# COASTAL SAGE SCRUB VARIATIONS OF SAN DIEGO COUNTY AND THEIR INFLUENCE ON THE DISTRIBUTION OF THE CALIFORNIA GNATCATCHER

KENNETH L. WEAVER, 1113 Senwood Way, Fallbrook, California 92028

The California Gnatcatcher is widely known to be strongly associated with coastal sage scrub, yet it does not occupy all stands of this highly variable vegetation type (Kirkpatrick and Hutchinson 1976, Westmann 1983, O'Leary 1990, Atwood 1993). Bontrager (1991) suggested that scrub dominated by *Salvia mellifera* is often not occupied by gnatcatchers, and that the species is similarly absent if "a major component of the area was large woody shrubs such as *Rhus integrifolia* and/or *Malosma laurina*." Yet no careful studies that objectively evaluate the impacts of scrub-species composition on gnatcatcher distribution have been presented.

Variations in coastal sage scrub occur in recognizable patterns. Climate is the major factor influencing distribution of plant species, as seen in the replacement of dominant shrubs with increasing distance from the coast. Soil types also affect scrub vegetation, as indicated by isolated stands of certain shrubs, as well as the local dominance of shrubs with restricted ranges. Slope aspect affects the density of the vegetation and may foster the replacement of one scrub type by another. North- and east-facing slopes often support chaparral rather than coastal sage scrub. Chaparral also occurs frequently on ridgelines and mesas, even at low elevations. Coastal sage scrub is often naturally fragmented by rivers and streams. Scrub stands, then, occur within a mosaic of habitats, assuring a patchy distribution of the California Gnatcatcher.

In this paper, I describe the primary variations of coastal sage scrub in San Diego County. I show that the occurrence of the California Gnatcatcher in the northwestern portion of the county is strongly influenced by the type of scrub cover. I also comment on the suitability of scrub types elsewhere in the county as likely reserves for the gnatcatcher.

## METHODS

I collected data on the distribution of the California Gnatcatcher while surveying coastal sage scrub birds at 84 locations in northwestern San Diego County. I had no prior knowledge of the presence or absence of the gnatcatcher at the time each site was originally selected for investigation. I surveyed areas from Camp Pendleton and Fallbrook south to Del Mar and Poway (Figure 1, Table 1). I collected most data from 1993 to 1995 but have also drawn on many earlier surveys and a few later surveys. With very few exceptions, I conducted bird surveys in the early morning at least twice during the breeding season. I made multiple visits to the vast majority of locations.

I completed a vegetation survey of all sites checked for gnatcatchers. To obtain a broader perspective of the distributional limits of coastal sage scrub

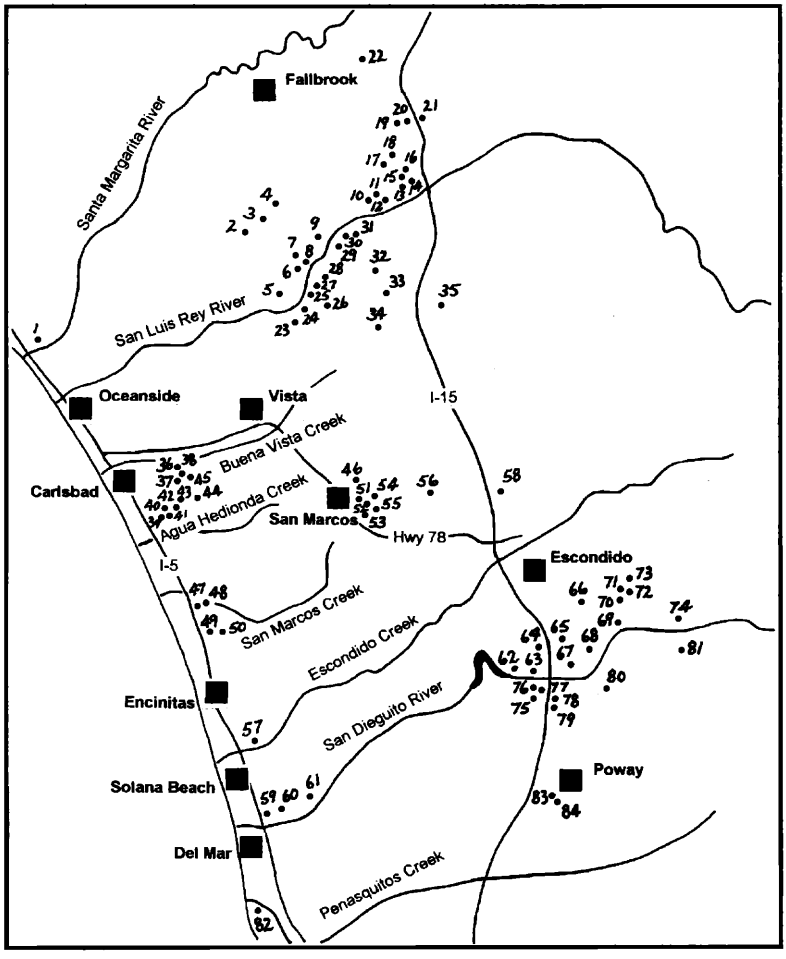


Figure 1. Location of coastal sage scrub sites surveyed for gnatcatchers in San Diego County, California. Numbers are keyed to sites listed in Table 1.

divisions, I surveyed an additional 148 locations throughout the county. I assigned values to coastal sage scrub plants by using a cover-abundance scale devised by Braun-Blanquet (1932). Each shrub and succulent species present was noted as covering more than 75% of the area, 50–75% of the area, 25–50% of the area, 5–25% of the area, or as few or solitary individuals providing little cover. To simplify plant surveys, I considered herbs and grasses as a single category. A "dominant" species has a minimum coverage of 25%. More than one species could, therefore, qualify as a dominant. A "prominent" species is characteristic of a specific type of scrub but has a cover of less than 25%. Plant names follow Dawson (1966) for cacti and

**Table 1** Locations Surveyed for California Gnatcatchers and Vegetation Types in Northwestern San Diego County[a]

| Location | Subassociation[b] | No. of pairs[c] |
|---|---|---|
| Santa Margarita River | | |
| 1. Camp Pendleton Marine Corps Base, Cliffs of Ysidora | 1 | 8 |
| San Luis Rey River | | |
| 2. Fallbrook, SW Sleeping Indian/Conejo | 4 | 0 |
| 3. Fallbrook, SW San Jacinto Circle/Brianna | 4 | 0 |
| 4. Fallbrook, SW Del Valle/Lemon Grove | 4 | 0 |
| 5. Bonsall, NE Hwy. 76/Holly[d] | 3[e] | 0 |
| 6. Bonsall, NE Hwy. 76/Montellano | 3 | 3 |
| 7. Bonsall,NE Via Puerta del Sol/Via Calvillo | 3 | 0 |
| 8. Bonsall, SW Hwy. 76/Olive Hill[f] | 3 | 1 |
| | 5 | 2 |
| 9. Bonsall, NE Hwy. 76/Mission | 5 | 1 |
| 10. Fallbrook, NE Hwy. 76/Gird | 5 | 3 |
| 11. Fallbrook, NW Montserrate Hill/Fire[d] | 5 | 2 |
| 12. Fallbrook, NW Hwy. 76/Star Track | 5 | 1 |
| 13. Fallbrook, NW Hwy. 76/Sage | 5 | 1 |
| 14. Fallbrook, NW Hwy. 395/Hwy 76[d] | 5 | 2 |
| 15. Fallbrook, SW Hwy. 395/Pala Mesa (south) | 4[e] | 1 |
| 16. Fallbrook, SW Hwy. 395/Pala Mesa (north) | 4 | 0 |
| 17. Fallbrook, NW Wilt/Foxglove | 4 | 0 |
| 18. Fallbrook, NW Wilt/Citrus | 4 | 0 |
| 19. Fallbrook, SE Hwy. 395/Canonita | 5 | 1 |
| 20. Fallbrook, NW Hwy. 395/Canonita | 5 | 4 |
| 21. Fallbrook, SE Stewart Canyon/Pala Mesa Heights | 5 | 4 |
| 22. Fallbrook, NW Mission/Las Vistas | 3 | 0 |
| 23. Vista, SW Hwy. 76/E Vista Way | 4 | 1 |
| 24. Vista, SE Old River/Gopher Canyon[d] | 4 | 1 |
| 25. Bonsall, SW Old River/Dentro de Lomas | 4 | 0 |
| 26. Vista, SE Gopher Canyon/Sagewood | 4 | 0 |
| 27. Bonsall, SE Old River/Dentro de Lomas | 4 | 0 |
| 28. Bonsall, SW Old River/Lake Vista | 3 | 1 |
| 29. Bonsall, NE Camino del Rey/W Lilac | 4 | 3 |
| 30. Bonsall, NW W Lilac/Camino del Cielo | 4 | 2 |
| 31. Bonsall, NE W Lilac/Camino del Cielo | 5 | 3 |
| 32. Bonsall, NE Camino del Rey/Eagles Perch | 5 | 0 |
| 33. Bonsall, NE Camino del Rey/La Reina | 4 | 0 |
| 34. Vista, SE Gopher Canyon/Twin Oaks Valley | 4 | 0 |
| 35. Escondido, NE Circle R/El Camino del Pinos | 4 | 0 |
| Buena Vista Creek | | |
| 36. Carlsbad, NW Seabury/Stockton | 3 | 0 |
| 37. Carlsbad, SW Tamarack/Milford | 2 | 0 |
| 38. Carlsbad, NE Tamarack/Elm | 6[g] | 1 |
| Agua Hedionda Creek | | |
| 39. Carlsbad, SW Adams/Highland | 1[e] | 0 |
| 40. Carlsbad, NW Park/Adams | 2 | 0 |
| 41. Carlsbad, NE Park/ Adams | 1 | 1 |
| 42. Carlsbad, NW Neblina/Horizon | 2 | 0 |
| 43. Carlsbad, SE Park/Valencia | 1[e] | 0 |
| 44. Carslbad, SE El Camino Real/Tamarack | 2 | 0 |
| 45. Carlsbad, NE Harwich/Elm | 3 | 2 |
| 46. Vista, NW Estrellita/Esplendido | 5 | 0 |

(*continued*)

**Table 1** *(continued).*

| Location | Subassociation[b] | No. of pairs[c] |
|---|---|---|
| San Marcos Creek | | |
| 47. Carlsbad, SW Batiquitos/Poinsettia[f] | 2 | 0 |
| | 1 | 1 |
| 48. Carlsbad, SE Gabbiano/Batiquitos[d] | 1 | 3 |
| 49. Encinitas, SW Saxony/La Costa | 2 | 0 |
| 50. Encinitas, SE Saxony/La Costa | 1 | 3 |
| 51. San Marcos, NE Santa Fe/Flores | 1[e] | 0 |
| 52. San Marcos, Palomar College, N of Comet Circle | 3 | 2 |
| 53. San Marcos, SW Mission/Knoll | 3 | 0 |
| 54. San Marcos, San Marcos Mountains, W of Twin Oaks Valley | 3 | 0 |
| 55. San Marcos, NE Mission/Vineyard | 3 | 0 |
| 56. San Marcos, NW Richland/Carmen Court | 3 | 0 |
| Escondido Creek | | |
| 57. Encinitas, SW Manchester/El Camino Real | 1 | 6 |
| 58. Escondido, NW N Broadway/Jack Rabbit Acres | 3[e] | 0 |
| San Dieguito River | | |
| 59. San Diego, NW San Andres/Flower Hill[d] | 1 | 2 |
| 60. San Diego, NE Via de la Valle/San Andres | 1 | 3 |
| 61. Rancho Santa Fe, SW Via de la Valle/Las Planideras | 1[e] | 0 |
| 62. Escondido, Bernardo Mountain | 5 | 19 |
| 63. Escondido, N of Lake Hodges, W of I-15 | 5 | 6 |
| 64. Escondido, NW Via Rancho/I-15[d] | 5 | 12 |
| 65. Escondido, W of Kit Carson Park | 5 | 4 |
| 66. Escondido, NE Bear Valley/El Dorado | 5 | 4 |
| 67. Escondido, N of Lake Hodges, S of Beethoven | 5 | 15 |
| 68. Escondido, NE San Pasqual/Sunset Hills[d] | 5 | 1 |
| 69. Escondido, SW San Pasqual/Old Pasqual | 5 | 3 |
| 70. San Diego, NW Hwy. 78/Cloverdale[d] | 5 | 3 |
| 71. San Diego, SW Cloverdale/Cloveridge | 5 | 2 |
| 72. Escondido, SE Cloverdale/Rockwood | 5[e] | 0 |
| 73. Escondido, NE Cloverdale/Rockwood[d] | 5[e] | 0 |
| 74. San Diego, San Pasqual Battlefield State Historic Park/San Diego Wild Animal Park | 5 | 28 |
| 75. San Diego, NW W. Bernardo/Aguamiel | 5 | 7 |
| 76. San Diego, S of Lake Hodges, W of W. Bernardo | 5 | 20 |
| 77. San Diego, NE W. Bernardo/Andanza | 5 | 1 |
| 78. San Diego, Battle Mountain[d] | 3[e] | 1 |
| 79. San Diego, S of Escala/E of Colonnades | 6[h] | 2 |
| 80. San Diego, SE Highland Valley/Sycamore Creek, approx. 1 km E | 6[i] | 0 |
| 81. San Diego, SE Bandy Canyon/Isabel Creek[d] | 5 | 5 |
| Los Peñasquitos Creek | | |
| 82. San Diego, Torrey Pines State Park, So. | 2 | 0 |
| 83. Poway, NW Camino del Norte/Pomerado[d] | 5 | 3 |
| 84. Poway, E of La Manda, W of Pomerado | 5 | 4 |

[a]Locations are listed by watershed, coast to inland, north to south. Subassociation numbers are keyed to Figure 1.

[b]1, Encelia scrub; 2, Lemonadeberry scrub; 3, Black Sage scrub; 4, Sagebrush–White Sage scrub; 5, Buckwheat scrub; 6, assemblage of vegetation unique.

[c]Maximum number of males or pairs recorded at site.

[d]Seriously degraded or lost as coastal sage scrub as of 1998.

[e]A disturbed site (herb/grass cover >25%) in which the vegetation is most similar to the subassociation indicated.

[f]Two subassociations occur at this site, thus the double listing.

[g]Dominated by *Salvia mellifera*, the subshrubs *Encelia californica* and *Artemisia californica* are prominent. Area appears to be intermediate between subassociations 1 and 3.

[h]Dominated by *Artemisia californica*; *Keckiella antirrhinoides* is prominent on slopes.

[i]Dominated by *Eriogonum fasciculatum*; *Keckiella antirrhinoides* is prominent; high cover of herbs/grasses.

Beauchamp (1986) for all other species, although I refer to *Artemisia californica* as California sagebrush rather than as coastal sagebrush.

Methods of classifying coastal sage scrub are quite diverse. Westman (1983), for example, identified two "associations" for the entire county. Each association incorporates a wide variety of scrub types. Others, such as Kirkpatrick and Hutchinson (1976), recognized scrub types based on the presence of certain key species. Similarly, the San Diego Association of Governments (SANDAG 1992) devised a listing agreed upon by biological consultants that uses the presence of characteristic but not necesssarily dominant plants (H. Wier pers. comm.).

I classified coastal sage scrub by which shrubs provide the primary cover at a site. My names for the various divisions have been selected accordingly. Because of the pervasiveness of California sagebrush in nearly all stands, however, I have used the term "sagebrush" only with those divisions in which it is generally the only dominant. I refer to scrub variations as "subassociations" rather than associations, since the latter term is used for divisions of large geographically based floristic formations (Westman 1983).

Sizes of scrub stands are based on information provided by the San Diego County tax assessor's office and vegetation maps compiled for the Multiple Habitats Conservation Program by Dudek, Inc. Sizes should be considered as approximate. Slope aspect was taken from U.S. Geological Survey 7.5' topographic maps, and information on soil types is derived from maps of the U.S. Soil Conservation Commission (Bowman 1973).

## RESULTS

### General Overview

Coastal sage scrub occurs in two disjunct areas in San Diego County. Coastal variations, including all subassociations of the northwestern part of the county, are collectively referred to as the "Diegan Association" by Westman (1983). All county records of the California Gnatcatcher, to my knowledge, are limited to this generalized type of vegetation. The gnatcatcher does occur at the easternmost extension of this scrub in Pamo Valley, 46 km from the coast (C. Edwards pers. comm.).

Inland scrub types, referred to as the "Riversidian Association" by Westman (1983), barely enter the county north and west of Oak Grove, over 60 km from the coast. I have observed the gnatcatcher in this scrub near Aguanga, Riverside County, but have not recorded it in nearby San Diego County.

Within San Diego County, coastal sage scrub has an elevational range from near sea level, as at Batiquitos Lagoon, to over 800 m above sea level on the south flank of Palomar Mountain and near Oak Grove just south of the Riverside County line. During my surveys, I recorded the gnatcatcher at elevations ranging from 3 m at several coastal lagoons to 540 m on Palomar Mountain.

### Composition and Structure of Coastal Sage Scrub

I identified nearly 40 species of shrubs and succulents on sites dominated by variations of coastal sage scrub. Only one or two species of semi-deciduous

"subshrubs," typically a meter or less in height, dominate most sites. Only rarely does the coverage of a single shrub species exceed 50%. "Emergent" shrubs 2–4 m in height are frequently prominent and occasionally dominant. Most are sumacs (Anacardiaceae).

Shrub canopies vary from nearly closed with esssentially no ground cover, as seen in chaparral, to rather open, somewhat resembling desert scrub. Scrub stands in northwestern San Diego County with an herb/grass coverage >25% have a history of disturbance. Scrub growing on north- and east-facing slopes has a denser cover and a greater number of emergent shrubs than that found on slopes with a south- or west-facing aspect. No shrub or succulent species is a strict indicator for any one subassociation since none is limited to a single type of scrub.

## Coastal Sage Scrub Subassociations of Northwestern San Diego County

I could readily classify the plant cover of most sites north of the San Diego River watershed into one of five different coastal sage scrub subassociations (Tables 1 and 2), including 71 of the 84 sites that I surveyed for coastal sage scrub birds. Ten additional sites have vegetation that is highly disturbed but still referrable to one of the five subassociations. The remaining three sites possess unique vegetation.

My records indicate wide variations in gnatcatcher frequencies and densities between different scrub subassociations (Table 3). Regardless of the vegetation, however, I did not find this bird on any of the 13 sites of less than 3 ha that I surveyed. This, I believe, reflects the influence of small size and fragmented habitat on bird distribution, as noted by Soulé et al. (1988). These sites are omitted from Table 3.

In the descriptions that follow, I refer to other areas of San Diego County in which these scrub types can be found. I have listed only representative localities that I have personally surveyed.

*Encelia scrub.* This subassociation is dominated by California encelia (*Encelia californica*) and California sagebrush (*Artemisia californica*). It is easily recognized by the prominence of succulents such as coastal cholla (*Opuntia prolifera*), short coastal prickly-pear (*Opuntia littoralis*), and Mohave yucca (*Yucca schidigera*). It is found along the northern San Diego County coast south intermittently to the Mexican border. Although it is most characteristic of the immediate coast, it extends exceptionally as far as 13 km inland along river valleys where maritime influences are strong. Lemonadeberry (*Rhus integrifolia*) is the primary emergent shrub. Overall, the canopy is fairly low and has frequent breaks because the terrain where it grows is highly eroded. Slopes typically have a southern aspect. Encelia scrub exists almost exclusively on old marine terrace (sedimentary) formations. This scrub is now very fragmented but was probably never extensive.

Kirkpatrick and Hutchinson (1977) recognized this same scrub as the "*Encelia californica–Artemisia californica* association." My classification incorporates the "southern coastal bluff scrub" of Holland (1986) and SANDAG (1992). Representative locations include the cliffs of Ysidora (Camp Pendleton), Agua Hedionda and Batiquitos lagoons (Carlsbad), and San Elijo Lagoon (Encinitas).

**Table 2** Characteristic Plants of Coastal Sage Scrub Subassociations in San Diego County[a]

| Species | Subassociation[b] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Subshrubs | | | | | | | | | |
| *Artemisia californica*, California Sagebrush | **3** | **2** | **3** | **3** | **3** | **2** | **3** | **3** | **2** |
| *Encelia californica*, California Encelia | **3** | 1 | p | p | p | 0 | 0 | 0 | 0 |
| *Eriogonum fasciculatum*, Flat-top Buckwheat | 1 | 1 | 1 | **2** | **3** | 2 | 1 | **3** | p |
| *Keckiella antirrhinoides*, Yellow Bush Penstemon | 0 | p | 0 | p | p | 0 | 0 | 0 | **3** |
| *Salvia apiana*, White Sage | p | p | p | **2** | 1 | p | p | 1 | 1 |
| *Salvia mellifera*, Black Sage | 1 | **2** | **3** | p | p | 0 | 0 | p | 0 |
| *Viguiera laciniata*, San Diego Sunflower | 0 | p | 0 | 0 | p | **3** | **2** | 0 | 0 |
| Emergent Shrubs | | | | | | | | | |
| *Heteromeles arbutifolia*, Toyon | p | 1 | p | p | 0 | p | p | 0 | 0 |
| *Malosma laurina*, Laurel Sumac | 1 | **1** | **2** | **2** | **1** | **1** | p | **3** | **2** |
| *Quercus berberidifolia*, Scrub Oak | 0 | 0 | p | p | p | p | 0 | **1** | **1** |
| *Rhus integrifolia*, Lemonadeberry | **2** | **3** | p[c] | 0 | 0 | p | **2** | 0 | 0 |
| *Sambucus mexicana*, Mexican Elderberry | p | p | p | p | 1 | p | p | p | 0 |
| *Simmondsia chinensis*, Jojoba | 0 | 0 | p | 0 | 0 | p | **2** | 0 | 0 |
| Succulents | | | | | | | | | |
| *Opuntia littoralis*, Short Coastal Prickly-Pear | 1 | p | p | 1 | p[d] | 1 | **1** | 0 | 0 |
| *Opuntia oricola*, Tall Prickly-Pear | p | p | p | p | p[e] | p | p | 0 | 0 |
| *Opuntia prolifera*, Coastal Cholla | 1 | p | p | p | p | p | 1 | 0 | 0 |
| *Yucca schidigera*, Mohave Yucca | 1 | 1 | p | p | p | p | **1** | 0 | 0 |
| *Yucca whipplei*, Our Lord's Candle | p | 0 | **1** | p | 1 | p | 0 | 1 | 0 |
| Herb/grass cover | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 1 |
| No. of locations surveyed | 10 | 8 | 51 | 31 | 60 | 10 | 10 | 5 | 5 |

[a]Cover listed for each species is the most frequently recorded for that subassociation. All dominant species have a minimum cover of 3 for any site assigned to a given subassociation. Bold-facing indicates 100% occurrence with a coverage of 3, 90% or more with a coverage of 2 or less. 3, 25–50% of total cover; 2, 5–25% of total cover; 1, less than 5% of total cover; p, scattered individuals present, occurs on less than half of sites.

[b]1, Encelia scrub; 2, Lemonadeberry scrub; 3, Black Sage scrub; 4, Sagebrush–White Sage scrub; 5, Buckwheat scrub; 6, Sunflower scrub; 7, Sagebrush–Sunflower scrub; 8, Laurel Sumac scrub; 9, Penstemon scrub.

[c]2 in coastal areas.

[d]2 in driest inland valleys.

[e]1 in driest inland valleys.

The median density of gnatcatchers in this scrub (Table 2) is the second highest that I recorded for any subassociation. Unpublished data by the U.S. Fish and Wildlife Service (L. Salata pers. comm.) indicate densities as high as 0.4 pairs/ha near the mouth of the Santa Margarita River on Camp Pendleton Marine Corps Base. Because of extensive development of the immediate coast, however, Camp Pendleton harbors the only significant remaining population (>20 pairs) of gnatcatchers within this scrub. It is unlikely to play an important role in the continued existence of this bird.

**Table 3** California Gnatcatcher Distribution by Scrub Type in Northern San Diego County, California

| | Scrub type[a] | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Number of sites surveyed | 7 | 7 | 14 | 15 | 27 |
| Total area surveyed (ha) | 110 | 54 | 491 | 171 | 620 |
| Number of sites occupied | 6 | 0 | 6 | 4 | 26 |
| Number of pairs recorded | 21 | 0 | 12 | 7 | 161 |
| Mean density (pairs/ha)[b] | 0.14 | 0 | 0 | 0 | 0.25 |
| Minimum density | 0.10 | 0 | 0 | 0 | 0.09 |
| Maximum density | 0.24 | 0 | 0.17 | 0.16 | 0.50 |

[a]1, Encelia scrub; 2, Lemonadeberry scrub; 3, Black Sage scrub; 4, Sagebrush–White Sage scrub; 5, Buckwheat scrub.

[b]Density estimates based on sites >8 ha in size.

*Lemonadeberry scrub.* This scrub is characteristic of north- and east-facing slopes near the coast. It is readily recognized by the abundance of lemonadeberry, a tall sumac. This dominant shrub forms a closed canopy, resulting in a very sparse herb layer. Toyon (*Heteromeles arbutifolia*), which is widely distributed in chaparral, is often prominent. Black sage (*Salvia mellifera*) and California sagebrush are the most prominent subshrubs. Lemonadeberry scrub frequently merges with chamise or southern maritime chaparral. This scrub is quite limited in extent. It occurs as far as 17 km from the coast in southern San Diego County but rarely extends more than 1–2 km inland in the north. It is found on the same soil types as encelia scrub. SANDAG (1992) referred to this subassociation as "lemonadeberry-dominated scrub." Representative locations include Agua Hedionda and Batiquitos lagoons (Carlsbad), Torrey Pines State Reserve (southern section), Tecolote Canyon (San Diego), and Long and Rice canyons (Chula Vista). I have no observations of the gnatcatcher within this scrub. The dominance of tall, evergreen shrubs strongly resembles chaparral, which is avoided by the gnatcatcher. Although it may function as a corridor for the dispersal of the gnatcatcher, I believe its overall value as a reserve is very low.

*Black sage scrub.* This scrub replaces the preceding two subassociations in mid and northern San Diego County as one proceeds a short distance inland. The habitat has a climate retaining a strong marine influence but is largely east of the summer "fog" belt. This scrub has a much darker appearance than other scrubs because of the dominance of *Salvia mellifera.* Black sage often constitutes much of the shrub cover on north- and east-facing slopes, usually with a prominent emergent shrub layer. California sagebrush is frequently a co-dominant, especially on south- and west-facing slopes. The canopy is largely closed, resulting in a poorly developed herb layer. Laurel sumac (*Malosma laurina*) is the most prominent emergent shrub, but lemonadeberry is numerous near the immediate coast. The structural aspect of this scrub is similar to chamise chaparral, with which it is often confused in aerial mapping of vegetation. Black sage scrub occurs as

far as 30 km inland, occupying a much larger area than the preceding scrubs. It is found on soils derived from marine sedimentary deposits, as well as granodiorite. It becomes scarce south of the San Diego River watershed. Isolated stands grow on gabbro soils within areas that are primarily dominated by the next two subassociations, as seen at Red Hill and Monserate Mountain near Fallbrook. Originally quite extensive, areas supporting black sage scrub are being rapidly urbanized.

This scrub corresponds to the "*Salvia mellifera–Rhus laurina* association" of Kirkpatrick and Hutchinson (1977). SANDAG (1992) refers to vegetation consisting primarily of *Salvia mellifera* as "black sage-dominated scrub," while areas where California sagebrush is a co-dominant are placed in a rather inclusive "California sagebrush-dominated scrub." Representative locations include Camp Pendleton Marine Corps Base (west of Morro Hill), the San Marcos Mountains (San Marcos, Vista), Merriam Mountains (San Marcos), Harmony Grove, Olivenhain, Los Peñasquitos Canyon (San Diego), and Sorrento Valley (San Diego).

I observed the gnatcatcher on less than half the sites I surveyed (Table 3). All sightings were confined to areas in which California sagebrush is a co-dominant. Such stands function as low-density reserves for the gnatcatcher, while areas overwhelmingly dominated by black sage are avoided.

*Sagebrush–white sage scrub.* This subassociation is characteristic of uplands and south-facing slopes primarily within the watersheds of the San Luis Rey and Santa Margarita rivers. Within its somewhat limited range in San Diego County, it typically separates black sage scrub from the following subassociation. California sagebrush is the dominant subshrub. White sage (*Salvia apiana*) has the second greatest cover and is frequently a co-dominant. The overall light coloration of the foliage is distinct among scrub associations. Laurel sumac is the chief emergent shrub. The canopy is often fairly closed, especially so on north- and east-facing slopes. It ranges from 19 to 43 km from the coast and grows on thin soils derived from granodiorite or granite alluvium. Much of this scrub has been converted to avocado groves. SANDAG (1992) merged this vegetation with "California sagebrush-dominated scrub." The nearly complete replacement of black sage by white sage, though, makes it readily distinguishable from the previous scrub. Representative locations include uplands and south-facing slopes of De Luz, Fallbrook, Bonsall, Lilac, and Pauma Valley.

I found the gnatcatcher on less than one third of all sites surveyed (Table 2). In general, this scrub appears to be marginal habitat for the gnatcatcher.

*Buckwheat scrub.* This is the characteristic scrub of the hot inland valleys in the foothill zone of the county. Marine influences are slight. Flat-top buckwheat (*Eriogonum fasciculatum*) co-dominates with California sagebrush. The canopy is open with a well-developed cover of herbs and grasses. Laurel sumac is the principal emergent shrub, although Mexican elderberry (*Sambucus mexicanus*) is frequent, especially on south-facing slopes. Overall, emergent shrubs are less conspicuous than in the preceding subassociations. Prickly-pears (*Opuntia* spp.) are frequently prominent and may form large patches on south-facing slopes. Buckwheat scrub ranges primarily from 20 to 46 km from the coast and grows on thin soils derived from granodiorite or metasedimentary rock.

This scrub resembles the "*Artemisia californica–Eriogonum fasciculatum–Salvia apiana* association" of Kirkpatrick and Hutchinson (1977). SANDAG (1992) included much of this subassociation in "California sagebrush-dominated scrub," while areas with dense cactus patches are distinguished as "prickly pear-dominated scrub." My field surveys reflect no apparent difference in gnatcatcher distribution whether prickly pears are abundant or not. Since assigning many stands to one or the other is subjective, I do not feel that subdividing this scrub is well justified.

Areas covered exclusively with buckwheat or dominated by white sage are merely disturbed variations of this scrub, from the soil types, geography, and a history of fire or grazing at most sites with which I am familiar. SANDAG (1992) listed these seral stages separately as "buckwheat-dominated scrub" and "white sage-dominated scrub," respectively. Representative locations include eastern Bonsall, Bernardo Mountain and Mule Hill (Escondido), the San Diego Wild Animal Park, Lake Hodges, highlands surrounding Poway, Wildcat Canyon, and Lake Jennings.

Most significant populations of the gnatcatcher in northwestern San Diego County occur in buckwheat scrub. Densities are even higher than those of encelia scrub (Table 3). I found the bird at every site larger than 3 ha with the exception of one isolated stand in Vista surrounded by black sage scrub. My observations indicate that buckwheat scrub should be the primary focus of conservation efforts on behalf of the gnatcatcher in northwestern San Diego County.

### Additional Coastal Sage Scrub Subassociations of San Diego County

A major change in scrub composition occurs within the watershed of the San Diego River. Black sage scrub is replaced on south- and west-facing slopes by San Diego sunflower (*Viguiera laciniata*), also called San Diego County viguiera. Black sage largely disappears south of the San Diego River watershed. Additional scrubs appear within the watersheds of the Sweetwater, Otay, and Tijuana rivers. Inland areas of the county support other, rather localized, subassociations. The total area of coverage of most subassociations listed below is too minimal to support major populations of the gnatcatcher, even if they are actually inhabited. Two subassociations, though, appear to serve as important reserves for the bird. As I have limited experience with the gnatcatcher in these regions, my comments are based partially on data collected by Mock (1993).

*Sunflower scrub.* This scrub is common within the watersheds of the San Diego, Sweetwater, and Otay rivers. San Diego sunflower is the dominant subshrub. Laurel sumac is the primary emergent shrub at most locations. Slope aspect is usually southern. This scrub has a low and rather open canopy and grows on thin soils derived from granodiorite, metasedimentary, and marine sedimentary rock. It ranges from 8 to 36 km inland from the coast. Much of this scrub is east of the summer "fog" belt. SANDAG (1992) referred to this as "San Diego County viguiera-dominated scrub." Representative areas include south-facing slopes in Mission Valley (San Diego), Mission Trails Regional Park (San Diego), Santee Lakes (Santee), Harbison Canyon, Dehesa Road, and the Jamul Mountains.

The replacement of black sage scrub by sunflower scrub appears to benefit the gnatcatcher in the eastern fringes of San Diego and its suburbs. Distribution maps of gnatcatcher sightings collected by Mock (1993) show a concentration of records near Mission Trails Regional Park, Santee, and El Cajon.

*Sagebrush–sunflower scrub.* This scrub is found along the lower reaches of the Sweetwater, Otay, and Tijuana rivers and their tributaries. California sagebrush is the dominant subshrub. San Diego sunflower may be a co-dominant but more often provides the second greatest cover. Sagebrush–sunflower scrub resembles the previous subassociation, but laurel sumac is largely replaced by two other emergent shrubs, lemonadeberry and jojoba (*Simmondsia chinensis*). Succulents, such as Mohave yucca and coastal cholla, are also prominent. Marine influences are strong. This scrub occurs up to 17 km from the coast, primarily on slopes with a southern aspect. It grows mainly on soils derived from marine sedimentary deposits, but a few stands in the eastern part of its range are found on soils with a metavolcanic base. SANDAG (1992) referred to this as "jojoba scrub" and considered it to be a variation of maritime succulent scrub. Jojoba, though, is also abundant in a different variation of coastal sage scrub growing in southwestern Riverside County near Aguanga. Representative locations include Sweetwater Dam (Bonita), Long and Rice canyons (Chula Vista), and the Otay River Valley east of Interstate 805.

Mock (1993) shows a large concentration of gnatcatcher sightings near Chula Vista where this is the dominant subassociation. Most sites are rapidly being fragmented by intense urbanization. Long-term prospects for the gnatcatcher in this scrub are not good.

*Munz's sage scrub.* This scrub is dominated by Munz's sage (*Salvia munzii*), which occupies a restricted area within the Sweetwater and Otay river watersheds. This species resembles a short black sage, but the canopy is much more open. Westman (1983) lists Munz's sage as one of the dominant shrubs of the scrublands of northwestern Baja California. Its range marks the edge of the summer "fog" belt. I surveyed only two sites where this subassociation occurs and have not included it in Table 2. Munz's sage scrub grows on soils of marine sedimentary, metavolcanic, and metasedimentary origin. SANDAG (1992) recognized this as "Munz's sage-dominated scrub". Representative locations include Proctor Valley Road and Upper Otay Reservoir. The gnatcatcher is present in both of these areas. The small area dominated by this scrub and the rapid development of nearby localities preclude its serving as a major reserve.

*Laurel sumac scrub.* This is a north- or east-slope complement to buckwheat scrub growing on steep terrain within the watershed of the San Diego River. Laurel sumac has a greater cover than either flat-top buckwheat or California sagebrush, which coexist with it. Scrub oak (*Quercus berberifolia*) is prominent. It occurs in inland areas 28–35 km from the coast. This scrub frequently merges with chaparral or oak woodland. SANDAG (1992) has listed this as "laurel sumac-dominated scrub". Representative locations include the Highway 67 corridor between Poway and Lakeside, Wildcat Canyon, El Monte Road, and hills south of Interstate 8

between Lakeside and El Cajon. I know of no records of the gnatcatcher from this scrub. Its resemblance to chaparral makes it an unlikely refuge.

*Penstemon scrub.* This association grows in a fairly limited area, primarily on steep north-facing slopes, within the San Luis Rey and San Dieguito river valleys, 32–40 km from the coast. Yellow bush penstemon (*Keckiellia antirrhinoides*) is the dominant shrub. Laurel sumac is often prominent. The shrub canopy is usually closed. Penstemon scrub grows on soils derived from granodiorite and granite alluvium. SANDAG (1992) referred to this as "penstemon-dominated scrub." Representative locations include the Rincon Indian Reservation, the San Luis Rey River valley east and west of Cole Grade Road, and north-facing slopes of the San Pasqual Valley, as near Santa Maria Creek. I know of no gnatcatcher observations from this scrub in San Diego County. Penstemon scrub is very difficult to survey, but its small extent and chaparral-like growth form do not indicate it is likely to harbor a major population of the gnatcatcher.

*Buckwheat–deerweed scrub.* This inland subassociation barely enters San Diego County north and west of Oak Grove near the Riverside County line, 60–64 km from the coast. It is dominated by flat-top buckwheat and deerweed (*Lotus scoparius*). Slope aspect is southern. Succulents are prominent, especially valley cholla (*Opuntia parryi*) and Mohave yucca. The shrub canopy is quite open with areas of bare soil. Sugarbush (*Rhus ovata*) is the primary emergent shrub within San Diego County. Jojoba is widespread in nearby areas of Riverside County, where this scrub is better developed. Buckwheat–deerweed scrub grows on soils underlain by granite alluvium. It was not listed by SANDAG. I have completed surveys of only two stands of this scrub in the county, but this is most of what occurs, and I have not included it in Table 2. I have no observations of the bird.

At a limited number of sites, coastal sage scrub does not fit neatly into any of the above categories. Some of these variations may represent distinct subassociations whose limited geographical range is due to specific edaphic conditions. One such example is dominated by California adolphia (*Adolphia californica*) and grows in dense thickets on clay soils (SANDAG 1992). Another may be the stunted scrub growing on the steep north and south slopes of Palomar Mountain. Other types are obviously at the fringes of their ranges. Scrubs typical of dry washes or extremely dry sites in southwestern Riverside County, for example, extend no more than a few hundred meters into San Diego County west of Oak Grove. The majority of sites that I surveyed that cannot not be included in one of the subassociations listed above have a high herb–grass cover (>25%). They are disturbed versions of the scrubs discussed above.

## DISCUSSION

The California Gnatcatcher shows decided habitat preferences within the coastal sage scrub of northwestern San Diego County. The birds avoid areas dominated by tall shrubs and occur in low numbers in closed-canopy scrub even where subshrubs dominate. In sharp contrast, I recorded gnatcatchers on all sites larger than 8 ha dominated by encelia scrub or buckwheat scrub.

Mean densities of gnatcatchers in buckwheat scrub were nearly twice those in encelia scrub. No other subassociations had a mean density above zero. In northwestern San Diego County only one subassociation, buckwheat scrub, serves as a major reserve for this species. The distribution of the gnatcatcher in southern San Diego County is likely to parallel its occurrence in the northern part of the county. Records appear to be concentrated in areas dominated by open-canopy scrub. However, additional research or review of the diverse and scattered survey data is needed to determine which, if any, subassociation is preferred.

This paper could have been titled "Can we predict the presence of the California Gnatcatcher by looking at the plant cover?" I believe the answer is "yes." While much of my findings are probably known intuitively by experienced field observers, intuition isn't what land planners, reserve managers, and government agencies will find acceptable when making decisions in the political and land-acquisition arena. An easily understood, objectively based approach might be.

Knowledge of vegetation patterns can, at the least, allow biologists to point out potential inadequacies in "reserve planning." For example, setting aside some closed-canopy scrubs appears to provide little in the way of suitable gnatcatcher habitat, although they may be valuable as corridors. I encourage other observers to look for relationships between shrub cover and where we are finding the California Gnatcatcher.

## SUMMARY

Surveys of the California Gnatcatcher in northwestern San Diego County reveal distinct preferences in the type of coastal sage scrub that it inhabits. The gnatcatcher occurs in high frequencies and densities in scrub with an open or broken canopy. It is absent from scrub dominated by tall shrubs and occurs in low frequencies and densities in low scrub with a closed canopy.

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