Habitat Requirements of the Coastal Cactus Wren, *Campylorhynchus brunneicapillus,* in Eastern Los Angeles County

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by

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Abstract

Coastal sage scrub is a malacopyllous, shrub dominated community found only in the coastal regions of coastal central and southern California. Due to urbanization, this plant community is rapidly disappearing, along with many of its residents. *Campylorhynchus brunneicapillus sandiegiensis*, the coastal subspecies of the cactus wren, is one such resident. In Orange and San Diego Counties Rea and Weaver (1990) found that coastal cactus wrens prefer vegetation containing patches of *Opuntia* cactus over 1 m tall and dominated by *Eriogonum fasiculatum* and *Artemesia californica* , however little has been done to examine coastal cactus wren populations and habitat throughout their range, especially smaller, marginal populations. Transect surveys and height measurements of cactus and general vegetation at four sites in eastern Los Angeles County showed strong similarities in cactus height, nest height, and dominant vegetative cover to sites studied in Orange and San Diego Counties. Observation suggests , although coastal cactus wrens utilize occasional treelike shrubs in their territories for observation perches, numerous large shrubs (> 2 m) reduce the desirability of the habitat. All four sites showed varying degrees of topographic and vegetative disturbance, yet the cactus wrens didn't exhibit any preference between more disturbed and less disturbed areas. Data collected suggested a potential relationship between cactus height and habitat desirability beyond just the height requirement of 1 m, and a possible correlation between the area of a cactus patch and its corresponding nest height. This study also identified the need for intensive vegetative study of coastal cactus wren habitat on a scale consistent with the size of individual nesting pairs' territories.

Introduction

Coastal sage scrub is a malacopyllous, shrub dominated plant community found only in the Mediterranean climate zone of North America between the San Francisco Bay Region, California, USA and Rosarito, Baja California, Mexico. Its half-woody, facultatively drought deciduous, dominant species form an open cover generally 0.5 to 1.5 m tall (O'Leary 1989). This diverse plant community occurs at elevations between sea level and 600 m, above which it is replaced by its sclerophyllus relative, chaparral. The dominant species of Coastal Sage Scrub consist of California Sagebrush (*Artemisa californica*), California buckwheat (*Eriogonum fasiculatum*), *Eriogonum cinereum*, several sages (*Salvia mellifera, Salvia leucophylla, and Salvia apiana*), and *Encelia californica* (O'Leary 1989).

Coastal sage scrub is a disturbance-based community. Axelrod (1978) suggests that the community arose from disturbed grasslands although there is little evidence to support this. It is proven, however, that fires, and to a lesser extent, floods, are responsible along with aspect and substrate type for local patchiness within coastal sage scrub. As one moves south or east along the range of coastal sage scrub, the floristic composition changes due the increased evapotranspirative stress associated with the climatic gradient. Numerous attempts have been made to classify and quantify these floristic gradients and patches (Kirkpatrick and Hutchinson 1977; Axelrod 1978; Westman 1981, 1983; Holland 1986; Mooney 1988; Desimone and Burk 1992; Sawyer and Keeler-Wolf 1995).

The initial breakdown of coastal sage scrub into a northern and southern component by Axelrod (1978) was further expanded by Westman (1981) into 6 associations (Figure 1). He refers to the northern association, from San Francisco south to about Santa Barbara, as Diablan. In the southern component he identified Venturan, Riversidian, Diegan, Martirian, and Vizcainan, the later two being dominated by succulents and

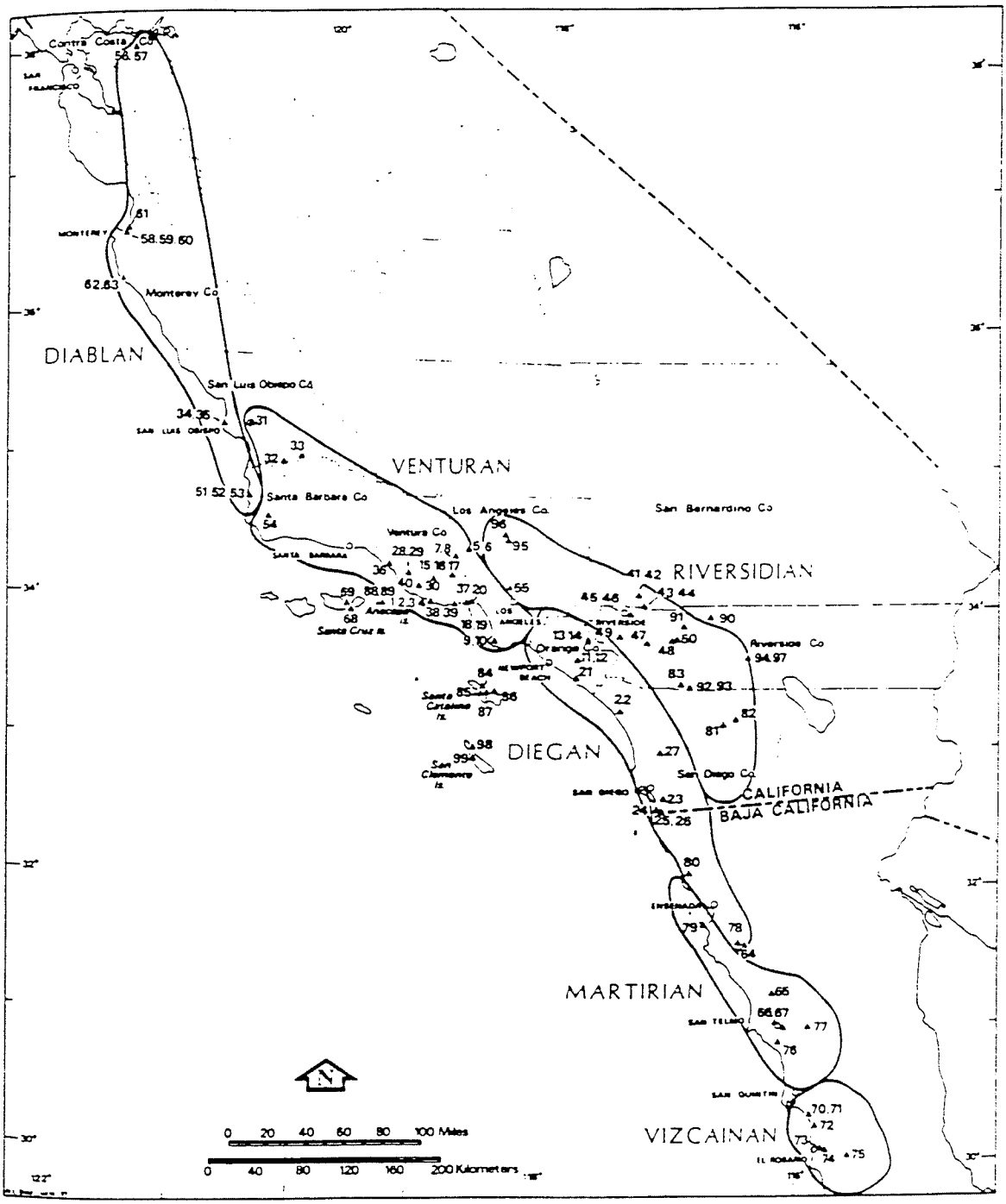


Figure 1. Geographic distribution of coastal sage scrub showing Westman's (1981) six floristic formations.

(from O'Leary, 1990, pg.26)

occurring only in Baja California. Within the Venturan and Riversidian associations, Kirkpatrick and Hutchinson found 11 subassociations. On a more local scale, 5 subassociations were observed by DeSimone and Burk (1992) within a 1585 ha site occurring in an area of transition from Diegan to Riversidian coastal sage scrub.

Southern California is one of the fastest growing regions of the United States. In 1990 the state's population was 30 million with 60% of those people living in the Los Angeles and San Diego areas (O'Leary 1989). Most coastal sage scrub occurs in fertile lowlands and on gentle sloping hills making it extremely vulnerable to both urban development and conversion to agriculture. Development is occurring at such a rapid pace that there is a distinct danger of coastal sage scrub being completely wiped out in Orange and San Diego counties. In most of Los Angeles County this is already the case. It has been estimated that 75-90% of coastal sage scrub has been developed (O'Leary 1989). In 1988, only 6% of the remaining coastal sage scrub was protected. Remaining coastal sage scrub is also threatened by the secondary effects of development. Air pollution, altered fire regimes, fragmentation, and invasive exotic species result in a decline in the overall health of the community and thereby degrade the quality of the habitat. Habitat loss, habitat degradation, and fragmentation has meant that over 90 species associated with coastal sage scrub are listed as sensitive, threatened, or endangered (Coastal Sage Scrub Scientific Review Panel 1992). Included in these are California gnatcatcher, the coastal cactus wren, and the orange-throated whiptail. The gnatcatcher is currently federally listed as a Threatened species under the 1973 Endangered Species Act, the other two are both Candidate Species for listing (Calif. Dept. of Fish and Game 1994).

The issue of federal protection for these three species has created much controversy over economic and ethical priorities, methods for protecting endangered species, and our approach to conservation, in general. It has become apparent that our piecemeal attempts to conserve and protect each threatened species individually is inefficient and ineffective,

especially when faced with a situation where not only are numerous species in danger, but an entire plant community as well (Jensen, Torn, and Harte 1993). In 1991 the California State Department of Fish and Game established a new program aimed at large-scale conservation planning emphasizing habitat and biodiversity preservation known as the Natural Communities Conservation Plan (NCCP). In theory, the NCCP should allow protection of a large section of a given community, including the full assortment of its resident organisms, but there is a definite potential for some species to fall thought the cracks (Jensen, et al. 1993). For this reason we must not completely abandon the individual species approach to conservation.

The majority of the research done on coastal sage scrub and its related species, such as the California gnatcatcher and the coastal cactus wren, has occurred in Orange and San Diego Counties. The reason for this is two-fold. First the majority of the remaining, high quality coastal sage scrub is found in these areas. Second, these areas support the largest populations of gnatcatchers and cactus wrens. However, it is important to keep in mind the diverse vegetative mosaic that characterizes coastal sage scrub (DeSimone and Burk 1992). Most research occurs in the southern coastal region because it is perceived to be the front line in the local battle between development and conservation of the remaining open space. Los Angeles County tends to be viewed as already lost since so little coastal sage scrub remains. As southern California's population has grown, development has fanned out from the city center, leaving only small patches in areas like the Santa Monica Mountains and the foothill region of the San Gabriel Valley. Cactus wren and gnatcatcher populations do exist here, but they are considered to be marginal due to their small numbers and the poor quality of their habitat. However, if we are to understand and protect these species then we need to examine these marginal populations too. They can offer us insight as to how these species cope with fragmentation, invasive exotic vegetation, and other disturbances.

The coastal population of *Campylorhynchus brunneicapillus* has been recognized as being distinctive for some time. However, the relationship of the coastal population to the Baja subspecies, *C. b. bryanti* and *C. b. affinis,* and the inland continental subspecies, *C. b. anthonyi* and *C.b. cousei,* has been debated (Rea and Weaver 1990). In 1986 Rea described the subspecies *C. b. sandiegensis* based on specimens from the San Diego coastal region (Rea and Weaver 1990). Currently the cactus wren populations of southern Orange County, coastal San Diego County, and northwesternmost Baja California are all being considered a part of the distinct subspecies, *Campylorhynuchus brunneicapillus sandiegensis.* Cactus wrens in the Los Angeles area do show some genetic traits of *sandiegensis,* but it has been determined that they are not taxonomically distinguishable from *anthonyi* (Rea and Weaver 1990). Nonetheless, rapidly declining population numbers due to development and habitat fragmentation have led to the entire coastal cactus wren population, including the Los Angeles area, becoming a Candidate 2 species for listing under the federal Endangered Species Act (Table 1)(Ogden 1992).

Table 1. Population Estimates of Coastal Cactus Wren Within Each County.

County	Number of Pairs	Source
Ventura	< 200	Garrett 1992
Los Angeles	125 - 160	Garrett 1992
San Bernadino	40-70	B. McKernan pers. comm.
Riverside	65 - 150	B. McKernan pers. comm.
Orange	150 *	Rea and Weaver 1990
San Diego	< 200 *	Rea and Weaver 1990

from Ogden, 1992 (page 2) *with corrections from Rea and Weaver 1990

The coastal cactus wren is a moderate sized, primarily insectivorous bird that resides year-round in coastal sage scrub (Ogden 1992). Although they forage on the ground and in vegetation, cactus wrens are dependent on patches of tall (usually over 1 m) *Opuntia* cactus for nesting sites. Rea and Weaver found the mean height of cactus

containing cactus wren nests to be 138 cm, while the mean nest height was 94 cm. In addition to the presence of tall cactus, coastal cactus wrens also seem to prefer a dominant vegetative cover of *Artemesia californica* and *Eriogonum fasiculatum,* much like the habitat of the California gnatcatcher. They tend to maintain territories of approximately 1.3 ha (Rea and Weaver 1990).

These habitat characteristics are based upon cactus wren populations occurring in the Diegan coastal sage scrub association in Orange and San Diego Counties. There are no such comparable studies of cactus wren habitat characteristics of the Riversidian association around the Los Angeles area. There are very few remaining large chunks of coastal sage scrub, and its close cousin, alluvial fan sage scrub, in the eastern portion of Los Angeles County. What does remain tends to be highly disturbed, both topographically and vegetatively. However, cactus tends to thrive in disturbed scrub and grassland sites, this along with a large number of exotic species that occur in these site means that Los Angeles area coastal sage scrub characteristics could vary greatly from those in the more extensively studied areas to the south (Benson 1969). The goals of this research were to examine the physical characteristics of the coastal cactus wren habitat in eastern Los Angeles County, compare and contrast the results against cactus wren habitat in Orange and San Diego Counties, and identify what physical characteristics constitute good cactus wren habitat in eastern Los Angeles County.

Methods

Study Sites

Sampling took place at four locations in the eastern San Gabriel Valley during the week of March 18, 1997. The sites were selected based on the known historical presence of cactus wrens and the representation of the two plant communities coastal cactus wrens are known to inhabit in this area, coastal sage scrub and alluvial sage scrub. All four sites show varying levels of disturbance including invasive exotic plant species, dumping, and dirt and paved roads.

Two of the sites, "Padua" and "Santa Fe" are representative of alluvial sage scrub. The "Padua" site (34 8' N, 117 42' W) is located in North Claremont, California, high on the San Antonio alluvial fan at an elevation of 550m, immediately southwest of the intersection of Mt. Baldy Rd. and Padua Rd. The portion studied was approximately 5 ha, with the northern portion partial bisected by Mt. Baldy road. The area is relatively flat with a slight southwest aspect. Residential development borders the site to the west and south. To the north lies the Angeles National Forest, and to the east lies the mouth of San Antonio Canyon. The vegetation is relatively low, with the dominant species being *Eriogonum fasciulatum, Toxicodendron diversilobum ,Opuntia littoralis, Artemesia californica, Opuntia imbricata, Lotus scoparius*, and an occasional *Malosma laurina* or *Adenostomata fasiculatum.*

The "Santa Fe" site (34 7' N, 117 56' W) consists of approximately 6.5 ha on the eastern side of the Santa Fe Dam Flood Control Basin in Irwindale, California, southwest of the First St. gate. The topography is relatively flat, with a mean elevation of 150m. The eastern and southern sides of the natural area are bordered by heavy industry. On the western side recreational swimming and picnic facilities exist. To the north, the natural area joins with the San Gabriel riverbed. Several dirt and paved roads crisscross the area. *Eriogonum fasciulatum, Opuntia littoralis, Opuntia imbricata, Lepidospartum squamatum, Ribes aureum, Malosma laurina, Rhus ovata*, and *Sambucus mexicana* dominate the

vegetation of the site which results in a taller, more closed structure than that found at Padua. Large exotics such as *Agave americana, Schinus molle, Ficus indica*, and *Nicotiana glauca* are also common, further contributing to the tall nature of the vegetative structure.

The other two sites, "Bonelli" and "Glendora", both contain coastal sage scrub, found in the transverse hills and foothills of the region. The "Bonelli" site is located in San Dimas, California (34 5' N, 117 48' W) within the Frank G. Bonelli Regional Park, immediately northeast of the park's maintenance yard parking lot. The 6.75 ha site was on south-facing, moderately sloped hillsides, ranging in elevation from 270-300m. *Eriogonum fasiculatum, Opuntia littoralis, Artemisia californica, Lotus scoparius*, and exotic herb species dominate the low, open vegetation punctuated by the occasional *Quercus agrifolia, Sambus mexicana*, or *Malosma laurina*. To the north, the site is bordered by the Raging Waters Theme Park, Interstate 210 runs west of the site , to the south is a parking lot, and the Puddingstone Reservoir is to the east. Several dirt roads pass through the site.

The "Glendora" site is located on the steep southern slopes of the San Jose Extension, a small cluster of hills in Glendora, California (34 7' N, 117 50' W). Interstate 210 runs along the southern base of the hills, the other three sides are surrounded by residential development. The site consists of 6 ha just south of the east-west ridgeline, between 1,000' - 1,200' (300-365m) in elevation. The vegetation, like that of "Bonelli", is low and open, dominated by *Eriogonum fasiculatum, Opuntia littoralis, Lotus scoparius*, and exotic herbs with occasional larger, tree-like shrubs.

Data Collection

Each site was visited once before data collection began to check for the presence of cactus wrens. These preliminary visits occurred during February and March 1997 on clear, windless days between the hours of 8 am and 11 am, as specified in the Coastal Sage

Scrub Review Panel's (1992) specifications for censusing cactus wren populations. A recording of cactus wren calls, in combination with "pishing", was used to attract the birds. The number of cactus wrens observed was recorded and later compared with the number of wrens observed during vegetative sampling.

Each cactus patch within a site was checked for the presence of a cactus wren nest. The outside perimeter and maximum height of each patch, along with the height of the wren nest, were measured and recorded. A minimum of five nests in separate patches were measured for each site. The size of each site was determined by how much area had to be surveyed to find five separate nesting sites.

Four patches at each site, containing nests built during the current breeding season, were selected for vegetative transect surveys. If more than four recently constructed nests were found, the four transect sites were randomly selected by assigning a sequential number to each nest and then selecting numbers using a random number table. If less than four recently constructed nests were found than only that many transects sets were performed, as was the case at the "Glendora" and "Santa Fe" sites. To perform the vegetative surveys, the approximate center of the cactus patch was determined and marked with flagging. Fiberglass tape measures were then stretched out 12.5 m from the center mark in each of the four cardinal directions, creating a 25m north-south transect (known as N/S) and a 25m east-west transect (known as E/W). These directions were chosen to take into account any directional biases resulting from aspect and sunlight intensity. Along each of these, the line-intercept method was employed to determine species coverage (Brower, Zar, and van Ende 1990). The average vertical height of the vegetation within a 10cm radius of the tape was also measured along each transect at every meter.

Data Analysis

A one way analysis of variance (ANOVA) was performed for each of the three cactus measurements, the total cactus height, cactus perimeter, and nest height to test for

similarity in the samples from each site. Normally an ANOVA measures the probability of a non-random difference between multiple means. With confidence limits of 95% a probability value (P) of 0.05 tells us that there is 5% of wrongly concluding that the means are equal (Zar 1984). However, just because a p-value is greater than 0.05 doesn't necessarily mean that we can confidently say that the means are equal, it just means that we can't be certain that they are different. Not significantly different is not the same thing as significantly not different. The closer the P-value is to 1.0, the greater our confidence is that these means are equal. For this study we used a P-value of > 0.50 for the confidence limits of the ANOVAs.

Linear regressions were performed to determine if there was a mathematical relationship between the nest height and either the total cactus height or the cactus perimeter. For the vegetative height profiles, an average profile was calculated for each site. All data was entered and analyzed using Microsoft Excel 5.0 for the Macintosh.

Results

The greatest number of cactus wrens were observed at the Bonelli site. The least number of birds were found at the Santa Fe site (Table 2). Although populations were surveyed within a given area, individual cactus wren territories were not measured.

Table 2. Cactus populations at study sites.

site	wrens observed during vegetative sampling	birds per hectare
Padua	5	1.0
Bonelli	8	1.18
Glendora	3	0.5
Santa Fe	2	0.31

Mean total cactus height was greatest at Bonelli (Table 3). Glendora and Santa Fe's means were slightly lower, but not statistically significant (Table 3). Mean cactus perimeter for Glendora was almost twice as high as the mean for the other three sites (Table 3). Padua, Bonelli, and Glendora all shared similar mean nest heights, with only Santa Fe being significantly lower (Table 3). The ANOVAs showed no significant similarity between sites for total cactus heights, cactus perimeter, or nest heights (Table 4).

Table 3. Mean values for cactus and nest measurements by location.

site	total cactus height (cm)	cactus perimeter (cm)	nest height (cm)
Padua	128.1	13.4	98.6
Bonelli	134.5	19.9	93.5
Glendora	118	30.7	90.6
Santa Fe	118	18.8	80.0

Table 4. One factor Analysis of Variance results for each: cactus height, cactus perimeter, and nest height, comparing means by site.

Measurement	DF	Sum of Squares	Mean Square	F - Value	P Value
cactus height	3	1381.339	460.446	1.359	0.2789
cactus perim.	3	923.126	307.708	4.486	0.0123
nest height	3	1389.640	463.213	2.505	0.0787

Nest height showed a strong negative correlation to cactus perimeter only for the Santa Fe site. This correlation also showed a significant linear regression. All other correlations were not significant (Table 5).

Table 5. Values for Nest Height to Cactus Structure Correlations and Regressions.

mean nest height by site	mean cactus height	mean cactus perimeter
Padua	C = 0.2996 P = 0.4709 R^2 = 0.0898	C = -0.2172 P = 0.6053 R^2 = 0.0472
Bonelli	C = 0.5552 P = 0.0957 R^2 = 0.3083	C = 0.0821 P = 0.8216 R^2 = 0.0067
Glendora	C = 0.3435 P = 0.4047 R^2 = 0.1180	C = 0.0622 P = 0.8836 R^2 = 0.0039
Santa Fe	C = -0.4069 P = 0.3649 R^2 = 0.1656	C = -0.8815 P = 0.0087 R^2 = 0.7769

At all sites but Santa Fe, *Eriogonum fasiculatum* and *Opuntia littoralis* were the dominant species in terms of vegetative cover in the cactus nesting areas. Bonelli showed the highest alpha diversity of 9 species; Padua had 6 species; Glendora and Santa Fe both had only 5 species (Table 6, Figures 2-5).

Three of the four vegetative profiles show roughly the same pattern. Padua, Glendora, and Santa Fe all show a relatively low and somewhat flat profile. Each shows the cactus as its longest, but not necessarily its tallest, rise in the middle of the profile,

Figure 2. Ranked vegetative cover at Padua.

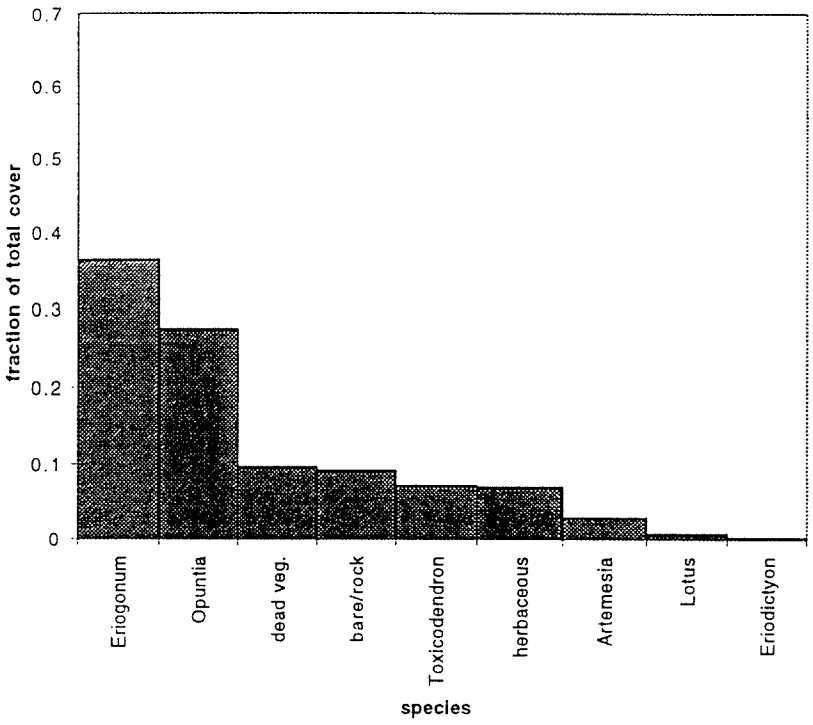


Figure 3. Ranked vegetative cover at Bonelli.

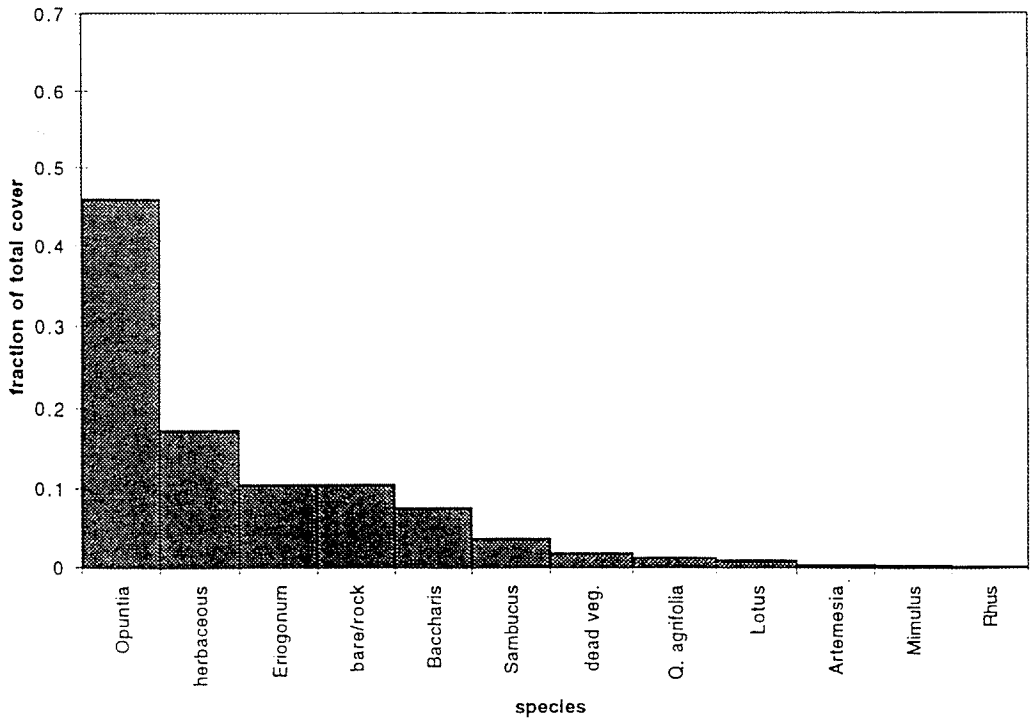


Figure 4. Ranked vegetative cover for Glendora.

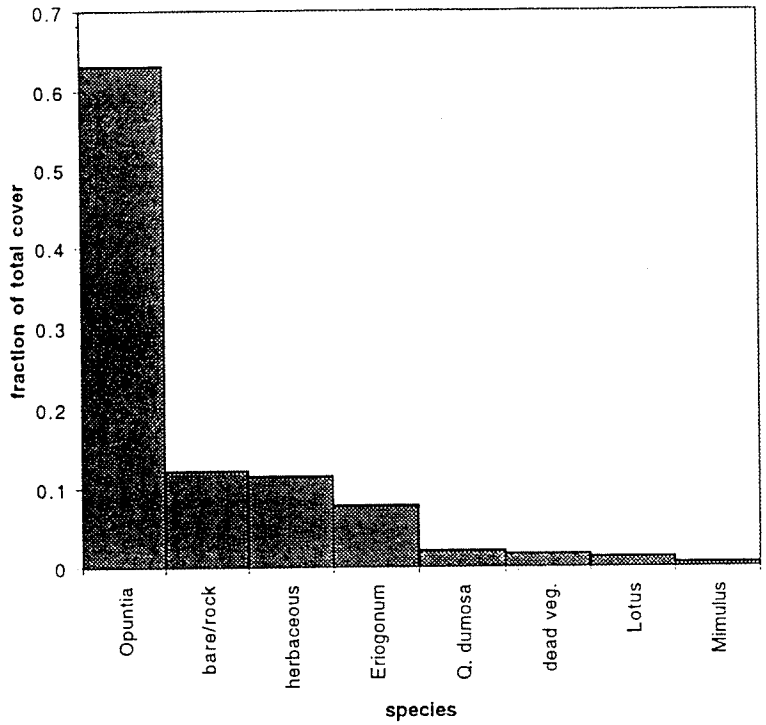


Figure 5. Ranked vegetative cover for Santa Fe.

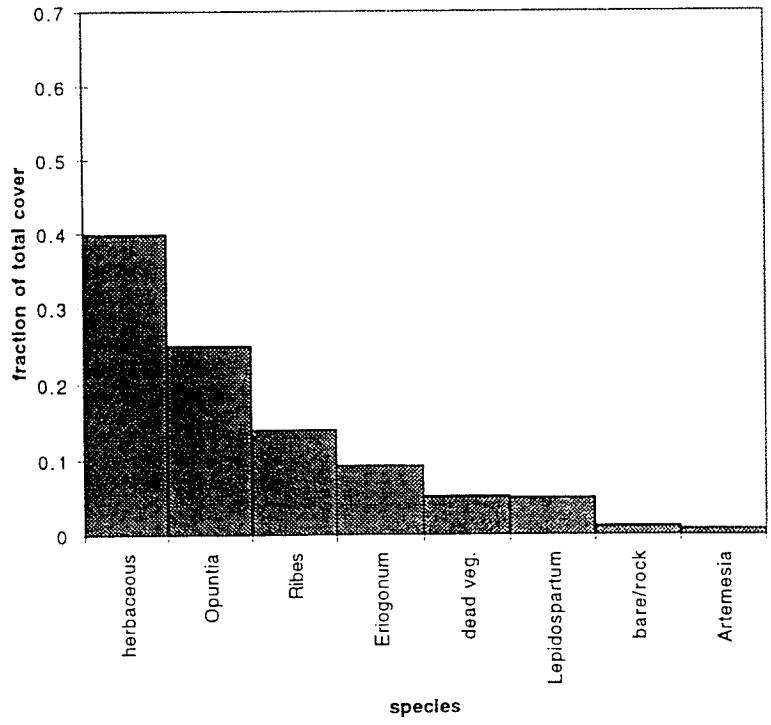


Table 6. Vegetative cover (%) by site.

species	Padua	Bonelli	Glendora	Santa Fe
Eriogonum fasiculatum	36.2	10.5	7.7	9.2
Opuntia littoralis	27.3	45.9	63.1	24.9
Artemesia californica	2.8	0.3	-	0.8
Lotus scoparius	0.6	0.9	1.2	-
Eriodictyon crassifolium	0.6	-	-	-
Baccharis pilularis	-	7.6	-	-
Toxicodendron diversilobum	7.1	-	-	-
Sambucus mexicana	-	3.6	-	-
Quercus agrifolia	-	1.2	-	-
Quercus dumosa	-	-	2.1	-
Lepidospartum squamatum	-	-	-	5.0
Mimulus aurantiacus	-	0.2	0.5	-
Ribes aureum	-	-	-	13.9
Rhus ovata	-	0.1	-	-
herbaceous annuals	6.9	17.3	11.5	39.8
dead vegetation	9.6	1.8	1.6	5.1
bare ground/rock	9.1	10.5	12.2	1.2

Figure 6. Average vegetative height profile for Padua.

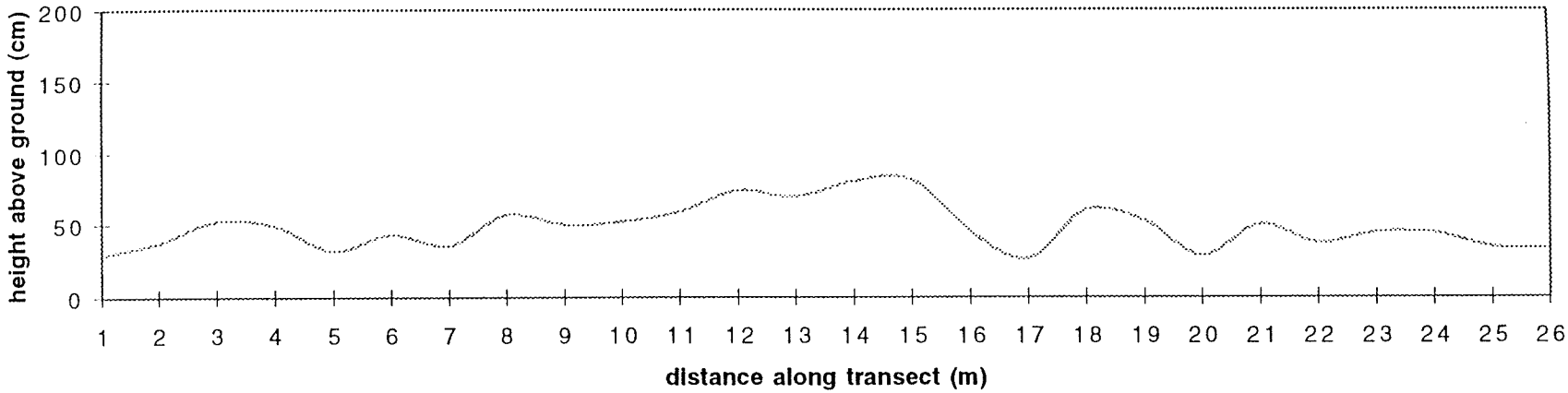


Figure 7. Average vegetative height profile for Bonelli.

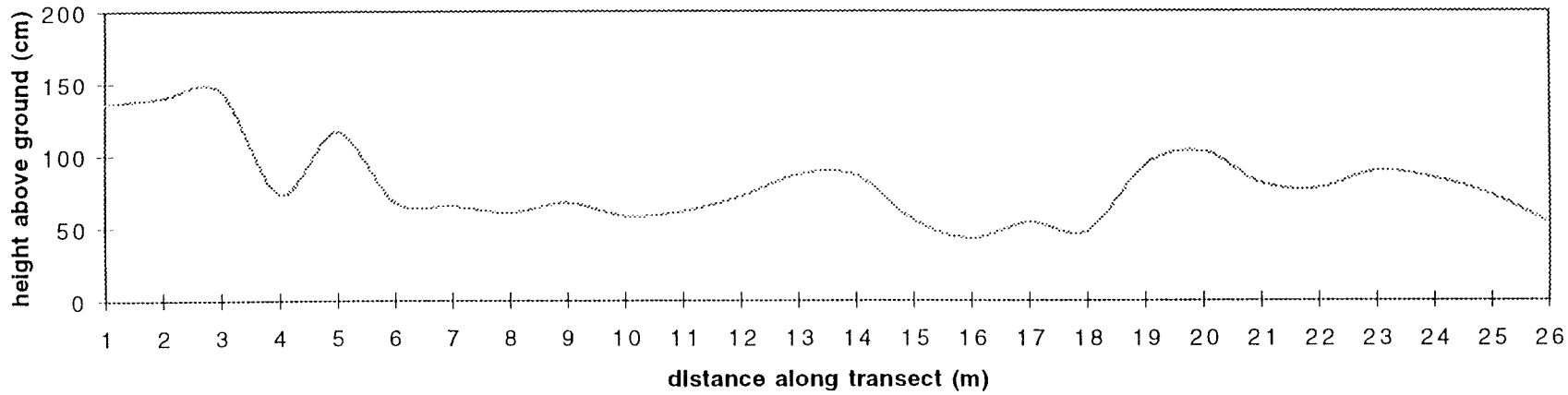


Figure 8. Average vegetative height profile for Glendora.

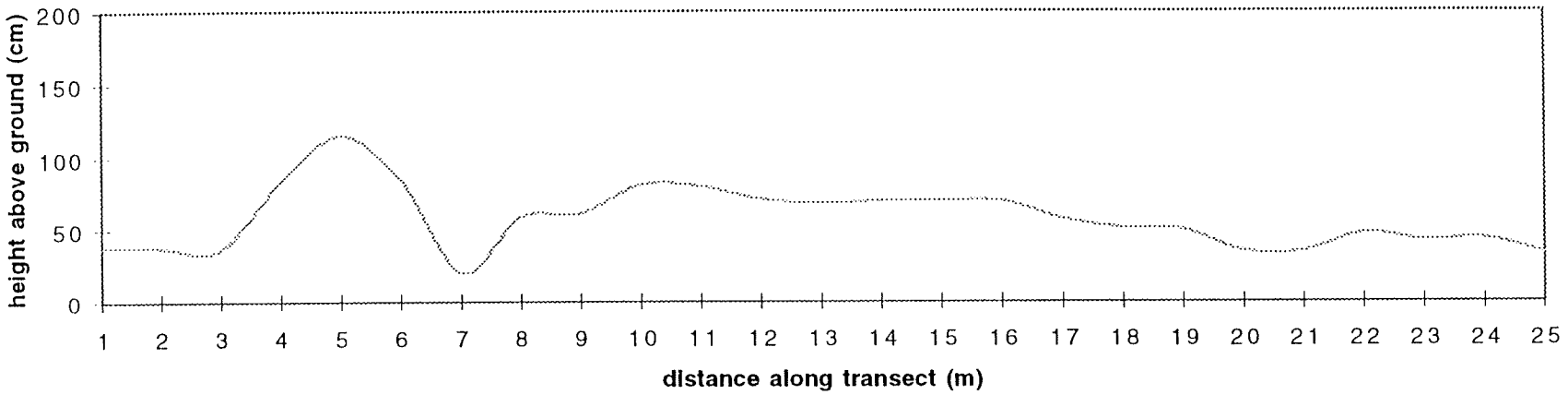
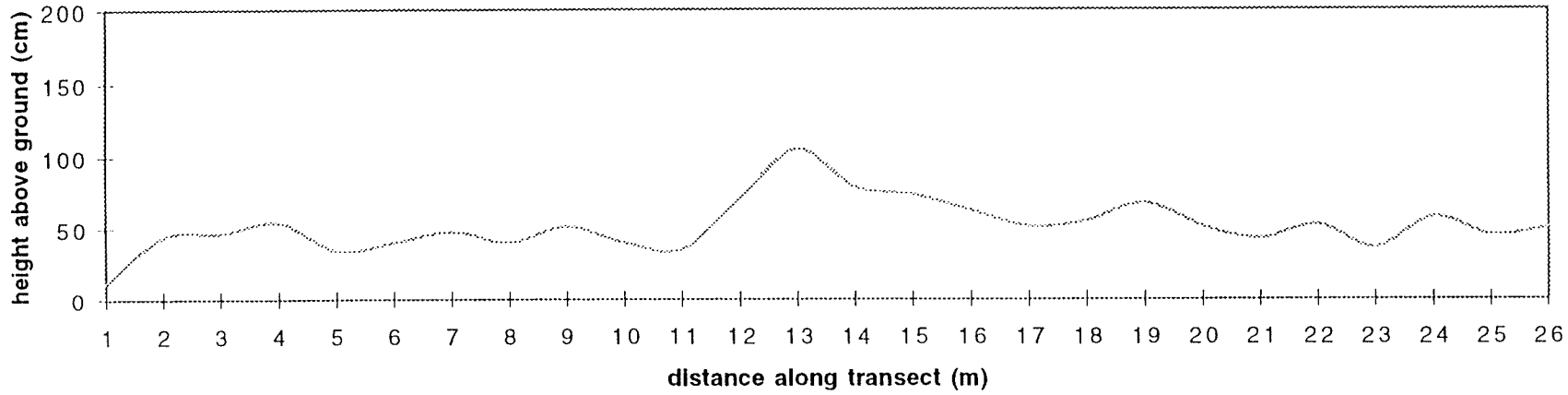


Figure 9. Average vegetative height profile for Santa Fe.



approximately 90 m tall. The height of the surrounding vegetation generally tapers down from the center rise. (Figures 6,8,9). The Bonelli profile also shows a rise of about 90 m in the middle which represents the cactus, however it is neither the tallest nor the longest. The profile shows much more diverse vegetative height structure than at the other three sites (Figure 7).

Discussion

The physical characteristics of cactus patches used as nesting sites by coastal cactus wrens in the eastern Los Angeles County area showed definite similarity to the characteristics Rea and Weaver (1990) described for Orange and San Diego County populations. Mean nest heights for Padua, Bonelli, and Glendora were within a few centimeters of Rea and Weaver's mean of 94 cm. Mean cactus heights for the four sites also appear to confirm the coastal cactus wren's preference for cactus over 1 m tall throughout the population's range (Rea and Weaver 1990, Ogden 1992) However, there does not appear to be any further relationship between the height of the nest and the height of the cactus. The significant negative correlation between cactus perimeter and nest height observed at the Santa Fe site does suggest that the area of a cactus patch may play a role in its suitability as a nesting site, but further sampling would be needed to confirm this.

The analysis of variance results for cactus height, cactus perimeter, and nest height show no significant similarity between the four sites. However, the sample sizes were small (n=28 for cactus structure measurements and n=33 for nest height measurements) compared to Rea and Weaver's sample of 98 in coastal Orange and San Diego Counties. They also showed a large range for cactus height and nest height (74-226 cm and 40-165 cm, respectively).

Vegetation at all four sites consisted of large amounts of exotic species, as expected. Most of the exotics occur as herbaceous annuals and their dominance is reflected in their high percent cover values for the Bonelli, Glendora, and Santa Fe sites. All four sites contained large amounts of *Eriogonum fasiculatum* and *Opuntia littoralis*, as predicted by the literature, but surprisingly, *Artemesia californica* was found in only limited quantities. It appears that large amounts of exotic vegetation is acceptable as habitat for coastal cactus wrens as long as the vegetation contains tall patches of *Opuntia* spp. cactus and approximates what the California Native Plant Society calls a California sagebrush-California buckwheat series.

Based on field observations and on the average vegetation height profiles generated for each site the height structure of the vegetation seems to be an important factor in determining the suitability of wren habitat. Low, open scrub with an average height of 0.5 -1.0 m seems to be the preferred vegetative structure in eastern Los Angeles County. In areas where large shrubs over 2 m tall, like *Malosma laurina* and *Sambucus mexicana* where common cactus wrens were noticeably absent. The same was true of areas where shrubs and herbaceous annuals grew less than 0.5 m tall. Its clear that vegetation between 0.5 and 1.0 m is needed to provide foraging opportunities with adequate cover. What isn't as clear is the lack of cactus wrens when large shrubs dominate an area. At all four sites, cactus wrens made use of the occasional large shrubs that occurred in their territories as observation perches. During population surveys, a cactus wren would usually land on the top of a nearby cactus patch, respond to the recorded calls with its own call, then perch within a *Malosma laurina* or *Sambucus mexicana* and watch. Its possible that a predominance of large shrubs decreases an area's value as cactus wren habitat because it offers only limited visibility, making it more difficult to detect predators or defend a territory. Numerous large shrubs may also compete with adjacent cactus for sunlight, water, and other nutrients, resulting in smaller, less robust cactus patches, and therefore less desirable nesting habitat.

Small scale physical disturbance in the form of previously graded areas and roads carrying vehicular, equestrian, and foot traffic doesn't seem to deter cactus wrens. Several recently constructed nests were found to occur in cactus patches immediately adjacent to roads at the Padua, Bonelli, and Santa Fe sites. The Bonelli and Glendora sites both had areas previously disturbed by grading and road construction which were covered with large patches of *Opuntia littoralis,* containing cactus wren nests. It appears that small disturbed patches located next to more intact vegetation may benefit cactus wrens by providing tall, robust patches of cactus with good, unrestricted visibility of the surrounding area.

According to Benson (1969), cactus thrives in disturbed areas, therefore its possible that cactus patches along roads and in graded areas are appealing due to their size and vigor.

Another method of examining which habitat characteristics are preferable and which are not is to compare the four study sites in terms of the size of their cactus wren populations. Of the four sites, Bonelli had the largest cactus wren population with eight individuals observed, which is interesting since Bonelli also showed the greatest mean cactus height, the highest alpha diversity along vegetative transects, and the most topographically diverse average vegetation profile. The Glendora and Santa Fe sites, which were home to the smallest populations (three and two cactus wrens, respectively) had the lowest mean cactus heights, the lowest vegetative alpha diversity, and relatively homogeneous mean vegetative height profiles.

The possible relationship between cactus height and population size is intriguing. It could be that there simply are more patches of tall (> 1 m) cactus at Bonelli than at other sites, offering an abundance of suitable nesting habitat or, perhaps, cactus wrens show a preference for the tallest cactus patches available, meaning an area with cactus 2 m tall would be selected over an area with cactus only 1.5 m tall. An extensive study involving more detailed population surveys and numerous nesting sites would be necessary to further examine this relationship.

Floristic diversity and its potential relationship to cactus wren habitat quality is difficult to quantify. The problems lies in heterogeneous, patchy nature of coastal sage scrub. The California Native Plant Society refers to coastal sage scrub as a collection of vegetative series, rather than as a single plant community. This question of scale has plagued researches and conservationists, especially when trying to design preserves. DicKard (1996) found the scale at which vegetation heterogeneity was measured made a significant difference in terms of whether or not ecological patterns and relationships were observed. In this study, vegetative composition was only studied in terms of individual nest sites which explains why *Opuntia littoralis* appears to be the dominant cover at three of

the four sites. The diversity and cover were only measured along two 25 m transects at each nest, yet Rea and Weaver found cactus wren territories ranging from 0.8 to 2.0 ha in size and containing as many as a dozen nests, suggesting that our vegetative measurements are on too small of a scale. A study in which actual wren territories are mapped and the corresponding area's vegetation is then surveyed and analyzed is needed to better understand the coastal cactus wren's relationship to vegetation other than just the cactus patches it nests in.

In this study the physical characteristics of coastal cactus wren nesting sites in eastern Los Angeles County seem to reflect those found by Rea and Weaver (1990) for populations in coastal Orange and San Diego Counties. A clearer understanding of the vegetative diversity of cactus wren habitat is needed. On a macro level, coastal sage scrub subassociations or series partially dominated by *Eriogonum fasiculatum* and *Artemesia californica* and containing tall specimens of *Opuntia* spp. seem to be the coastal cactus wren's only requirements, however, floristic study at the proper scale could reveal many subtle patterns in habitat preference and geographic variation. Such work has important implications for designing habitat protection for the coastal cactus wren. I encourage researchers to consider and include so-called marginal populations and their habitat in future studies and not just focus on the larger, more viable populations, lest the larger populations become "marginalized" themselves.

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Appendix A.
Cactus and nest measurements for all sites.

cactus height	nest height	cactus perimet	location
130	85	17	pad
125	90	8	pad
120	90	16	pad
115	115	12	pad
130	90	14.5	pad
125	90	12.5	pad
140	110	16.5	pad
140	120	11	pad
160	80	14	bon
135	100	19	bon
125	90	21	bon
165	110	21.5	bon
170	100	21.5	bon
105	80	12	bon
130	90	45	bon
95	75	19	bon
120	90	9.5	bon
140	120	17	bon
110	90	53	glen
130	110	27.5	glen
130	65	27.5	glen*
130	105	27.5	glen*
130	85	27.5	glen*
105	85	21	glen
110	80	24	glen
135	105	28	glen
110	90	14.5	santa
100	85	22	santa
100	75	22	santa*
145	70	23	santa
145	70	23	santa*
110	75	20.5	santa
125	95	14	santa

Appendix A.
Vegetative cover (m) along a 25 m transect at Padua.

site	pad	pad	pad	pad	pad	pad	pad	pad
#	1	1	2	2	3	3	4	4
transect	n	w	n	w	n	w	n	w
Opuntia	10.6	7.7	5.3	5	6.9	6.8	9.5	2.5
Eriogonum	10.3	13.2	3.1	7.1	10.9	12.9	9.6	5
Toxicodendron	5.8	2.3			0.8	0.2	1	4.1
herbaceous	0.4	3.3	2.1	0.1	2.5	1.2	1.6	2.5
bare/rock		3.2	1.5	3.1	2.9	0.3	2	2.9
Artemesia		1	1.5	0.9			0.6	1.7
dead veg.	2.9	1.5	1.2	0.1	1.5	5.1	1.3	5.4
rock	0.2		0.5		0.4	0.5	0.6	
lotus							0.3	1
mimulus								
bacch								
Sambucus								
Ribes								
yerba			0.3					
live oak								
rhus								
scrub oak								
scalebroom								
total	30.2	32.2	15.5	16.3	25.9	27	26.5	25.1

Appendix A.
Vegetative cover (m) along a 25 m transect at Bonelli.

site	bon	bon	bon	bon	bon	bon	bon	bon
#	1	1	2	2	3	3	4	4
transect	n	w	n	w	n	w	n	w
Opuntia	15.8	9.7	8.9	9.2	9.3	13.9	14.9	13.2
Eriogonum			0.4	8.4	1.3	8	3.4	0.2
Toxicodendron								
herbaceous	6.7	13.4	4	1.1			1.8	8.8
bare/rock	2.5	1.9	1.5	3.2	2.1	2.3	2.6	3.2
Artemesia				0.5				0.1
dead veg.			2.9	0.4	0.4			
rock							0.9	1.5
lotus						0.3	1.5	
mimulus				0.5				
bacch			3.2	0.4	7.2	4.9		
Sambucus			3.6	3.9				
Ribes								
yerba								
live oak			2.5					
rhus			0.3					
scrub oak								
scalebroom								
total	25	25	27.3	27.6	20.3	29.4	25.1	27

Appendix A.
Vegetative cover (m) along a 25 m transect at Glendora and Santa Fe.

site	glen	glen	glen	glen	santa	santa	santa	santa
#	1	1	2	2	1	1	2	2
transect	n	w	n	w	n	w	n	w
Opuntia	19.1	15	15.9	16.7	4.6	10.9	4	5.7
Eriogonum	2.8	5.4			3.2	2	0.6	3.5
Toxicodendron								
herbaceous	1.2	2.9	4.1	4	12.6	3.9	19.2	4.5
bare/rock	1.7	0.9	4.4	5.9				1
Artemesia							0.8	
dead veg.	0.9	0.8			2.8		0.8	1.6
rock						0.2		
lotus			1.3					
mimulus				0.5				
bacch								
Sambucus								
Ribes					4.7	9.4		
yerba								
live oak								
rhus								
scrub oak	2.2							
scalebroom						5		
total	27.9	25	25.7	27.1	27.9	31.4	25.4	16.3

Appendix A.
Vegetative heights along a 25 m transect for Padua.

	pad site 1	pad site 1	pad site 2	pad site 2	pad site 3	pad site 3	pad site 4	pad site 4
meters	n/s	e/w	n/s	e/w	n/s	e/w	n/s	e/w
0	80	0	0	10	40	45	5	50
1	70	30	20	5	40	50	5	75
2	145	55	50	10	55	35	35	30
3	25	25	35	20	95	15	65	110
4	35	0	55	10	80	35	15	20
5	0	75	40	20	20	55	70	60
6	0	15	0	20	40	105	95	5
7	45	60	30	20	35	90	80	95
8	65	35	0	25	45	70	20	140
9	55	65	60	0	30	55	40	110
10	45	70	80	40	55	20	70	90
11	45	25	110	95	75	60	100	80
12	45	45	105	110	85	85	80	0
13	70	55	100	115	75	50	80	95
14	90	80	100	95	40	110	85	50
15	75	50	50	0	55	60	0	70
16	75	15	10	40	5	20	45	0
17	70	90	30	85	30	65	40	70
18	55	80	15	40	55	35	90	50
19	35	40	10	35	0	20	60	25
20	15	75	0	80	45	40	120	25
21	0	70	20	60	10	15	40	80
22	80	10	10	65	5	80	60	45
23	90	25	25	55	30	40	65	20
24	50	75	0	50	0	45	45	10
25	45	70	0	60	15	60	15	0

Appendix A.
Vegetative heights along a 25 m transect for Bonelli.

	bon	bon	bon	bon	bon	bon	bon	bon
	site 1	site 1	site 2	site 2	site 3	site 3	site 4	site 4
meters	n/s	e/w	n/s	e/w	n/s	e/w	n/s	e/w
0	115	120	600	60	70	30	45	45
1	130	90	400	310	40	30	50	70
2	100	50	400	290	140	55	25	100
3	10	40	40	210	140	50	35	60
4	15	40	0	500	160	55	100	60
5	0	20	0	65	210	105	60	80
6	90	25	0	50	195	90	70	0
7	80	0	0	0	160	40	120	85
8	80	65	0	60	140	65	130	0
9	75	70	35	55	110	30	80	10
10	80	95	70	40	65	0	80	60
11	70	70	85	75	0	95	100	80
12	70	60	70	80	110	90	115	100
13	60	60	70	80	100	80	120	120
14	70	65	0	50	0	85	90	80
15	80	60	35	0	80	0	55	30
16	90	80	30	45	70	95	0	20
17	100	0	90	0	40	100	40	10
18	95	0	280	5	50	220	65	30
19	85	110	230	50	50	180	65	50
20	90	115	150	60	70	70	60	30
21	70	100	160	80	0	85	65	60
22	80	110	200	90	0	110	60	65
23	120	110	180	90	0	75	40	60
24	110	100	180	60	0	55	45	30
25	120	105	55	50	0	40	15	40