

Abstract. Coastal Cactus Wrens (*Campylorhynchus brunneicapillus*) not only depend upon suitable habitat for breeding nests but also for year-round roosting nests. Several parameters of nest containing and non-nest containing prickly pear cactus patches in Chino Hills State Park were measured to determine the characteristics of a nest-site. Multiple logistic regression indicates coastal Cactus Wren nest-sites correlate to percent cover and average height of shrubs within the cactus patch. Coastal Cactus Wrens place the nest in a cactus patch with the nest entrance at a significant distance from nearby shrubs. These results contribute to producing a more complete Habitat Suitability Index for coastal Cactus Wrens in southern California's cactus scrub habitat.

Key words: cactus scrub, Cactus Wren, *Campylorhynchus brunneicapillus*, coastal sage scrub, nest-site selection.

INTRODUCTION

Birds have a great potential to encounter and survey a wide range of habitats to select a territory for a suitable nest-site. A viable population is largely dependent on the contribution of successful nests producing fledglings (Sutter 1997). Correlating reproductive success with habitat characteristics to determine how nest-sites are chosen may not be reliable because studies have shown that females chose their nest-site before emergence of the nestlings preferred food type (Pribil and Picman 1997). Males of most bird species acquire a territory to attract a potential breeding mate. Since females are typically not territorial, they may spend time choosing the best nest-site location from existing male territories. The female's assessment of a suitable habitat is not always reliable because of factors such as diseases, predators, future resource availability and adverse weather conditions, that may not be apparent at the time of nest-site selection (Orians and Wittenberger 1991). A better alternative to using the reproductive success method is to compare the sites chosen by females to comparable sites not chosen. Several studies have used this method for determining nest-site selection (Belthoff and Ritchison 1990, Sieg and Becker 1990, Orians and Wittenberger 1991, Haggerty 1995, Pribil and Picman 1997, and Sutter 1997). Most of these nest-site selection studies focused on birds building only a breeding nest. Because Cactus Wrens construct a year-round roosting nest in addition to a breeding nest, their duration of commitment to a nest-site is relatively longer than other birds.

Measuring 20 centimeters in length, the Cactus Wren, *Campylorhynchus brunneicapillus*, is the largest wren in the Family Troglodytidae. A heavily spotted breast, barred wings, a white eyebrow on a brown crown, and black and white bars underneath a long tail characterize male and female plumage. The male is typically the aggressor in maintaining the one-hectare minimum territory and has a more complex and clearer song than the female. The diet of a southern Californian population, reported by Bent (1948), contained 83% animal matter consisting of Coleoptera, Hymenoptera, Orthoptera, Hemiptera, Lepidoptera, and some Arachnids. The remaining 17% are comprised of laurel sumac (*Malosma* spp.), filaree (*Erodium* spp.) and fiddleneck (*Amsinckia* spp.) seeds, and cactus (*Opuntia* spp.), elderberry (*Sambucus* spp.) and buckthorn (*Rhamnus* spp.) fruit pulp.

The coastal Cactus Wren constructs about a 30-centimeter long, enclosed, bulky nest of stems and grasses. The nest is securely wedged between pads of prickly pear cactus (*Opuntia littoralis*) within coastal sage scrub. Males and females construct their own individual year-round roosting nest and cooperatively build a separate breeding nest during the breeding season (Anderson and Anderson 1959). Cactus Wrens continue maintaining their personal nest by adding plant material and feathers. If their nest is destroyed beyond repair, the Cactus Wren will construct a new nest of either new material or old nest material in the same territory (Flaagan per. obs.). Anderson and Anderson (1973) reported the above ground height range of Cactus Wren nests was 0.9 to 2.3 meters and the minimum height of a nest-containing plant was 90 cm.

Cactus Wrens, in the different regions they occupy, prefer to nest in spiny shrubs or trees, such as cholla and prickly pear cacti (*Opuntia* spp.), mesquite (*Prosopis* spp.), and acacia (*Acacia* spp.) (Bent 1948, Anderson and Anderson 1973, and Baicich and Harrison 1997). This preference is assuming that Cactus Wren have adapted their nesting behavior to place their conspicuous nest in prickly structures for protection against nest predators; mainly snakes and small mammals. Predators may gain access to a nest located in a prickly pear cactus when invasive shrubs provide an easy route. Cactus Wrens have occasionally been observed to nest in non-native and non-spinescent plants (Anderson and Anderson 1973, Farley and Stuart 1994). All non-native and non-spinescent plants that contained nests were over 2.0 meters tall and all nests found were at least 2.0 meters above ground. This height may be sufficient to put a nest out of reach or sight of a predator and, therefore, compensate for nesting in non-spinescent plants. Short (1985) suggested, in his Cactus Wren Habitat Suitability Index model, that as the density of thorny or spiny shrubs increased from 0 to 125 plants per hectare the number of potentially suitable Cactus Wren nest-sites increased.

METHODS

STUDY SITE

The study site is located in north Orange County, California, on the United States Geological Survey Yorba Linda quadrangle (7.5 minute topographic map). The study site incorporates the westerly one-third of Chino Hills State Park (CHSP), the Northeast

Preserve, adjacent to the southwestern border of CHSP, land owned by Aera adjacent to CHSP, and the Robert B. Diemer Filtration Plant where coastal sage scrub (CSS) is the dominant habitat. The CSS community fits into the category of Sawyer and Keeler-Wolf's (1995) California sagebrush series.

The study site's elevation range is 120-330 m. The frost-free season is 200-340 days. Precipitation ranges from 35.6 to 63.5 cm annually with a mean air temperature of 34°C (USDA 1974). For multiple periods of 1-3 days in the spring and fall, "Santa Ana" winds reaching speeds of 80 km hr⁻¹ originate from the desert to the northeast creating extremely dry and warm conditions throughout Southern California.

STATISTICAL ANALYSES

This study was conducted from 5 February 1998 - 14 June 1999. Coastal Cactus Wren nests were located by searching all *Opuntia littoralis* patches within the study site. Only active nests determined by observing Cactus Wren activity were measured for this study. Nine parameters of nest-containing cactus patches were measured including height, length, and width of the cactus patch. Point-line analysis provided the percent cover and the average height of shrubs within the cactus. To determine if the proximity of a shrub to the nest is a nest-site predictor I measured the distance from the nest entrance to the nearest shrub. The distance to the nearest cactus patch and *Sambucus mexicana* was also measured because of the various resources the plants provide the coastal Cactus Wren.

Non-nest patches studied were within one square hectare of an active coastal Cactus Wren's nest with the nest-containing patch marking a corner of the square hectare. By walking in a random cardinal direction the first 90 cm tall non-nest cactus patch encountered was measured. All measurements for nest-containing patches were duplicated for non-nest patches. A hypothetical nest was located within non-nest patches based on the shape of the cactus pads that could be used for support of a "nest." The exception to this method was if an abandoned nest was found within 1 square hectare of the active nest. A nest was classified as abandoned when it appeared to be dishevelled or flattened. This was measured in order to get a true nest entrance to shrub distance.

The data were analyzed using multiple logistic regression to determine which characteristics of a prickly pear cactus patch a coastal Cactus Wren uses to choose a suitable nest-site. To test if the model fit the data I used the Hosmer and Lemeshow goodness-of-fit test.

RESULTS

Sixty-six nests within 51 cactus patches were measured. Cactus patch parameters were analyzed using the multiple logistic regression model to determine the likelihood (odds ratio) of the coastal Cactus Wren's nest-site selection based on the variables I measured. Backwards selection excluded the insignificant variables ($P > 0.05$) including the distance to the nearest *Opuntia littoralis* and *Sambucus mexicana*, and the height of the

cactus patch. The fit of the resulting measurements of cactus patch width and length, percent cover and average height of shrubs within the patch, and the distance of the nest entrance to the nearest shrub all tested significant at $P < 0.05$. The Hosmer and Lemeshow goodness-of-fit test indicated that the model was adequate ($P = 0.53$). The null hypothesis that all of the regression coefficients for the cactus patch measurements are zero was tested and rejected by a chi-square statistic ($P = 0.03$). This indicates that one or more of the variables can be used to predict the preferred cactus patch for a coastal Cactus Wren nest-site (Table 1).

Cactus patch height was on average 1.4 m for nest-containing patches and 1.3 m for non-nest patches. Height was excluded from the final model ($P > 0.05$). Measurements of patch width for nest-containing patches averaged 3.2 m and it was 3.3 m for non-nest patches. Length measurements averaged 4.5 m for nest-containing patches and 3.6 m for non-nest patches. Cactus patch width and length were suggestive of being factors for nest-site selection ($P = 0.07$ and 0.10 , respectively). Removal of either of these parameters resulted in a higher P -value for the remaining variable. Coastal Cactus Wrens are more likely to nest in small patches (odds ratio, width, = 0.71 , 95% CI is 0.48 to 1.03 and odds ratio, length, = 0.79 , 95% CI is 0.60 to 1.05).

Within the model, percent cover is one of the predictable factors for nest-site selection ($P = 0.02$; odds ratio = 0.96 , 95% CI is 0.94 to 0.99). The average height of shrubs within nest-containing patches averaged 82.2 cm and the average for non-nest patches was 89.3 cm. Average height of the shrubs within cactus patches was also

significant ($P = 0.01$; odds ratio = 0.98, 95% CI is 0.97 to 0.99). Measurements of distance from nest entrance to the nearest shrub were averaged for those patches that contained more than one nest at any time during this study. The average distance between nest entrance and nearest shrub of at least the same height in nest-containing patches was 112.8 cm. The hypothetical nest within a non-nest patch to represent a nest had a corresponding average distance to the nearest shrub of 49.3 cm. The distance from a shrub to the nest entrance was significant within the model ($P < 0.01$; odds ratio = 0.97, 95% CI is 0.96 to 0.99).

The average distance between a nest containing cactus patch and its adjacent cactus patch was 7.14 m. The average distance between a non-nest cactus patch and its adjacent cactus patch was 4.68 m. This difference was insignificant ($P > 0.05$). Measurements of *S. mexicana* that exceeded 50 meters from a cactus patch were coded as 50 m to exclude outliers. The average distance from a nest-containing patch to the nearest *S. mexicana* was 20.91 m. The average distance from a non-nest patch was 19.75 m. This difference was insignificant ($P > 0.05$). Coastal Cactus Wrens were often observed gleaning for insects from *S. mexicana* and *O. littoralis* and on the berries of these plants when in season.

DISCUSSION

Coastal Cactus Wrens prefer prickly pear cactus with a minimal percent cover of shrubs within the cactus. Nests were found in patches with shrub growth, however, the

average height of shrubs within the patch was below the height of the nest. Nests that were constructed in a patch that contained shrubs were placed above the shrub growth or the entrance was oriented at a significant distance from the shrubs. A few nests in patches free of shrubs in 1998 were found destroyed or abandoned in 1999. These cactus patches had shrubs growing in it over the year and had reached the height of the nest, which is a possible explanation for nest abandonment.

Height measurements of nest-containing and non-nest patches were excluded from the logistic regression model indicating that patches taller than 90 cm is not a determining factor for nest-site selection in CHSP. The length and width of the cactus patch was marginally insignificant indicating a possible preference for round patches for their nest-site. Larger cactus patches increased the likelihood of finding multiple nests within it.

All coastal sage scrub that contained prickly pear cactus patches within the study site contained at least one pair of coastal Cactus Wrens except for a south-facing slope on South Ridge Trail west of Diemer Trail (CHSP). At this site, a number of large patches (height > 90 cm) were covered with Cochineal Scales (*Dactylopius* spp.). Damage, to the extent of killing the cactus, can occur when these insects become too abundant on the host plant (Hogue 1993). This may indicate poor habitat quality to a Cactus Wren and, therefore, an unsuitable nest-site. Further analysis of Cochineal Scales as a characteristic used for nest-site selection by the coastal Cactus Wren would be an interesting study.

The distance of *S. mexicana* to a nest-site is not a significant factor for nest-site selection. I observed coastal Cactus Wrens flying over fifty meters to an elderberry tree. Not only were they observed gleaning leaves for insects and feeding on the berries, males were frequently observed perched and singing from the top of the tree. Mexican elderberry is usually the tallest structure in the area and, therefore, a good place to perch and look out for predators or intruders into his territory. In developed areas, telephone wires or fence posts were often used as perches where the male would sing and advertise his territory. An interesting study would be to analyze how effective the coastal Cactus Wren is as a propagator of *S. mexicana* to explain its observable association with *O. littoralis* within coastal sage scrub habitat in Orange County.

ACKNOWLEDGEMENTS

Funding for this research was provided by the CSUF Department of Biological Sciences. I thank Dr. Barry Thomas for this research opportunity, his critic and support, Alissa Ing for numerous contributions including access to CHSP, Dr. Jack Burk and Dr. Joel Wientraub for their contributions towards the methods and research for this project and to Dr. Karen Messer for data analysis assistance. Also, thank you to Sam Couch of Aera and the Robert B. Diemer Water Filtration Plant for their cooperation and access to their property. I thank my field assistants Alissa Ing, Rick Doan, Darryl Smith, and Clay Elliott.

LITERATURE CITED

- Anderson, A.H. and A. Anderson. 1959. Life history of the Cactus Wren part I: winter and pre-nesting behavior. *Condor* 59:274-296.
- Anderson, A.H. and A. Anderson. 1973. *The Cactus Wren*. Univ. Arizona Press, Tucson. p. 226.
- Baichich, P.J. and C.J.O. Harrison. 1997. *A Guide to the Nests, Eggs, and Nestlings of North American Birds*. 2nd ed. Academic Press, San Diego, Cal. p. 243.
- Belthoff, J.R. and G. Ritchison. 1990. Nest-site selection by Eastern Screech-Owls in central Kentucky. *Condor* 92:982-990.
- Bent, A.C. 1948. *Life Histories of North American Nuthatches, Wrens, Thrashers and Their Allies*. United States National Museum Bulletin 195:219-231.
- Farley, G.H. and J.N. Stuart. 1994. Atypical nesting sites of the Cactus Wren. *The Texas Journal of Science* 46:193-195.
- Haggerty, T.M. 1995. Nest-site selection, nest design and nest-entrance orientation in Bachman's Sparrow. *Southwestern Naturalist* 40:62-67.
- Hogue, C.L. 1993. *Insects of the Los Angeles Basin*. 2nd ed. Natural History Museum of Los Angeles County.
- Orians, G.H. and J.F. Wittenberger. 1991. Spatial and temporal scales in habitat selection. *American Naturalist* 137:S29-S49.

- Pribil, S. and J. Picman. 1997. The importance of using the proper methodology and spatial scale in the study of habitat selection by birds. *Canadian Journal of Zoology* 75:1835-1844.
- Sawyer, J.O., Jr. and T. Keeler-Wolf. 1995. *A Manual of California Vegetation*. California Native Plant Society, Sacramento.
- Short, H.L. 1985. *Habitat Suitability Index Models: Cactus Wren*. Western Energy and Land Use Team. Division of Biological Services: Research and Development. Fish and Wildlife Service, U.S. Department of the Interior. Washington, DC
- Sieg, C.H. and D.M. Becker. 1990. Nest-site habitat selected by Merlins in southeastern Montana. *Condor* 92:688-694.
- Sutter, G.C. 1997. Nest-site selection and nest-entrance orientation in Spragues's Pipet. *Wilson Bulletin* 109:462-469.
- United States Department of Agriculture, Soil Conservation Service and Forest Service. 1974. *Soil Survey of Orange County and Western Part of Riverside County, California*. National Cooperative Soil Survey.

Table 1. Nest-containing patches compared to non-nest containing patches. Multiple logistic regression was used to determine which variables are predictors for coastal Cactus Wren nest-site selection. Hosmer and Lemeshow Goodness-of-Fit Test ($P > 0.05$) indicated that the model fits the data. Chi-square analysis of remaining variables, excluding insignificant variables ($P > 0.05$), indicated that at least one or more of the variables are used as predictors ($P < 0.05$). $N = 51$ for each nest sites and non-nest sites.

Variable	Multiple Logistic				
	Nest sites		Non-nest sites		Regression
	Mean	(SD)	Mean	(SD)	P -value
Cactus Patch Measurements					
Height (cm)	1.4	(0.2)	1.3	(0.2)	> 0.05
Length (cm)	4.5	(2.3)	3.6	(1.5)	> 0.05
Width (cm)	3.2	(1.4)	3.3	(1.4)	> 0.05
Cactus Patch Shrub Composition					
Shrub cover (%)	26.8	(11.5)	54.6	(19.4)	0.02
Average shrub height (cm)	82.2	(23.3)	89.3	(18.9)	0.01
Nest-shrub distance (cm)	112.8	(47.2)	49.3	(31.1)	< 0.001
Nearest <i>Opuntia littoralis</i> (m)	7.1	(7.6)	4.7	(4.9)	> 0.05
Nearest <i>Sambucus mexicana</i> (m)	20.9	(18.4)	19.7	(15.9)	> 0.05