ Shady Ridge (BSR)**	**El Toro (ET)**				**Ridgeline Drive (RL)**		**Sycamore Hills (SH)**	**UC Irvine (UC)**		**Upper Newport Bay**
Date	**Workers**	**01**	01	03	**07**	11	13	**01**	02	**03**	01	**3/4**	01
8/3/07	DK	**T**			**T**			**T**		**T**		**T**	
8/4/07	DK, KM		**B**										
8/6/07	DK				**T**			**T**		**T**		**T**	
8/7/07	DK	**T**						**T**				**T**	**F**
8/8/07	DK				**T**			**T**		**T**			
8/9/07	DK	**T**						**T**				**T**	
8/10/07	DK	**T**			**T**			Tx		**T**			
8/11/07	DK	**T**						Tx				**T**	
8/13/07	DK				**T**			Tx					
8/14/07	DK	**T**						Tx		**T**		**T**	
8/15/07	DK				**T**								V
8/16/07	DK	**T**						Tx				**T**	
8/17/07	DK				**T**					**T**		**T**	
8/18/07	DK, MT, BN, MS							Tx				**T**	
8/19/07	DK, PA	Tx			**T**							**T**	**F**
8/20/07	DK	Tx			**T**							**T**	
8/21/07	DK, PA	Tx			**T**			Tx		**T**		**T**	**F**
8/22/07	DK	Tx			**T**			Tx				**T**	
8/23/07	DK				**T**			Tx		**T**		**T**	
8/24/07	DK	Tx			**T**					**T**		**T**	
8/25/07	DK				**T**							**T**	
8/27/07	DK	Tx			**T**					**T**		**T**	
8/28/07	DK	Tx			**T**			Tx		Tx		**T**	
8/29/07	DK				**T**					Tx		**T**	**F**
8/30/07	DK	Tx			**T**							**T**	
8/31/07	DK	Tx			**T**							**T**	
9/2/07	DK				**T**							**T**	
9/4/07	DK	Tx			**T**							**T**	
9/6/07	DK				**T**							Tx	
9/9/07	DK				**T**							Tx	
9/11/07	DK				**T**								
9/13/07	DK				Tx								

Appendix 2: Vegetative Cover

Estimated Percent Cover of Dominant Plant Species at the 2007 Cactus Wren Telemetry Study Sites					
	<5%	**5 - 25%**	**25 - 50%**	**50 - 75%**	**75 - 100%**
Sycamore Hills (Laguna Canyon)					
Coastal prickly pear/cholla (*Opuntia littoralis/Cylindropuntia prolifera*)			■		
Coastal sage (*Artemisia californica*)		■			
California buckwheat (*Eriogonum fasciculatum*)		■			
Black sage (*Salvia mellifera*)		■			
Lemonade berry (*Rhus integrifolia*)		■			
Laurel sumac (*Malosma laurina*)	■				
California scrub oak (*Quercus berberidifolia*)		■			
Bare Ground/Rock		■			
Ridgeline Drive 01 (Ridgeline & University Drives)					
Coastal prickly pear/cholla (*Opuntia littoralis/Cylindropuntia prolifera*)		■			
Coastal sage (*Artemisia californica*)			■		
California buckwheat (*Eriogonum fasciculatum*)		■			
Black sage (*Salvia mellifera*)		■			
Mexican elderberry (*Sambucus mexicana)*		■			
Lemonade berry (*Rhus integrifolia*)	■				
Laurel sumac (*Malosma laurina*)	■				
Grass and Forbs	■				
Bare Ground/Rock		■			
Ridgeline Drive 02 (Ridgeline & University Drives)					
Coastal prickly pear/cholla (*Opuntia littoralis/Cylindropuntia prolifera*)		■			
Coastal sage (*Artemisia californica*)			■		
California buckwheat (*Eriogonum fasciculatum*)		■			
Black sage (*Salvia mellifera*)		■			
Mexican elderberry (*Sambucus mexicana)*		■			
Lemonade berry (*Rhus integrifolia*)	■				
Laurel sumac (*Malosma laurina*)	■				
Grass and Forbs		■			
Bare Ground/Rock	■				
University of Calif., Irvine 01 (Ecological Reserve & E. Peltason Dr.)					
Coastal prickly pear/cholla (*Opuntia littoralis/Cylindropuntia prolifera*)			■		
Coastal sage (*Artemisia californica*)	■				
California buckwheat (*Eriogonum fasciculatum*)		■			
California encelia (*Encelia californica*)		■			
Mexican elderberry (*Sambucus mexicana)*		■			
Lemonade berry (*Rhus integrifolia*)	■				
Laurel sumac (*Malosma laurina*)	■				
Grass and Forbs			■		
Bare Ground/Rock		■			
University of Calif., Irvine 3/4 (Ecological Reserve & 73 Toll Road)					
Coastal prickly pear/cholla (*Opuntia littoralis/Cylindropuntia prolifera*)		■			
Coastal sage (*Artemisia californica*)		■			
California buckwheat (*Eriogonum fasciculatum*)		■			
California encelia (*Encelia californica*)		■			
Mexican elderberry (*Sambucus mexicana)*		■			

Appendix 2: Vegetative Cover

Estimated Percent Cover of Dominant Plant Species at the 2007 Cactus Wren Telemetry Study Sites					
	<5%	**5 - 25%**	**25 - 50%**	**50 - 75%**	**75 - 100%**
Lemonade berry (*Rhus integrifolia*)		■			
Laurel sumac (*Malosma laurina*)	■				
Bladderpod (*Cleome isomeris*)	■				
Grass and Forbs			■		
Bare Ground/Rock		■			
El Toro 03 (Irvine Blvd & Magazine Road) *					
Coastal prickly pear/cholla (*Opuntia littoralis/Cylindropuntia prolifera*)		■			
Coastal sage (*Artemisia californica*)		■			
California buckwheat (*Eriogonum fasciculatum*)		■			
Black sage (*Salvia mellifera*)		■			
Coastal deerweed (*Lotus scoparius*)	■				
Mexican elderberry (*Sambucus mexicana)*	■				
Lemonade berry (*Rhus integrifolia*)	■				
Laurel sumac (*Malosma laurina*)	■				
Toyon (*Heteromeles arbutifolia*)	■				
Coyote brush (*Baccharis pilularis*)	■				
Mule fat (*Baccharis salicifolia*)	■				
Grass and Forbs			■		
Bare Ground/Rock		■			
El Toro 07 (Irvine Blvd & Magazine Road) *					
Coastal prickly pear/cholla (*Opuntia littoralis/Cylindropuntia prolifera*)		■			
Coastal sage (*Artemisia californica*)	■				
California buckwheat (*Eriogonum fasciculatum*)		■			
Black sage (*Salvia mellifera*)	■				
Coastal deerweed (*Lotus scoparius*)		■			
Mexican elderberry (*Sambucus mexicana)*		■			
Lemonade berry (*Rhus integrifolia*)	■				
Laurel sumac (*Malosma laurina*)	■				
Toyon (*Heteromeles arbutifolia*)	■				
Coyote brush (*Baccharis pilularis*)		■			
Mule fat (*Baccharis salicifolia*)	■				
Grass and Forbs			■		
Bare Ground/Rock		■			
El Toro 11 (Irvine Blvd & Magazine Road) *					
Coastal prickly pear/cholla (*Opuntia littoralis/Cylindropuntia prolifera*)		■			
Coastal sage (*Artemisia californica*)	■				
California buckwheat (*Eriogonum fasciculatum*)		■			
Black sage (*Salvia mellifera*)	■				
Coastal deerweed (*Lotus scoparius*)	■				
Mexican elderberry (*Sambucus mexicana)*		■			
Lemonade berry (*Rhus integrifolia*)	■				
Laurel sumac (*Malosma laurina*)		■			
Toyon (*Heteromeles arbutifolia*)	■				
Coyote brush (*Baccharis pilularis*)	■				
Grass and Forbs			■		

Appendix 2: Vegetative Cover

Estimated Percent Cover of Dominant Plant Species at the 2007 Cactus Wren Telemetry Study Sites					
	<5%	**5 - 25%**	**25 - 50%**	**50 - 75%**	**75 - 100%**
Bare Ground/Rock		■			
El Toro 13 (Irvine Blvd & Magazine Road) *					
Coastal prickly pear/cholla (*Opuntia littoralis/Cylindropuntia prolifera*)		■			
Coastal sage (*Artemisia californica*)		■			
California buckwheat (*Eriogonum fasciculatum*)		■			
Black sage (*Salvia mellifera*)		■			
Coastal deerweed (*Lotus scoparius*)	■				
Mexican elderberry (*Sambucus mexicana)*		■			
Lemonade berry (*Rhus integrifolia*)		■			
Laurel sumac (*Malosma laurina*)		■			
Toyon (*Heteromeles arbutifolia*)	■				
Grass and Forbs			■		
Bare Ground/Rock		■			
Buck Gully (San Joaquin Hills & Spy Glass Hill Rds.)					
Coastal prickly pear/cholla (*Opuntia littoralis/Cylindropuntia prolifera*)		■			
Coastal sage (*Artemisia californica*)		■			
California buckwheat (*Eriogonum fasciculatum*)		■			
Black sage (*Salvia mellifera*)	■				
California encelia (*Encelia californica*)		■			
Mexican elderberry (*Sambucus mexicana)*		■			
Lemonade berry (*Rhus integrifolia*)		■			
Laurel sumac (*Malosma laurina*)	■				
Grass and Forbs	■				
Bare Ground/Rock	■				
Bommer/Shady Ridge (73 San Joaquin Hills Toll Road)					
Coastal prickly pear/cholla (*Opuntia littoralis/Cylindropuntia prolifera*)		■			
Coastal sage (*Artemisia californica*)	■				
California buckwheat (*Eriogonum fasciculatum*)	■				
Mexican elderberry (*Sambucus mexicana)*	■				
Lemonade berry (*Rhus integrifolia*)	■				
Laurel sumac (*Malosma laurina*)		■			
Coyote brush (*Baccharis pilularis*)		■			
Grass and Forbs				■	
Bare Ground/Rock	■				
Upper Newport Bay (2006 Translocation Site 1)					
California encelia (*Encelia californica*)			■		
Coastal prickly pear/cholla (*Opuntia littoralis/Cylindropuntia prolifera*)		■			
Coastal sage (*Artemisia californica*)		■			
Lemonade berry (*Rhus integrifolia*)		■			
Poison oak (*Toxicodendron diversilobum*)		■			
Mexican elderberry (*Sambucus mexicana)*	■				
California buckwheat (*Eriogonum fasciculatum*)	■				
Grass and Forbs		■			
Bare Ground/Rock		■			

* Plant cover estimates based on vegetation present prior to 22 October 2007 Santiago Wildfire.

Appendix 3: Photographs of 2007 Study Sites

Sycamore Hills Telemetry Site

Photo 1: Ravine northwest of peak where the cactus wren pair (SH03) was initially found nesting, foraging, roosting. The recently fledged chick roosted and was feed in this location. These were the only wrens detected in the area in 2007.

Photo 2: Ravine southeast of peak where pair built roost nests and feed older fledgling. The wrens were captured in this draw.

Photo 3: Ravine southwest of peak where pair roosted after fledgling was predated. Predated fledgling was found in this draw.

Photo 4: Cactus scrub at south end of observed use area (Figure 2a) where the wrens sometimes foraged and roosted during the day.

Appendix 3: Photographs of 2007 Study Sites

Ridgeline Drive Site

Photo 5: Ridgeline Drive 01 telemetry site where pair and fledgling were observed during most site visits (Figure 2b).

Photo 6: Ridgeline Drive 02 wren monitoring site where nest was predated at the nestling stage.

Appendix 3: Photographs of 2007 Study Sites

UC Irvine 3/4 Telemetry Site

Photo 7: UCI site 3/4 on the peak at south end of reserve (Figure 2c).

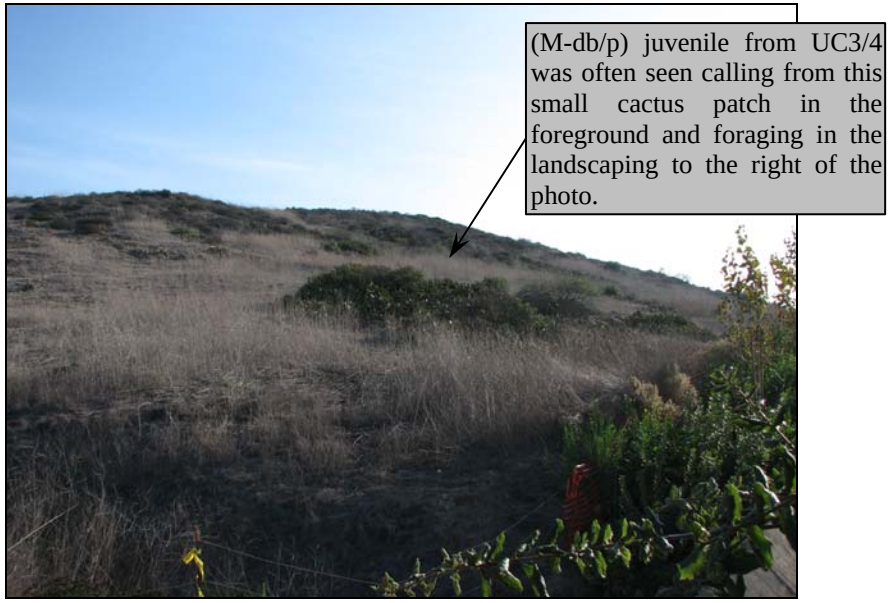

Photo 8: NW view of peak, breeding nest was at the apex to the right.

Photo 9: E view of peak. San Joaquin Corridor 73 to left of photo.

Photo 10: Patch of coastal sage scrub at SE corner of use area (Fig. 2c) where pair and fledgling (M-db/p) were sometimes found foraging.

Appendix 3: Photographs of 2007 Study Sites

UC Irvine 01 Monitoring Site

Photo 11: Area where pair was often found prior to nesting attempt. UC3/4 juvenile (M-db/p) was observed foraging surreptitiously in the elderberry trees in the background on the upper left and being chased by the UC01 pair in the habitat in the background on the upper right.

Photo 12: Area where UC01 pair attempted nesting, but the nest was predated at the nestling stage. Nest was located at the edge of habitat. The grey sticks are dried black mustard (*Brassica nigra*) flowering stalks from previous years.

Appendix 3: Photographs of 2007 Study Sites

El Toro 07 Telemetry Site

Photo 13: El Toro 07 telemetry site nearly a month after the 22 October 2007 Santiago wildfire. Prior to the fire, the wrens foraged in the cactus patch in the foreground, but roosted and nested in the cactus in the grassland in the background. They also foraged in the Elderberry in an arroyo beyond the grassland cactus.

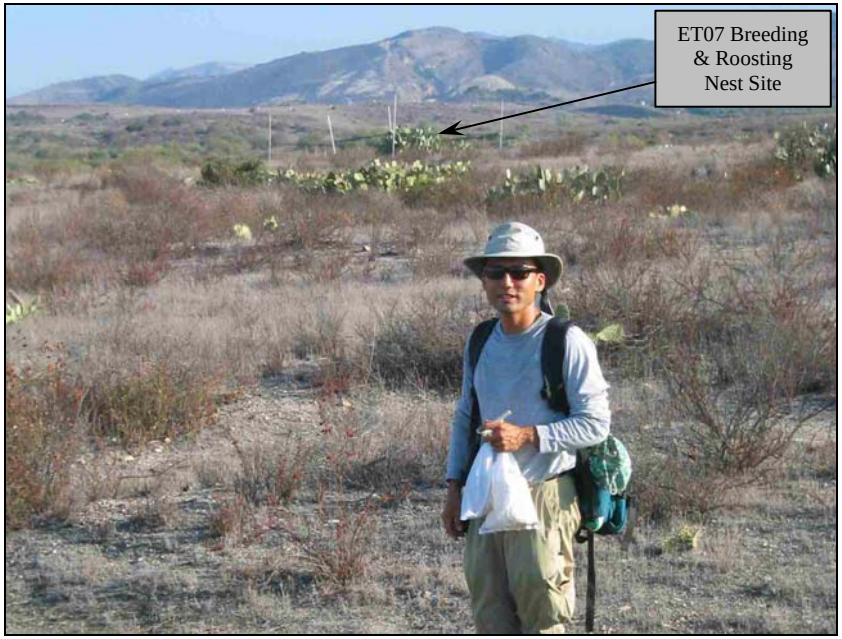

Photo 14: El Toro 07 site 3 months prior to fire. Photo taken just prior to banding and outfitting the wrens with transmitters.

Appendix 3: Photographs of 2007 Study Sites

El Toro Monitoring Sites

Photo 15: El Toro 03 monitoring site almost a month after the 22 October 2007 Santiago wildfire.

Photo 16: El Toro 11 monitoring site after the 22 October 2007 Santiago wildfire. This cactus wren pair often interacted with the ET07 along territorial boundaries (Figure 2d).

Appendix 3: Photographs of 2007 Study Sites

El Toro Monitoring Sites (continued)

Photo 17: El Toro 13 cactus wren monitoring site nearly a month after the 22 October 2007 Santiago wildfire.

Buck Gully Telemetry Site

Photo 18: Buck Gully cactus wren telemetry site where Robert Hamilton found two adults feeding two fledglings. The wrens were detected mostly on the far slope above the willow riparian at the floor of the gully, although at times they were seen foraging from Mexican elderberry (*Sambucus mexicana*) near the willow riparian. Access to the slope was limited due to residents in a gated community above and vegetation and terrain on and below the slope. These were the only wrens detected in Buck Gully.

Appendix 3: Photographs of 2007 Study Sites

Bommer/Shady Ridge Site

Photo 19: Bommer/Shady Ridge site where Robert Hamilton found two adults feeding one fledgling north of the San Joaquin Corridor (73).

Photo 20: Upper Newport Bay 2006 relocation site where in 2007 a cactus wren pair produced one fledgling.