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A MAXIMUM ESTIMATE OF THE CALIFORNIA GNATCATCHER'S POPULATION SIZE IN THE UNITED STATES

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The California Gnatcatcher, *Polioptila californica*, was recently recognized as a species distinct from the widespread Black-tailed Gnatcatcher, *P. melanura*, of the southwestern desert regions of the United States and Mexico (Atwood 1988, American Ornithologists' Union 1989). Although California Gnatcatchers are distributed throughout much of Baja California, the northernmost subspecies, *P. c. californica*, now occurs only in remnant fragments of coastal sage scrub habitat from Los Angeles County, California, south to El Rosario, Baja California (Atwood 1991).

Atwood (1980) speculated that the number of California Gnatcatchers remaining in the United States was "no more than 1,000 to 1,500 pairs," from estimates of 30 pairs in Ventura County, 130 pairs in Los Angeles County, 50 pairs in San Bernardino County, 325 pairs in Orange County, 400 pairs in Riverside County, and 400 pairs in San Diego County. These values were derived from reports of various observers, limited field work in different portions of the species' range, and visual estimates of habitat availability in different areas. Despite the preliminary nature of these results, the pattern of continuing habitat loss evident at that time indicated "immediate concern for the survival" of *P. c. californica* in the United States (Atwood 1980).

Extensive destruction of suitable California Gnatcatcher habitat has continued since 1980 (Rea and Weaver 1990). Of 56 southern California sites where Atwood (1980) recorded coastal sage scrub vegetation and California Gnatcatchers, 18 (32%) had been completely destroyed by urban development by 1990, and 15 (27%) had been partially degraded by current construction projects (J. Atwood and K. Shields, unpubl. data). Similar habitat loss, primarily associated with agricultural development, has also increased in northwestern Baja California; Best (1983) found that the San Quintin Kangaroo Rat (*Dipodomys gravipes*), which historically occurred along Baja California's Pacific coast from San Telmo south to El

Rosario, "has been virtually eliminated from most of its native range during the past decade [owing] to extensive cultivation." Because of continuing habitat loss throughout the gnatcatcher's United States and Mexican range, federal and California endangered species status was recently proposed for the California Gnatcatcher's northern subspecies. As an effort to provide a baseline for future studies, in this paper I estimate the maximum population of *P. c. californica* that might currently exist in the United States.

METHODS

Determining numbers of a small passerine whose population density varies throughout a relatively extensive geographic range is difficult. Because California Gnatcatchers are confined to coastal sage scrub vegetation (Atwood 1980), population estimates could, in theory, be derived from measurements of the available acreage of this habitat coupled with the species' average territory size. However, many areas of vegetation that are correctly classified as coastal sage scrub are not occupied by gnatcatchers, suggesting that population estimates based on vegetation mapping will invariably be inflated. Direct censusing of gnatcatchers throughout southern California has also proven impossible, because public access to many large tracts of private land has been denied. Although some census data have been collected by the southern California development industry, little of this information has been released to the public, and independent verification of these results has been prevented.

In this analysis, I use a more general approach to estimate crudely the maximum number of California Gnatcatchers remaining in the United States. Atwood and Bolsinger (in press) showed that in Los Angeles, Orange, and San Diego counties, 93% of recent California Gnatcatcher observations were made at elevations under 250 m; in Riverside County, most recent records (75%) were made at elevations under 500 m. Here I use these elevations to approximate the maximum range of California Gnatcatchers in each of these counties. Using the geographic information system CAMRIS (Computer Aided Mapping and Resource Inventory System; R. Glenn Ford, Ecological Consulting, Inc., Portland, Oregon) and elevation contours digitized from U.S. Geological Survey (USGS) 1:100,000 scale topographic maps, I calculated the extent of land lying below 250 m elevation in Los Angeles, Orange, and western San Diego counties, and below 500 m in western Riverside County. Next, again using these topographic maps, I examined all 1-minute blocks of latitude–longitude below these elevations, and entered into CAMRIS those blocks that were predominately designated as "Built Up" or as "Orchard, Vineyard." Finally, I calculated the remaining amount of undeveloped lowland that might support California Gnatcatchers in each county. Although *P. c. californica* historically occurred in Ventura and San Bernardino counties, Atwood (1980) found that the species has been largely or entirely extirpated from these areas; consequently, these counties were excluded from analysis. Similarly, I excluded from area calculations those lowland portions of Los Angeles County located near the Santa Monica Mountains, where California Gnatcatchers have never been reliably reported (Atwood 1980).

USGS maps (1:100,000 scale) used in this analysis included (followed by publication date and, in brackets, dates of aerial photography used in the most recent revisions): Borrego Valley, 1982 [1976–77]; El Cajon, 1979 [1975]; Long Beach, 1981 [1979]; Los Angeles, 1979 [1976]; Oceanside, 1982 [1972–74, 1979]; Palm Springs, 1984 [1975, 1979]; San Bernardino, 1982 [1975, 1978]; San Diego, 1979 [1972, 1975–77]; Santa Ana, 1983 [1978–79]; Santa Barbara, 1982 [1977–78].

Focused surveys conducted during 1990 by the U.S. Fish and Wildlife Service (L. Salata, unpubl. data) and U.S. Navy (T. Burr, unpubl. data) located approximately 175–200 pairs of California Gnatcatchers on Camp Pendleton Marine Corps Base, San Diego County, and 25–50 pairs on the adjacent Fallbrook Naval Weapons Station. On the basis of topographic map designations of "Built Up" and "Orchard" areas, approximately 405 km^2 of undeveloped land lie below 250 m elevation on these two military bases. These acreage measurements and population estimates suggest that California Gnatcatchers occur in undeveloped lowlands of coastal southern California at densities ranging from 0.49 to 0.62 pairs per square kilometer. Note that these values do not refer to population densities within particular areas of coastal sage scrub that are occupied by gnatcatchers, or to densities within pure stands of occupied and unoccupied coastal sage scrub. Rather, the "habitat" definition used here is simply "low-elevation, undeveloped" land. I used these densities in conjunction with the measurements of undeveloped acreage in each county to estimate the population size of California Gnatcatchers remaining in the United States during the late 1970s. Assumptions inherent in this analysis suggest that current (1991) population levels cannot significantly exceed these values.

Unpublished documents cited in the text have been deposited in the Josselyn Van Tyne Memorial Library of the Wilson Ornithological Society, University of Michigan, Museum of Zoology, Ann Arbor, Michigan 48109.

RESULTS AND DISCUSSION

Figure 1 shows the distribution of undeveloped lowland within the United States range of the California Gnatcatcher during the mid- to late 1970s, when the USGS maps on which my analysis is based were compiled. Multiplying the acreage of this area by the densities derived from surveys on Camp Pendleton and Fallbrook yields population estimates of 1811 to 2291 pairs (Table 1). These results are similar to Atwood's (1980) population estimate (1000–1500 pairs), which was based on different types of information that were obtained shortly after the time period considered here.

This analysis assumes that no California Gnatcatchers occur above the elevational limits used to define the species' potential distribution. In fact, small numbers of *P. c. californica* do occur above 250 m elevation in Orange and San Diego counties, and above 500 m elevation in Riverside County (Atwood and Bolsinger, in press). Use of elevation as an index of gnatcatcher distribution thus tends to underestimate the total number of birds remaining in the United States. However, this inaccuracy is more than offset by four other assumptions that inflate estimates of the population

size, and suggest that fewer than approximately 2000 pairs currently remain north of Mexico.

First, the amount of land currently developed in southern California is certainly greater than indicated on maps prepared during the mid- to late 1970s. For example, the Riverside County Planning Department (1990) noted that "from 1980 through January 1, 1985, the county's population grew from 663,166 to 800,949 people, an increase of 137,783 or 20.8%. From January 1, 1985, to January 1, 1990, the population grew . . . to 1,110,021 people, an increase of . . . 38.6%." Comparisons of 1980 and

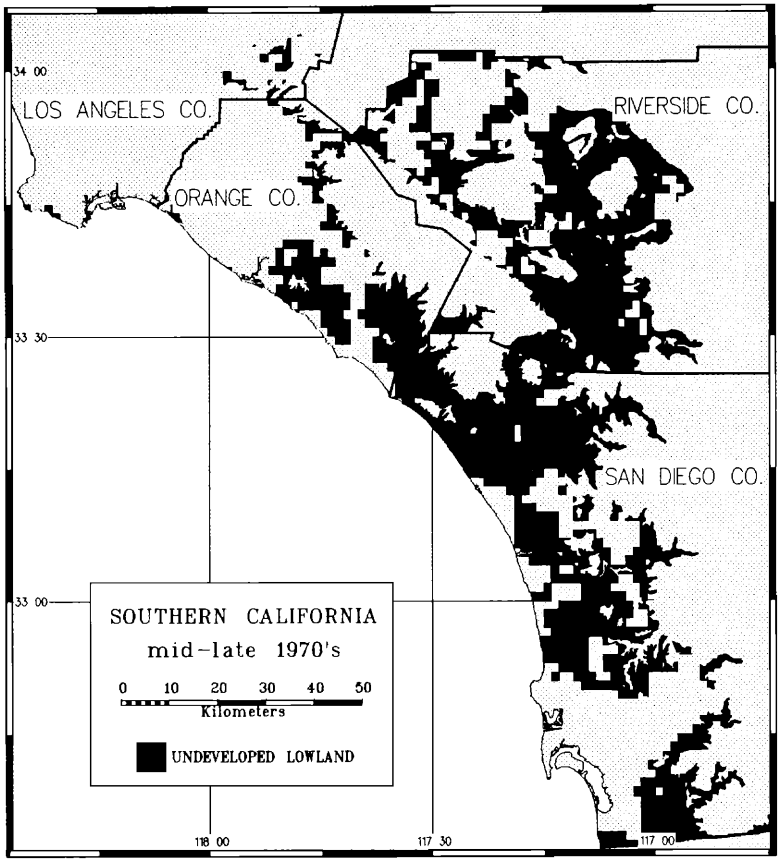

Figure 1. Extent of undeveloped lowland in coastal southern California during the mid- to late 1970s. Based on (a) designations of "Built Up" and "Orchard, Vineyard" areas shown on USGS 1:100,000 scale topographic maps and (b) the 250-m (Los Angeles, Orange, San Diego counties) or 500-m (Riverside County) elevation contours.

1990 U.S. Census Bureau data indicate that four of the ten fastest growing major cities in the United States (Escondido, Oceanside, Rancho Cucamonga, and Chula Vista) are located in southern California; more than 90,000 people moved to the city of Moreno Valley between 1980 and 1990, representing an increase of 322%. All of these cities are located in areas from which there are historic or recent records of California Gnatcatchers (Atwood 1980, 1990); however, none of this human population growth, or its associated destruction of natural habitats, is reflected in the calculations of undeveloped acreage that were used here as the basis for gnatcatcher population estimates. Also, the USGS topographic maps on which this analysis was based failed to identify agricultural lands other than orchards or vineyards; thus, many areas identified here as "undeveloped" may, in fact, have been planted in a variety of flower or vegetable crops.

Second, gnatcatcher surveys based on unbanded individuals, such as the censuses conducted on Camp Pendleton and Fallbrook, frequently overestimate the number of birds actually present (e.g., Lettieri–McIntyre and Associates 1987, ERC Environmental and Energy Services Co. 1990). In general, this tendency may reflect the surprisingly extensive movements that some pairs of gnatcatchers undertake; the average home range size of color-banded birds in San Diego County has been reported as greater than 18 acres, and the breeding season home range of one pair was documented at 45 acres (ERC Environmental and Energy Services Co. 1990, Mock et al. 1990, P. Mock pers. comm.). Consequently, the densities implied by the Camp Pendleton and Fallbrook surveys may be too high, thereby inflating the final population estimate.

Table 1 Maximum Population Estimates of California Gnatcatchers in the United States

County	Undeveloped Lowland (km^2)[a]	Population Estimates[b]	
		0.49 pairs/km^2	0.62 pairs/km^2
Los Angeles	48	24	30
Orange	458	224	284
Riverside	1478	724	916
San Diego	1712	839	1061
Total	3696	1811	2291

[a]Based on delineations of "Built Up" and "Orchard, Vineyard" areas as shown on 1:100,000 scale USGS topographic maps prepared in the mid- to late 1970s. In Los Angeles, Orange, and San Diego counties, the 250-m elevation contour was used to define the maximum extent of suitable California Gnatcatcher habitat; in Riverside County, the 500-m elevation contour was used (Atwood and Bolsinger in press).

[b]Densities based on surveys of Camp Pendleton Marine Corps Base (L. Salata, U.S. Fish and Wildlife Service, unpubl. data) and Fallbrook Naval Weapons Station (T. Burr, U.S. Navy, unpubl. data).

Third, of 405 km^2 of undeveloped land located below 250 m elevation on Camp Pendleton and Fallbrook military bases, general vegetation maps prepared by Oberbauer (1977) showed that 346 km^2 (85%) were covered by "coastal sage scrub" or "grassland" vegetation types (Figure 2); Atwood (1980) found that Oberbauer's definitions of both of these habitats frequently included areas occupied by California Gnatcatchers. In contrast, of

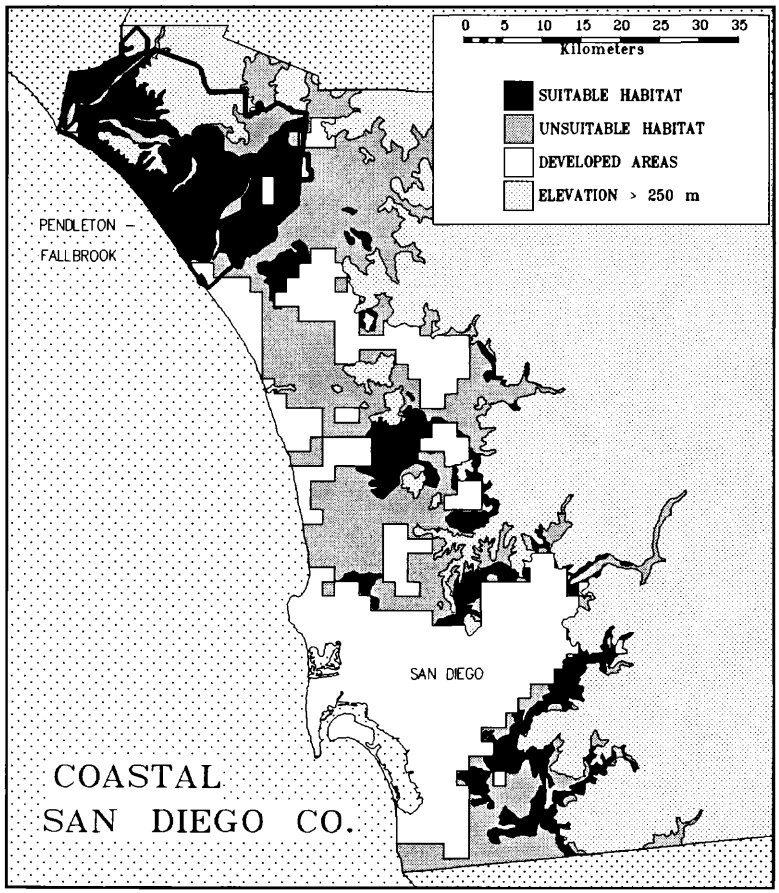

Figure 2. Relative abundance of coastal sage scrub and grassland vegetation in lowland (<250 m elevation), undeveloped portions of Camp Pendleton Marine Corps Base/Fallbrook Naval Weapons Station and the remainder of western San Diego County. Boundaries of Camp Pendleton Marine Corps Base and Fallbrook Naval Weapons Station shown in northwest corner of county. Based on (a) vegetation mapping by Oberbauer (1977) and (b) designations of "Built Up" and "Orchard, Vineyard" areas shown on USGS 1:100,000 scale topographic maps.

1307 km^2 of undeveloped land in lowland portions of western San Diego County away from these military bases, only 304 km^2 (23%) supported habitats identified by Oberbauer (1977) as coastal sage scrub or grassland (Figure 2). These results indicate that, in general, the undeveloped lowlands of Camp Pendleton and Fallbrook probably include more extensive gnatcatcher habitat than does most of the rest of undeveloped coastal San Diego County . Therefore, population densities derived from gnatcatcher surveys on Camp Pendleton and Fallbrook probably exceed, on average, the densities characteristic of other lowland, undeveloped regions of coastal southern California. Application of the Camp Pendleton/Fallbrook densities to less suitable portions of the species' range would predictably overestimate the true population size of California Gnatcatchers.

Fourth, this analysis assumes that the density of California Gnatcatchers in inland portions of the species' range is similar to that of coastal areas such as Camp Pendleton and Fallbrook. In fact, densities of *P. c. californica* are generally lower farther inland (Mock et al. 1990; Atwood, unpubl. data). Application of density values derived from coastal sites thus inflates estimates of the true number of California Gnatcatchers remaining in Riverside County and inland San Diego County.

Although population estimates provide a useful starting point for further investigation and continued monitoring, the exact number of remaining California Gnatcatchers is, in many ways, a secondary issue with regard to the species' status in the United States. Given that (1) approximately 90% of southern California's historic distribution of coastal sage scrub has already been destroyed by urbanization (Hanes 1976, Kirkpatrick and Hutchinson 1977, Mooney 1977, Westman 1981, 1987, O'Leary 1990), (2) most remaining United States populations of California Gnatcatchers are located on private lands where urban development is imminent (Atwood 1990), and (3) increasing habitat fragmentation may inhibit the gnatcatcher's dispersal and reduce its reproductive success (e.g., Soulé et al. 1988, Bolger et al. 1991), the long-term survival of *P. c. californica* in the United States would be questionable even if there were currently many thousands of breeding pairs remaining north of Mexico. Without reversal of present land use trends, California Gnatcatchers will be extirpated from most or all of their range in the United States in the near future.

SUMMARY

Analysis by means of a geographic information system of the extent of undeveloped lowland in coastal southern California, coupled with density indices derived from recent surveys of Camp Pendleton Marine Corps Base and Fallbrook Naval Weapons Station, indicates that 1811–2291 pairs of California Gnatcatchers remained in the United States in the late 1970s. Various assumptions inherent in this analysis imply that these values are inflated and that the species' current population size north of Mexico cannot significantly exceed 2000 pairs. Continuing loss and fragmentation of the California Gnatcatcher's required coastal sage scrub habitat, of which most remaining tracts occur on private properties threatened by urban

development, will eliminate the species from much or all of its United States range in the immediate future.

ADDENDUM

On 1 August 1991, public testimony was received by the California State Fish and Game Commission regarding the petition to add the California Gnatcatcher to the state's list of endangered species. During this hearing, lobbyists for the southern California development industry presented the results of preliminary gnatcatcher population surveys conducted within the last few years (H. L. Jones, 1991, A rangewide assessment of the California Gnatcatcher (*Polioptila californica*), unpublished report prepared for the Building Industry Association of Southern California, Santa Ana). No details were given concerning methods used in surveys, specific areas censused, or the rationale used in extrapolating estimated totals from actual observations. Because only observers employed by the development industry have been allowed access to many important tracts of private land, these results have not been independently verified. Nonetheless, to provide all currently available information regarding the population size of California Gnatcatchers in the United States, I repeat Jones' estimates here: *Los Angeles County*, 11–20 pairs actual census results, 20–30 pairs estimated total; *Orange County*, 245 pairs actual census results, 325–350 pairs estimated total; *San Diego County*, 830 pairs actual census results, 1000–1100 pairs estimated total; *Riverside County*, census data unavailable, 300–400 pairs estimated total. Jones concludes that "we have conservatively estimated approximately 1645 to 1880 pairs of [California] gnatcatchers within the United States." This value is approximately 10–20% lower than the maximum population estimates (1811–2291 pairs) derived above.

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California Gnatcatcher *Sketch by Lou Barnicle*