1993 CALIFORNIA GNATCATCHER AND CACTUS WREN STUDIES IN THE SAN JOAQUIN HILLS

June 29, 1994

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TABLE OF CONTENTS

APPENDIX

LIST OF FIGURES

PAGE

LIST OF TABLES

PAGE

EXECUTIVE SUMMARY

Studies of California gnatcatchers and cactus wrens in the San Joaquin Hills in 1993 focused primarily on the former species. Systematic surveys of the San Joaquin Hills Transportation Corridor route were not undertaken, but considerable information on gnatcatcher distribution was obtained throughout the year. A study of six pairs of gnatcatchers at the uppermost elevations in the hills provided data on timing of nesting, clutch size, nesting success, and noise levels at nest sites. Color-banding of gnatcatchers could not be not conducted as planned, but information was gathered on gnatcatchers and wrens banded in the area by David Bontrager.

The Laguna Beach fire in late October altered all previous plans, and dominated studies for the remainder of the year. The entire San Joaquin Hills Transportation Corridor route between Laguna Canyon Road and Newport Coast Drive burned. Surveys conducted following the fire suggested that few birds perished in the blaze. Post-fire conditions were insufficient to support pre-fire bird numbers, however, so bird densities diminished rapidly. Pockets of unburned and lightly burned scrub, especially associated with dense stands of cactus, continue to support a few wrens, and smaller numbers of gnatcatchers. Unburned areas on the periphery of the fire apparently absorbed many displaced gnatcatchers, but few wrens. More wrens were apparently able to remain within burned areas because the fire-dampening effect of dense cactus patches allowed a disproportionate amount of that vegetation to remain intact.

The prospects for post-fire recolonization of the San Joaquin Hills by gnatcatchers and wrens are enhanced by the presence of these habitat refugia within the fire perimeter. Five unburned areas around the periphery of the fire (Sand Canyon Reservoir, north Laguna Laurel, Sycamore Hills, coastal Crystal Cove State Park, and the Bonita Reservoir area) support wren and/or gnatcatcher concentrations that should serve as important sources of birds to recolonize the hills.

INTRODUCTION

This report has been prepared in accordance with the terms and conditions of the U.S. Fish & Wildlife Service's Biological Opinion (USFWS 1994b) concerning effects of the San Joaquin Hills Transportation Corridor on coastal California gnatcatchers (*Polioptila californica californica*[1]) and coastal cactus wrens (coastal populations of *Campylorhynchus brunneicapillus*[2]).[3]

Studies of these birds were subject to numerous modifications in 1993, and considerable time was spent during the nesting season in an effort to locate nestling gnatcatchers of the appropriate age for banding. Ultimately, however, it proved too difficult to accomplish any banding in the state of regulatory flux that developed following formal listing of the gnatcatcher as a federally threatened species in March, 1993, i.e., banders that were available to subcontract to LSA did not possess the necessary Section 10a permits.

In late October, 1993, the Laguna Beach fire burned most of the San Joaquin Hills, including the entire route of the Transportation Corridor between Laguna Canyon Road and Newport Coast Drive. LSA conducted surveys of much of the burned area immediately following the fire in an attempt to judge the impact of the fire on gnatcatchers, wrens, and other wildlife. Many of the findings reported here have been presented more formally by

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1 Hereinafter referred to as gnatcatchers, or California gnatcatchers

2 Hereinafter referred to as wrens or cactus wrens

3 Terms and Conditions item number 11 states: "The Federal Highway Administration or its agents shall perform a series of monitoring studies to provide additional information on gnatcatcher and coastal cactus wren habitat utilization. The purposes of these studies may include, but are not limited to:

a. The study of the recovery of the gnatcatchers, coastal cactus wrens and their habitat from the fire,

b. An examination of the success of the revegetation efforts in providing nesting opportunities for the gnatcatcher and coastal cactus wren, with consideration of predation, nest parasitism and other factors.

Maximum funding for studies will be $60,000 annually for a total of ten years, beginning with the 1993 studies. Although the specific focus and methodology for the studies will be recommended each year by the SJHTC Conservation Committee, the studies shall be at the direction of the Service. The Service shall fully consider the recommendations of the Committee and shall actively seek the input of the Department of Fish and Game. Reports detailing study finding [sic] and recommendations shall be due each calendar year for the life of the study period.

Bontrager *et al.* (in review). The 1994 study plan is being designed to monitor gnatcatcher and wren use of the fire altered habitats in the San Joaquin Hills.

SURVEY SUMMARIES, 1988-1993

Several rounds of focused sensitive species surveys have been conducted along the San Joaquin Hills Transportation Corridor alignment. This section provides an overview of the results of sensitive species surveys with regard to California gnatcatchers and cactus wrens. It must be noted that survey areas were not constant from year to year. In particular, surveys in 1990 and 1991 were the most limited, being restricted to the actual grading limits of the Corridor. Relatively high concentrations of gnatcatchers in the vicinity of Bonita Reservoir, but outside the area of direct SJHTC effects, were not included. Appendix A indicates the timing and personnel for each survey along the Corridor alignment since 1988.

SWEETWATER ENVIRONMENTAL BIOLOGISTS - 1988

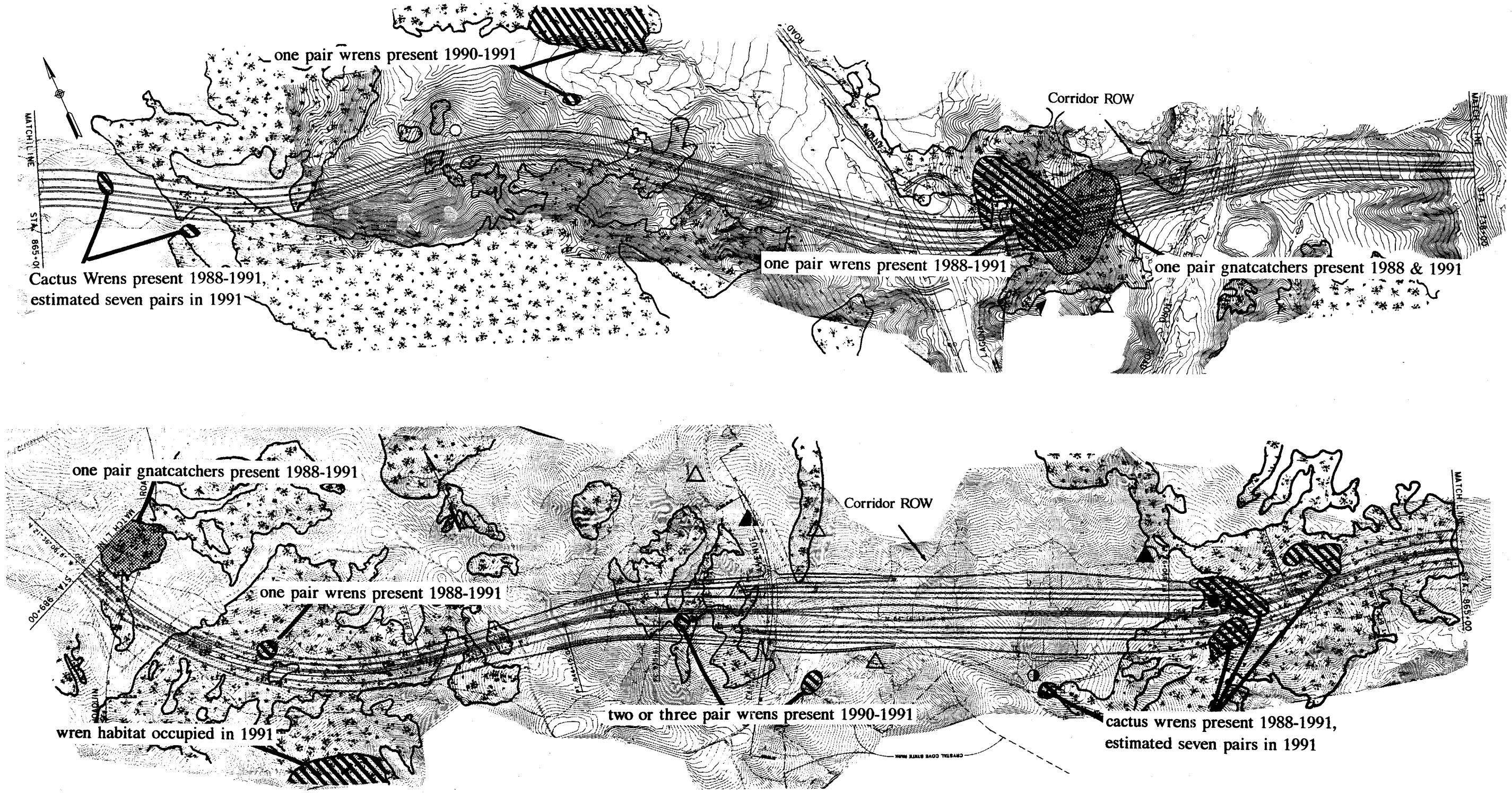
During directed gnatcatcher surveys in April and May, 1988, Barry L. Jones found a total of 12 territorial male gnatcatchers and at least 14 cactus wrens between MacArthur Boulevard and El Toro Road (SEB 1988). Those birds closest to the Corridor are shown on Figure 1; most were around Bonita Reservoir.

LSA - 1990

LSA biologists completed their first round of surveys of the Corridor alignment (grading limits) in spring, 1990 (May 16 through July 11), sighting 12-15 California gnatcatchers at five locations (LSA 1991). As shown on Figure 1, most of the sightings were along the north and west sides of Bonita Canyon Reservoir; LSA (1990) indicates that "this area was more intensively covered by us than anywhere else along the route." Cactus wren numbers were not specifically noted in 1990, but wren locations are shown on Figure 1 and generally match the pattern of other years.

LSA - 1991

Approximately ten gnatcatchers were found at four sites within the Corridor right-of-way in 1991 (LSA 1991; Figure 1). A total of 27 cactus wrens was found, with another six birds nearby (LSA 1991). The primary concentration was found along the Bommer Canyon ridge, where as many as seven pairs were estimated to be present (Figure 1).

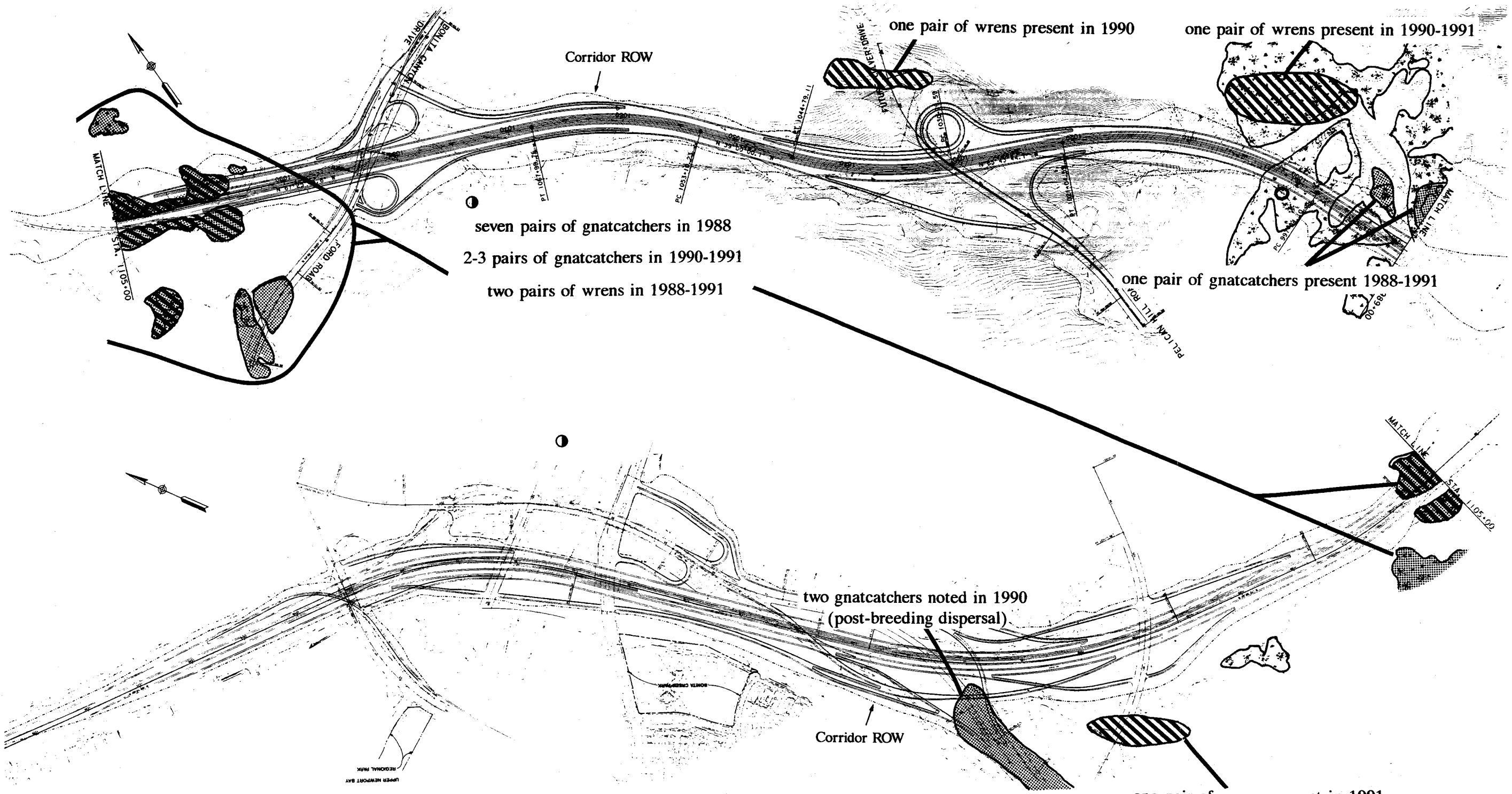


3/14/94(CRN301C)

Figure 1a

LSA Scale in Feet 0 420 840

Localities of California Gnatcatcher, Cactus Wren, and Associated Habitat, 1988 - 1991



3/14/94(CRN301C)

Figure 1b

LSA Scale in Feet 0 420 840

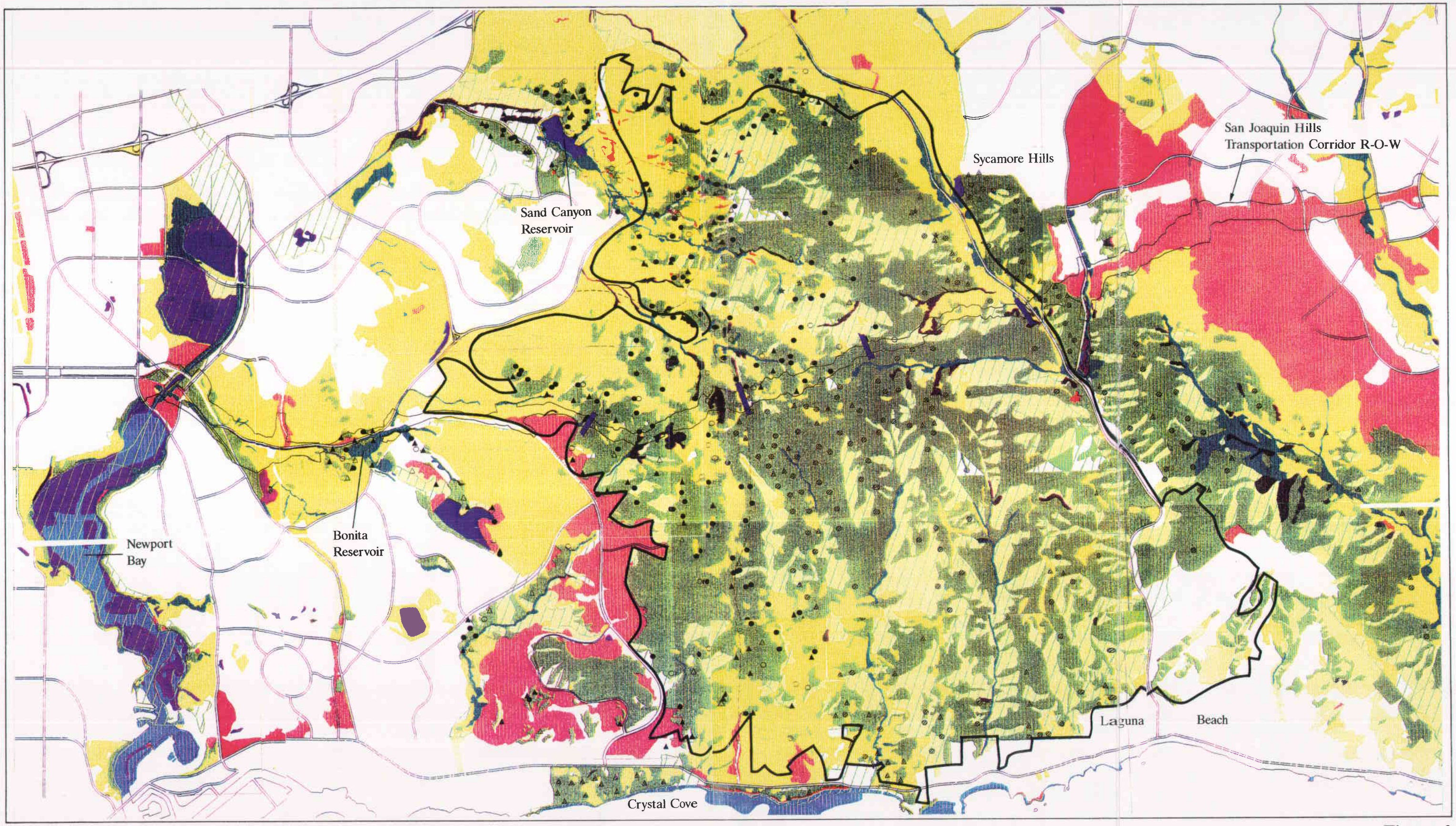
Localities of California Gnatcatcher, Cactus Wren, and Associated Habitat, 1988 - 1991

NCCP-1992

The final round of surveys in the vicinity of the Corridor alignment (prior to LSA's 1993 surveys, which comprise the main subject of this report) was completed in spring, 1992. The primary purpose of these surveys was to provide information on selected lands for the Natural Communities Conservation Planning (NCCP) program, according to the field survey protocol established by the NCCP Scientific Review Panel. Surveys on land owned by The Irvine Company (TIC) were conducted by Jones and Stokes, Associates. Surveys on open space lands, with which the County of Orange has some involvement, were conducted by David Bontrager, Sweetwater Environmental Biologists and P&D Technologies, under subcontract to Ed Almanza and Associates. Detailed information on the survey dates or locations for these surveys is not available. Figure 2 shows the survey results for the area in the general vicinity of the Corridor, based on data from the Jones & Stokes GIS system and maps supplied by the County. As in previous studies, a small, relatively dense, concentration of California gnatcatchers was detected in the vicinity of Bonita Reservoir.

LSA - 1993

Systematic surveys of the entire Corridor route were not undertaken in 1993. The Sycamore Hills, among other areas, were studied in detail by Bontrager (1994a, b), who found totals (pairs plus singles) of 24 gnatcatchers and 20 wrens there. That area was not included in pre-fire surveys by LSA. Cactus wrens were not monitored in 1993, but Figure 3 shows the locations of 31 pairs of gnatcatchers found in the vicinity of the Corridor. As shown in Table A, several pairs were seen only in fall, and may represent young of the year rather than established adult pairs. Juvenile gnatcatchers are known to establish pair bonds within weeks of fledging (Ogden 1992). For example, the female gnatcatcher color-banded as a juvenile at UCI on April 20, 1993 (No. 1710-49930) moved to Bonita Reservoir and appeared to be paired by August 3, 1993. Pairs numbered three, seven, and nine were in areas where the habitat did not appear sufficient to support nesting activities. Thus, autumn pair counts probably do not accurately reflect nesting densities.



3/18/94(CRN301C)

LEGEND:

- Scrub
- Chaparral
- Grassland
- Woodland
- Marsh
- Riparian
- Lakes, Res., Basins
- Watercourses
- Marine and Coastal
- Pools, Seeps, Meadows
- Cliff and Rock
- Agriculture
- Disturbed Areas
- Unidentified
- Boundary of Fire Area
- Gnatcatcher Single
- Gnatcatcher Pair
- Cactus Wren Single
- Cactus Wren Pair
- County Survey

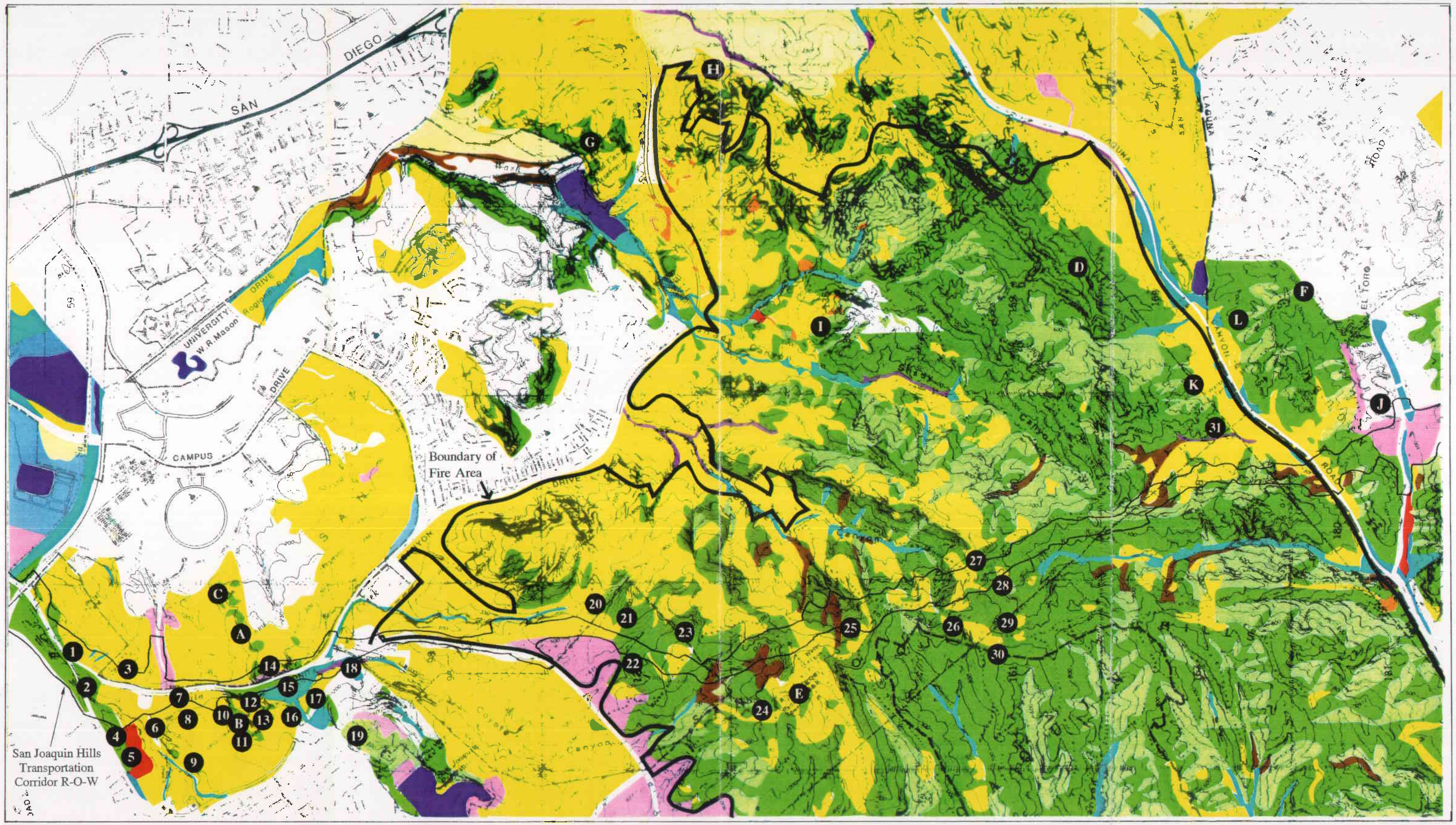
LSA

Scale in Feet

0 2000 4000

Figure 2

California Gnatcatcher and Cactus Wren Locations, 1992 Laguna Fire Area



3/18/94(CRN301C)

LEGEND:

- Scrub
- Chaparral
- Grassland
- Woodland
- Marsh
- Riparian
- Lakes, Res., Basins
- Watercourses
- Pools, Seeps, Meadows
- Cliff and Rock
- Agriculture
- Disturbed Areas
- 22 California Gnatcatcher Pairs
- A Color-Banded Birds

LSA

Approximate
Scale in Feet
0 1350 2700

Figure 3

Locations of California Gnatcatcher Pairs and Color-Banded Cactus Wrens and Gnatcatchers in 1993

Table A - Pairs of California Gnatcatchers Found in the Vicinity of the San Joaquin Hills Transportation Corridor in 1993

See text (page 6) for caveats and limitations concerning these data.
Numbers refer to locations shown on Figure 3.

Number	Explanation
Bonita Canyon area	
1 (S-5)	Pair present in July (with nest and four eggs) and September
2	Pair present in July and September
3	Pair present in September
4	Pair present July - December
5	Pair present July (with juveniles) - December
6	Pair present in September and October
7	Pair present in September
8	Pair present in September and October
9	Pair present in September
10	Pair present June - October
11	Pair present June and September
12	Pair present in June and September
13 (S-3)	Pair present in June (with three juveniles) and September
14	Pair present in September
15	Pair present in June - October
16	Pair present June - December
17	Pair present in June (with juveniles)
18	Pair present in June
19 (S-2)	Pair present in June (with four juveniles) and September
Coyote Canyon area	
20	Pair present in July
21 (S-4)	Pair present in July (with nest and four young)
22	Pair present in July
23	Pair present in September
24	Pair present in September
Bommer Canyon ridge	
25 (E-1)	Pair present March - June (fledged four young in May)
26 (C-1)	Pair present March - June (fledged four young in May; second nest with three eggs in June)
27 (E-2)	Pair present March - June (with nest and four young in June)
28 (E-3)	Pair present March - May (with nest and four eggs in May)
29 (C-3)	Pair present March - May (fledged four young in May)
30 (C-2)	Pair present March - May (nest building in May)
Laguna Canyon	
31	Pair present in June

1993 GNATCATCHER NESTING STUDY

Initially, one of the study's primary goals was to gather data on the effects of construction and traffic noise on nesting gnatcatchers. By monitoring noise levels, gnatcatcher nesting behavior, and gnatcatcher nesting success in the local area over several years, the effects of noise associated with Corridor construction and operation on the local California gnatcatcher population could be analyzed. This report presents the results of LSA's 1993 studies, and discusses modifications to the study design for subsequent years of this long-term project.

STUDY DESIGN

The study design involved monitoring California gnatcatchers and cactus wrens both inside and outside the projected 60 dBA contour line for traffic noise on the completed Corridor (LSA 1993a, pages 81-86). In planning the 1993 survey effort, it was found that much of the occupied habitat along the Corridor alignment in the San Joaquin Hills is subject to existing noise effects from 1) operation of an existing gas plant northwest of Signal Peak, 2) traffic and construction along Newport Coast Drive, 3) traffic on Laguna Canyon Road, and 4) traffic on El Toro Road; therefore, these areas were not considered suitable to test the effects of introducing construction and traffic noise on nesting gnatcatchers in undisturbed areas. The only suitably large area of quiet scrub habitat that lies along the Corridor alignment is located roughly between Signal Peak and the lower hills of Laguna Canyon. This potential study area was further limited by the need to compare results from pairs nesting at similar elevations.

These combined constraints limited the study area to coastal sage scrub habitat areas located along the spine of the San Joaquin Hills, above approximately 800 feet in elevation. This is significant, since gnatcatchers selectively occupy habitat at lower elevations; for example, Atwood and Bolsinger (1992) found that 84 percent of recent gnatcatcher localities are under 800 feet in elevation.

METHODS

From March 20 through March 30, 1993, LSA biologists conducted reconnaissance surveys to locate gnatcatcher pairs within the study area. As expected from the available literature and previous surveys of the area, our early season surveys yielded relatively few pairs of gnatcatchers in the study area. Only three "experimental pairs" (with territories within the 60 dBA contour) and three "control pairs" (with territories outside the 60 dBA contour) were located, compared to the goal of six pairs of each.

From March 30 through June 11, 1993, LSA 1) monitored the nesting activities of the six pairs of gnatcatchers, and 2) continued to search for additional

nesting pairs to monitor. During this phase of the study, LSA reported the low gnatcatcher density to the USFWS, and discussed the limitations that this would place on the study. At this point, the USFWS suggested that the 1993 surveys focus primarily on locating and observing gnatcatchers, with decreased emphasis on locating and observing cactus wrens.

From June 22 through June 29, 1993, LSA made another sweep through the study area in an attempt to locate active nests for a planned late season banding effort that ultimately proved infeasible.

SITE CONDITIONS

In the San Joaquin Hills, as in other locales, gnatcatcher density is inversely related to elevation. This suggests that habitat considerations (i.e., plant community composition and/or density), environmental factors (e.g., temperature, wind, rainfall) and/or physical factors (e.g., slope) limit the birds at higher elevations. While it was outside the scope of this study to determine the reasons why gnatcatcher density was low in the study area, this section discusses some of the factors that may affect gnatcatcher density in LSA's 1993 nesting study area.

Plant Communities

The extensive Orange County Parks survey (SEB 1992) found gnatcatchers in 11 identifiable subtypes of coastal sage scrub with 75 percent of all birds located in three sub-types: sagebrush-buckwheat (41 percent), southern cactus scrub (17 percent) and sagebrush scrub (17 percent). It should be noted that this may largely reflect the relative abundance of scrub sub-associations in the area surveyed rather than a significant preference for these particular subassociations.

The coastal sage scrub habitat that comprised the home ranges of the gnatcatchers in the study area conformed to these three coastal sage subtypes, plus one additional sub-type that is of high value to gnatcatchers: sagebrush-monkeyflower. The dominant species in the study area included California sagebrush (*Artemisia californica*), California buckwheat (*Eriogonum fasciculatum*), coastal prickly pear (*Opuntia littoralis*), coast cholla (*Opuntia prolifera*), buff monkeyflower (*Mimulus aurantiacus*), coast goldenbush (*Isocoma menziesii* var. *venetus*), lemonade berry (*Rhus integrifolia*), laurel sumac (*Malosma laurina*) and Mexican elderberry (*Sambucus mexicana*). It may be significant that 1) scrub at higher elevations of the San Joaquin Hills tends to be denser and more contiguous than scrub growing at lower elevations, and/or 2) there is less ecotonal area with grasslands at higher elevations.

Rainfall/Weather

Anecdotal evidence indicates that drought is associated with depressed gnatcatcher productivity. According to data from the County of Orange Environmental Management Agency, rainfall in nearby Costa Mesa totalled 14.9 inches in 1991/92 (135 percent of the annual mean since 1955) and 22.2 inches in 1992/93 (187 percent of the annual mean since 1955). Based on these totals, rainfall was not a limiting factor for gnatcatchers in the San Joaquin Hills during 1993.

On the other hand, the more severe winter weather associated with increased precipitation may play an important role in gnatcatcher mortality. Ogden Environmental and Energy Services Company, Inc. (1992) compared the annual survival of adult California gnatcatchers in the Rancho San Diego area (three year study by Ogden) and on the Santa Margarita Ranch (one year study by David Bontrager). During the cold, wet winters of 1989-1990 and 1991-1992, adult survival was 25.6 percent and 32.6 percent, respectively, at Rancho San Diego. During the milder 1990-1991 winter, survival was 59.5 percent at Rancho San Diego and 60.9 percent at Santa Margarita Ranch. These results indicate that severe winter weather may increase gnatcatcher mortality by as much as 100 percent; this may be an important factor contributing to decreased gnatcatcher density at higher, more exposed sites.

Other Factors

Additional site conditions that may have affected gnatcatcher density in the study area were not specifically monitored. It is possible that lower temperatures associated with increased altitude and exposure contributed to the delayed onset of nesting activities in LSA's study area compared to the typical results obtained at lower elevations. The role of temperature on gnatcatcher nesting ecology is not adequately addressed in the literature, and represents a research need.

RESULTS

This section discusses the results of LSA's surveys of nesting gnatcatchers in spring, 1993.

Nest Location and Elevation

Figure 3 shows the locations of the gnatcatcher nests that were found during the nesting study, keyed according to Table A. All were located along the ridge between Signal Peak and Shady Canyon, approximately 3.0 miles from the coast at elevations of approximately 850 to 950 feet.

Noise Measurements

On May 26, 1993, between 8:25 a.m. and 10:35 a.m., LSA noise specialist Mike Greene obtained noise measurements at the five known nest locations. Each location was monitored for 15 minutes, and readings were obtained indicating Leq (ranging from 39.3 dBA to 42.5 dBA), Lmax (50.0 dBA to 60.5 dBA) and Lmin (35.5 dBA to 36.5 dBA). Table B indicates the measurements obtained at each nest site.

Table B - Noise Measurements

Pair	Leq (dBA)	Lmax (dBA)	Lmin (dBA)
Experimental-1 (E-1)	42.5	55.5	36.5
Experimental-2 (E-2)	N.A.[1]	N.A.	N.A.
Experimental-3 (E-3)	39.3	56.0	35.5
Control-1 (C-1)	40.1	50.0	36.0
Control-2 (C-2)	41.3	55.5	35.5
Control-3 (C-3)	41.0	60.5	35.0

These data indicate that the nest locations were uniformly quiet, with only occasional loud noises (e.g., airplanes flying overhead, distant jets). Noise should not have affected the suitability of any of the nest sites or the nesting success of any of the gnatcatcher pairs observed in the study.

Timing of Nesting Activities

The 1993 study provided information on the timing of California gnatcatcher nesting activities in the study area. Table C lists the activities that were noted for each experimental and control pair; Table D summarizes the timing of nesting activities of these pairs and the supplemental pairs discussed later.

First Nesting Attempt

This section discusses the timing of nesting activities related to the first attempts at nesting. Nesting activities within the study area started later in the season than is typical for lower elevations in coastal Orange County. For example, near sea level LSA (unpublished data) observed newly hatched young in a nest near the Santa Ana River mouth on March 24, 1993;

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1 No measurements were taken because the nest location was never found.

Table C - Summary of California Gnatcatcher Nesting Activities

Nesting Pair	Date	Observations
Experimental-1	4/2/93	Nest building observed - the first nesting activity noted for any of the observed pairs (experimental or control)
	4/3/93	Continued nest building - no other pairs showing nesting activity
	4/4/93	Continued nest building - no other pairs showing nesting activity
	4/17/93	Followed male foraging throughout home range; female remained near the nest; no eggs yet
	4/24/93	Four CAGN eggs in nest
	5/2/93	Four nestlings; stray male gnatcatcher observed near nest (across dirt road)
	5/5/93	Stray male not re-found
	5/19/93	All four young fledged successfully
	5/26/93	Adult pair and all four young observed
	6/2/93	Young still following adult pair
	6/8/93	Followed adult pair for a couple hours; no sign of young or nesting activity
	6/9/93	Could not find adult pair or young
	6/11/93	Followed adult pair; no sign of young or nesting activity
	6/24/93	Pair, presumably E-1, observed foraging
	6/26/93	Pair plus an additional bird heard.
	6/29/93	One bird heard
Experimental-2	4/8/93	Nest building observed
	4/24/93	Could not find nest
	5/2/93	Could not find nest
	5/5/93	Could not find nest
	5/9/93	Could not find nest
	6/22/93	Pair, presumably E-2, observed foraging

Table C - Summary of California Gnatcatcher Nesting Activities (Continued)

Nesting Pair	Date	Observations
Experimental-2 continued	6/23/93	Pair, presumably E-2, observed foraging
	6/24/93	Nest with four large young located in the area frequented by E-2
	6/26/93	Nest now empty, young presumably fledged
Experimental-3	4/8/93	Nest building observed
	4/24/93	Three CAGN eggs in nest
	5/2/93	Four CAGN eggs in nest
	5/19/93	Eggs gone; no young
Control-1	4/8/93	Nest building observed
	4/18/93	Followed male foraging throughout home range; no eggs yet
	4/25/93	Four CAGN eggs in nest; followed male and female as they foraged and moved about their territory
	5/2/93	Four nestlings
	5/19/93	All four young fledged successfully
	5/26/93	Adult pair and all four young observed
	6/2/93	Young still following adult pair
	6/9/93	Adult pair observed, young absent
	6/11/93	Followed adult pair; no sign of young or nesting activity
	6/22/93	Adult pair, presumably C-1, observed just south of the upper eastern Bommer Canyon ridge
	6/23/93	Adult pair observed, plus a stray adult female
	6/24/93	Adult pair found at nest (near original nest) containing three eggs
	6/26/93	Adult pair observed foraging to the northeast of where they were on 6/24
	6/29/93	Pair heard near nest

Table C - Summary of California Gnatcatcher Nesting Activities (Continued)

Nesting Pair	Date	Observations
Control-2	4/8/93	Carrying nesting material
	4/18/93	Followed male foraging throughout home range; could not find nest
	4/21/93	Followed male and female foraging throughout home range; could not find nest
	4/25/93	Could not find nest
	5/2/93	Could not find nest; male ranged widely
	5/8/93	Nest building approximately 100 yards north of previous center of activity - possibly moved due to mountain bike and other activity in Crystal Cove State Park
	5/9/93	Pair lining nest; no eggs yet
	5/23/93	Nest abandoned before eggs laid
Control-3	4/8/93	Nest building observed
	4/21/93	Followed male and female foraging throughout home range
	4/25/93	Four CAGN eggs in nest; followed male and female throughout home range
	5/2/93	Four nestlings
	5/19/93	All four young fledged successfully

Table D - Summary of Nesting Phenology

Pair	Nest Building	Egg Dates	Nestling Dates	Fledgling Dates[1]
First Nesting Attempt				
E-1	April 2-4	April 24	May 2	May 19 - June 2
E-2	April 8			
E-3	April 8	April 24 - May 8		
C-1	April 8	April 25	May 2	May 19- June 2
C-2	April 8			
C-3	April 8	April 25	May 2	May 19
S-1				April 26
Subsequent Nesting Attempt(s)				
E-2			June 24	
C-1		June 24		
C-2	May 8-9			
S-2				June 30
S-3				June 30
S-4		July 1		
S-5		July 2		

[1] Includes all observations of juvenile gnatcatchers still actively tended by their parents

nestlings were first observed in the study area on May 2, 1993, a difference of approximately five weeks. In the San Joaquin Hills outside of the study area, LSA observed four fledglings of "Supplemental Pair 1" (see the subsequent Table E) on the frontal slope of Pelican Hill at an elevation of approximately 300 feet on April 26, 1993; fledglings were first observed in the study area on May 19, 1993, a difference of over three weeks. In general, Ogden (1992) and Atwood (1993) indicated that nesting at lower elevations near the coast may commence as early as mid-February.

Table E - Summary of Supplemental Gnatcatcher Nesting Activities

Nesting Pair	Date	Observations
Supplemental-1	4/26/93	pair with 4 juveniles
(near Pelican Hill Road x Newport Coast Drive; not on Figure 3)		
Supplemental-2	6/30/93	pair with 4 juveniles
Supplemental-3	6/30/93	pair with 3 juveniles
Supplemental-4	7/1/93	nest with 4 large young
Supplemental-5	7/2/93	nest with 4 large young

Nest Building

The first indication of nest building was by Experimental Pair No. 1 (E-1) on April 2. All six pairs were observed carrying nesting material or actually constructing nests by April 8.

Egg Laying

Based on data gathered on the four nests found, it appears that egg laying occurred more or less synchronously between April 17-18 and April 24-25.

Nestlings

The nests of pairs E-1, C-1 and C-3 each contained four nestlings on May 2.

Fledglings

Pairs E-1, C-1 and C-3 each fledged four young by May 19.

Second Nesting Attempt

Surveys were conducted in the study area to search for nests in late June/early July, 1993. This section discusses the results of these surveys.

Nest Building

Pair C-2 was observed building a nest on May 8-9, but the nest was found empty on May 23, indicating that nesting failed. No other late season nest building was observed.

Egg Laying

On June 24, a nest containing three eggs was found near the location of the first nest of Control Pair No. 1 (C-1), and is presumed to be a subsequent nesting attempt undertaken by C-1. The eggs had not hatched by June 29, the last date the nest was monitored.

Nestlings and Fledglings

On June 24, a nest with four large young was found in the area frequented by Experimental Pair No. 2 (E-2), and is presumed to be a subsequent nesting attempt for E-2. The nest was empty on June 26, the young having presumably fledged.

Additional Nesting Data

In addition to the study group discussed above, LSA obtained information on several additional pairs of gnatcatchers nesting at lower elevations in the San Joaquin Hills. Table E indicates the nesting evidence obtained and the dates of observation for these birds; locations are shown on Figure 3, keyed according to Table A.

Clutch Size

Atwood (1988) found that California gnatcatchers lay three to five eggs, with four the most common number in normal years; the mean clutch size is 3.84. These findings are consistent with LSA's findings, summarized below.

Information was obtained on first nesting clutch size for five pairs (E-1, E-3, C-1, C-3, and S-1); all were four egg sets. Brood size data on six pairs (E-2, C-1, S-2, S-3, S-4, and S-5) were obtained during subsequent nesting attempts; four pairs had four eggs or young, and two pairs had three, for an average of 3.67. The combined average of all pairs in 1993 was 3.82.

STUDY DESIGN MODIFICATIONS/RECOMMENDATIONS

As the nesting study progressed, several circumstances contributed to a decision by LSA and the USFWS to alter the study design in subsequent years. First, it became apparent that the low density of California gnatcatchers in the study area would seriously restrict efforts to draw definitive conclusions. Second, anecdotal evidence continued to mount calling into question the potential significance of road noise on California gnatcatcher nesting ecology[1]; this included a closely monitored pair of gnatcatchers that successfully fledged young directly adjacent to road widening activities at Palomar Airport Road, near the USFWS Carlsbad Field Office. Finally, most of the San Joaquin Hills, including the study area, burned during the Laguna Beach Fire of October, 1993.

As a result of these considerations, the original study plan for 1994 has been revised in order to obtain the most relevant and useful information possible on the local California gnatcatcher population. Based on comments from the USFWS and other experts, the revised study plan outline involves studying the recovery of gnatcatchers, cactus wrens and vegetation from the effects of the fire. This study need was identified in the revised Biological Opinion on the Corridor (USFWS 1994b, p. 26). LSA has prepared a draft study plan for the 1994 studies, involving a color-banding study based on birds remaining within the area burned in the Laguna Beach Fire. It is anticipated that future studies will also include revegetation sites that are done in connection with the SJHTC project.

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[1] Information originally summarized by LSA (1991, 1992).

BANDING STUDY

Color-banding of gnatcatchers and cactus wrens was identified early as a priority in long-term studies in the San Joaquin Hills. Formal listing of the gnatcatcher as an threatened species in March required specific permits for these activities, however. Permits were not widely available until late in the year, too late to allow for banding of any individuals associated with these studies.

LSA surveys did reveal the locations of several birds color-banded by David R. Bontrager in the course of his ongoing studies in the San Joaquin Hills[1]. These resightings documented two gnatcatchers crossing Newport Coast Drive in Irvine, one young gnatcatcher moving at least 2.8 miles (from Laguna Laurel to Signal Peak), and two cactus wrens crossing Laguna Canyon Road, one moving over three miles to do so. Table F indicates the banding dates/locations and resighting dates/locations of those birds found in this study. Figure 3 shows this information graphically.

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1 The nine colors used in this study are dark blue, light blue, dark green, light green, mauve (purple), orange, red, white, and yellow.

Table F - Observations of Color Banded Birds

	Banding Information			*Re-Sighting Information*	
Bird Information	**Date**	**Age**	**Location**	**Date(s)**	**Location**
California Gnatcatchers					
Male #1350-76172[1] right tarsus: red left tarsus: red over metal	11/25/1991	unknown	A - UCI Ecological Reserve	1/21/93 8/3/93 9/21/93 10/93	B - below Bonita Reservoir B - below Bonita Reservoir B - below Bonita Reservoir B - below Bonita Reservoir
Female #1710-49930[1] right tarsus: dark green over metal left tarsus: yellow	4/30/93	juvenile	C - UCI Ecological Reserve	through - 6/4/93[2] 6/28/93 8/3/93 9/21/93 10/93	 C - UCI Ecological Reserve B - below Bonita Reservoir B - below Bonita Reservoir B - below Bonita Reservoir B - below Bonita Reservoir
#1710-49977 (sex unknown)[3] right tarsus: dark green over metal left tarsus: orange	5/19/93	nestling	D - Laguna Laurel	9/23/93	E - Signal Peak
Male #1350-76177 right tarsus: white left tarsus: mauve over metal	7/14/92	adult	F - Sycamore Hills	11/4/93 11/12/93[2]	F - Sycamore Hills F - Sycamore Hills

1 #1350-76172 and #1710-49930 appeared paired in August, September, and October

2 Bontrager (1994a)

3 Not seen in subsequent months

Table F - Observations of Color Banded Birds (Continued)

	Banding Information			*Re-Sighting Information*	
Bird Information	**Date**	**Age**	**Location**	**Date(s)**	**Location**
#1710-49954 (sex unknown) right tarsus: dark green over metal left tarsus: dark green	5/4/93	nestling	G - Sand Canyon Reservoir	11/9/93	H - east of Sand Canyon Reservoir
Cactus Wrens					
#8071-77630 (sex unknown) right tarsus: light green left tarsus: yellow over metal	8/2/93	fledgling	I - Shady Canyon	11/3/93	J - Sycamore Hills
#961-36286 (sex unknown) right tarsus: dark green over metal left tarsus: light green	5/4/93	nestling	K - Laguna Laurel	11/4/93	L - Sycamore Hills
#961-36279 (sex unknown) right tarsus: dark blue over metal left tarsus: dark blue	4/27/93	unknown	G - Sand Canyon Reservoir	11/9/93	H - east of Sand Canyon Reservoir
#8061-77632 (sex unknown) right tarsus: metal over yellow left tarsus: dark blue	5/20/93	adult	G - Sand Canyon Reservoir	11/10/93	G - Sand Canyon Reservoir

COWBIRD TRAPPING

The brown-headed cowbird (*Molothrus ater*) is a brood parasite, a species that lays its eggs in the nests of other species. Nestling cowbirds are fast-growing and aggressive, so that host young rarely fledge successfully. The cowbird population in California has expanded greatly in the last century and the species has been identified as a major contributor to the decline of a number of native host species, primarily in riparian habitats. There is increasing evidence that cowbirds are impacting California gnatcatchers as well (USFWS 1994a). A pair of gnatcatchers was observed tending a fledgling cowbird in Coyote Canyon, on the Corridor route, on June 12, 1991 (LSA 1991), and David Bontrager (*pers. comm.*) found a number of parasitized gnatcatcher nests along Sand Canyon Wash in 1993.

A trapping program for cowbirds was conducted along the route of the corridor from April 18 to August 18, 1993 (LSA 1993b). The trapping program was required pursuant to the Terms and Conditions of the Conference Opinion[1] resulting from the Section 7 consultation on the California gnatcatcher and cactus wren.

Twenty traps were placed along the corridor alignment between El Toro Road and MacArthur Boulevard, as shown on Figure 4. The selection of trap locations was based on the most suitable habitat, i.e., adjacent to known gnatcatcher nesting territories, observed cowbird flight paths and riparian

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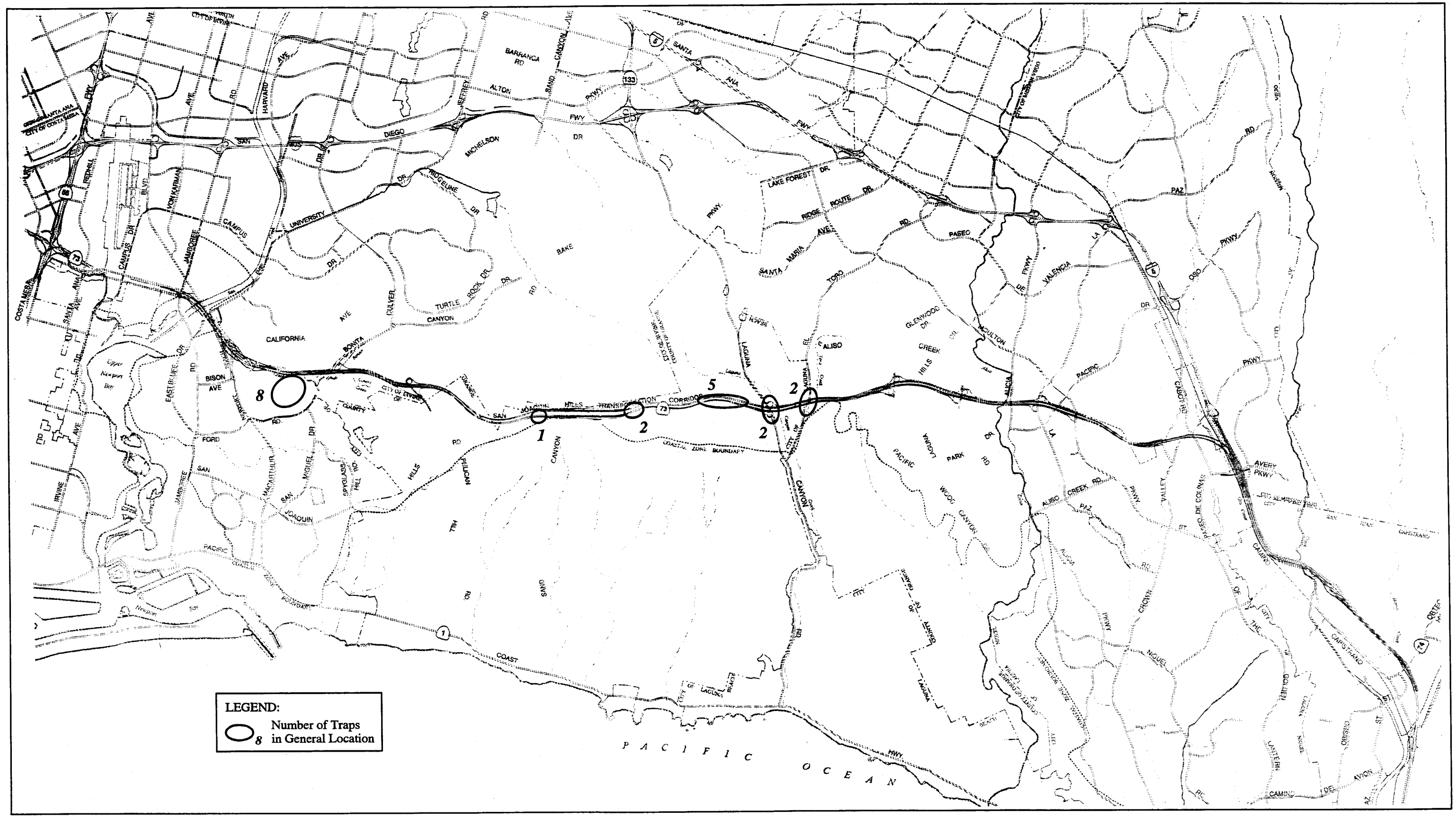
1 Letter dated February 26, 1993, from the U.S. Fish and Wildlife Service to the U.S. Department of Transportation, Federal Highway Administration states: "The Federal Highway Administration or its agents shall insure the operation of twenty cowbird traps in the San Joaquin Hills in perpetuity. Funds shall be provided sufficient to conduct trapping annually or to establish an endowment sufficient to provide trapping in perpetuity. Cowbird trapping shall begin during the spring of 1993 and shall continue for a minimum of five months each calendar year, unless the Service and the Federal Highway Administration or its agents unanimously agree that a lesser effort is justified during a given calendar year. The design, placement, and operation of the traps shall be directed and approved by the Service. A report detailing cowbird management activities shall be provided to the Service within two months of the conclusion of trapping efforts during each and every calendar year. Upon request of the Federal Highway Administration or its agents, the Service shall attempt to locate a suitable public or non-profit foundation or organization that is willing to provide, under contract, the services necessary to meet this mitigation requirement. In any case, the Federal Highway Administration or its agents shall be responsible for obtaining permission from The Irvine Company to operate traps on their property."



3/14/94(CRN301C)

Figure 4

Cowbird Trap Locations

areas, especially those containing singing male least Bell's vireos, available along the Corridor route. Nearly half of the traps (8), were placed in the area around Bonita Reservoir.

The total number of trapped cowbirds over 18 weeks included 106 males, 55 females, and 8 juveniles. The results indicate that the most successful period of trapping was between late April and late May. Juvenile cowbirds were caught between mid-July and mid-August. The most successful trapping locations were the eight traps in the Bonita Reservoir area. The proximity of these traps to a riparian area is most likely the reason for their greater success. Least successful were the traps in the Signal Peak area, which were located on the top of the ridge in grassland habitat with little or no woody vegetation close by. This grassland area was apparently a poor attraction for these birds.

FALL SURVEYS/HABITAT USE

During September and October, 1993, LSA surveyed the Corridor route from MacArthur Boulevard to Laguna Canyon Road searching for banded gnatcatchers and cactus wrens. Notes were taken on plant species used by all gnatcatchers and wrens observed. Tables G and H summarize these observations regarding habitat utilization. To the extent possible, the habitat designations in these tables conform to the County's GIS habitat classifications.

CALIFORNIA GNATCATCHER

Identification of Adults and Juveniles

To the extent possible, the age and sex was determined for all gnatcatchers observed. Back color is helpful in this regard; in general, adult males are the bluest, adult females are the brownest, and juveniles are the grayest. Following the post-juvenile moult, however, young may be indistinguishable from adults, as was the case with the color-banded female below Bonita Reservoir. "Pairs" were identified based on "paired" behavior, and may include young of the year that have never bred. Adult males were found to be the most conspicuous gnatcatchers, generally responding aggressively to tapes or "pishing;" juveniles (which may not yet defend territories) were generally the least responsive/aggressive; with adult females intermediate in their responses.

Discussion of Habitat Use

As expected, most of the gnatcatchers observed during the fall surveys were in sage scrub associations comprised primarily of California sagebrush (*Artemisia californica*), California buckwheat (*Eriogonum fasciculatum*) and California sunflower (*Encelia californica*), along with several other native shrub species. Gnatcatchers were also found throughout the area's limited amount of quail brush habitat (dominated by *Atriplex lentiformis* ssp. *breweri*), located near the Corridor's northwest terminus. As is typical outside of the breeding season, several pairs and a few juveniles were also found in scrub/ruderal ecotones, as well as the more marginal mulefat scrub and ruderal habitats.

Table G - California Gnatcatcher Habitat Utilization, Fall 1993

Habitat Type/Plant Species[1]	Encounters[2]	Notes
Mixed Sage Scrub *Encelia californica* *Sambucus mexicana* *Malosma laurina* *Opuntia littoralis* *Artemisia californica* *Eriogonum fasciculatum* *Salvia mellifera* *Isocoma menziesii* var. *venetus* *Opuntia prolifera* *Mimulus aurantiacus*	pairs:8 singles: 1	one pair observed in "mock copulation"
Sage Scrub/Ruderal Ecotone *Artemisia californica* *Eriogonum fasciculatum* *Brassica nigra* *Conyza canadensis* *Sambucus mexicana* *Encelia californica* *Cynara cardunculus* *Stephanomeria* sp.	pairs:5 singles: 2	two "juveniles" observed traveling through scrub and ruderal habitats near Bonita Reservoir adult male observed traveling between patches of scrub near Bonita Reservoir
Sagebrush/Buckwheat Scrub *Artemisia californica* *Eriogonum fasciculatum* *Sambucus mexicana* *Opuntia littoralis* *Opuntia prolifera* *Mimulus aurantiacus* *Rhus integrifolia*	pairs: 4 singles: 2	
Quail Brush *Atriplex lentformis* ssp. *breweri* *Baccharis salicifolia* *Baccharis emoryi* *Bassia hyssopifolia* *Stephanomeria* sp. *Artemisia californica* *Opuntia littoralis* *Hemizonia fasciculata*	pairs: 3 singles: 1	one pair was in remnant patch of scrub with average height 5-10 feet
Mulefat Scrub/Ruderal Ecotone *Baccharis salicifolia* *Conyza canadensis*	pairs: 2	
Ruderal *Brassica nigra* *Conyza canadensis*	pairs: 2	

1 Plant species listed in order of relative importance (based on approximate number of bird observations).

2 Two birds together were considered "pairs." Single birds, and birds traveling with "pairs" were considered juveniles.

Table H - Cactus Wren Habitat Utilization, Fall 1993

Habitat Type/Plant Species[1]	Encounters[2]	Notes
Southern Cactus Scrub	pairs: 4	
Opuntia littoralis	juveniles: 4	
Opuntia prolifera		
Eriogonum fasciculatum		
Artemisia californica		
Rhus integrifolia		
Sambucus mexicana		
Cynara cardunculus		

1 Plant species listed in approximate order of relative importance (based on number of bird observations).

2 Two birds together were considered "pairs." Single birds, and birds traveling with "pairs" were considered juveniles.

CACTUS WREN

Identification of Adults and Juveniles

Male, female and juvenile cactus wrens are essentially inseparable based on plumage characteristics; therefore, "pairs" were identified based on "paired" behavior (although this would not rule out the possibility of two juveniles traveling together). Additional birds that were associated with "pairs" were taken to be juveniles.

Discussion of Habitat Use

Habitat utilization by cactus wrens is far more straightforward than for California gnatcatchers; the essential requirement is dense stands of tall cactus (*Opuntia* spp.). Cactus wrens uniformly occupy patches of southern cactus scrub habitat, usually associated with other scrub habitats (e.g. sagebrush/buckwheat scrub) or chaparral. They also make use of surrounding communities, including riparian and ruderal areas. Of the seven plant species that cactus wrens were observed to utilize during the fall surveys, the two predominant species were coastal prickly pear (*Opuntia littoralis*) and coast cholla (*Opuntia prolifera*). Four of the remaining plant species were native scrub dominants. One pair was observed utilizing cardoon (*Cynara cardunculus*), a non-native, invasive thistle that is common in overgrazed grassland and ruderal habitats in the San Joaquin Hills.

THE LAGUNA BEACH FIRE

The biota of the San Joaquin Hills was dramatically impacted by the Laguna Beach fire in October, 1993. Among those species impacted were the coastal California gnatcatcher and the coastal cactus wren. Presented here is an overview of fire ecology, followed by an assessment of the impacts of the Laguna Beach fire and prospects for recovery, all as they relate to birds in general and California gnatcatchers and cactus wrens in particular. Bontrager *et al.* (in review) expanded upon the discussion of fire impacts on gnatcatchers and wrens included here.

SUMMARY OF WILDLIFE RESPONSE TO FIRE IN COASTAL SAGE SCRUB

Fire's ability to return vegetation, and consequently wildlife, to earlier seral stages is fairly well understood. In a more or less natural setting, wildfire typically burns native communities in a mosaic pattern; this phenomenon is important in maintaining habitat diversity and providing habitat refugia from which plants and animals can recolonize nearby areas. Generalities concerning the reestablishment of wildlife communities following fire have been set forth, but research needs remain, especially in coastal sage scrub. Long-term studies on the order of ten or more years have not been conducted and represent an obvious research need. Also lacking are studies examining the spatial and temporal pattern of reestablishment within large burns. The role of refugia within and outside burns, accessibility of recovered habitat to wildlife, and the variation in recovery time according to burn intensity can be more closely examined in such a way. The obvious relationship between wildlife and vegetation must continue to be emphasized, and proposed plant and wildlife studies should complement one another.

Because so little has been published on the response of wildlife to fire in coastal sage scrub, this summary has to rely heavily on the fire ecology literature as it relates to other habitats, especially chaparral. Of the papers cited here, only Moriarty *et al.* (1985) and Stanton (1986) pertain specifically to coastal sage scrub. Writing in 1969, Udvardy stated that the literature on special adaptations toward fire resistance in animals is scarce and that the effect of recurring fires on their distribution has not yet been assessed.

The Role of Fire in Natural Communities

The role of disturbance in creating early successional habitats, and how it relates to the overall health of wildlands, is receiving increasing attention in the conservation biology community (e.g., Litvaitis 1993, Rotenberry *et al.* 1993). Under natural conditions, fire is the most common disturbance in many plant communities, including coastal sage scrub. The positive role of fire in maintaining a mosaic of habitats has often been emphasized (Fox and McKay 1981, Quinn 1982, Willan and Bigalke 1982, Pyne 1984). The latter

author noted that the variable intensities of fire ensure that a variety of biotic ensembles, a mosaic, persists. The following summary was also provided:

> "Free burning fire, it is argued, is a primary mechanism for ensuring complexity, variety, and ultimately stability in natural systems."

Direct Effects of Fire on Wildlife

The indirect influence of fire (primarily the temporary loss of habitat) has long been recognized as being far more important than direct effects (Leopold 1933). Direct effects are discussed here.

Considerable attention has been given to the fate of wildlife during fires. The negative observations of Chew *et al.* (1959) are the exception. They found 43 dead mammals and 2 dead birds in 1.7 acres following a Malibu, California chaparral fire and suggested that the fire's toll on wildlife was enormous. Howard *et al.* (1959), Stoddard (1963), Komarek (1969), and Biswell (1989) especially downplay the loss of life due to fire, based largely on their experiences with controlled burns, which typically burn less intensely than wildfires. Leopold (1933), Lawrence (1966), Catling *et al.* (1982), Chandler *et al.* (1983), and Pyne (1984) took more moderate positions, suggesting that few birds and mammals die in wildfires, but acknowledging that under certain conditions, usually intensely burning fire, many animals may die. Kaufman *et al.* (1990) listed direct causes of mortality in fire: burns, heat stress, asphyxiation, physiological stress, trampling, and predation while fleeing. Most insects are not believed capable of escaping wildfire (Komarek 1969, Hogue 1993).

Komarek (1969) provided considerable information concerning animal responses to fire, and included a lengthy appendix detailing specific species' reactions. Most of his observations were in the southeastern United States, in the general vicinity of the Tall Timbers Research Station in Tallahassee, Florida. He observed ants relocating their nests (including eggs and larvae) from burned areas to unburned vegetation within one hour after burning. He found frogs seeking moist areas to avoid fire, and heard the spring chorus of certain species resume soon after a fire passed by a breeding pond. Similarly, he found little evidence of lizards or snakes killed by fire. He watched hispid cotton rats (*Sigmodon hispidus*) herding and carrying young to safety ahead of fires, and never found dead young in burned nests.

In a controlled experiment, Howard *et al.* (1959) measured the lethal temperature for several chaparral rodents at 138-145°F. Burrows a few inches deep were sufficient to insulate animals from these temperatures as fire burned on the surface. Lawrence (1966) examined this issue further, finding that three inches depth was probably enough to survive heat and increased vapor pressure in burrows. He suggested that post-burn predation is probably a more restrictive factor on small birds and mammals than the fire itself.

Biswell (1989) reported that birds have been observed to fly in back of a fire and begin feeding almost immediately.

Some animals are drawn to active fires. Raptorial birds and predatory mammals exploit birds and small mammals fleeing fires, while flycatchers, swallows and other aerial feeders prey on displaced insects (Stoddard 1963, Komarek 1969). Other species, especially ground feeders such as mourning doves (*Zenaida macroura*), northern flickers (*Colaptes auratus*), American robins (*Turdus migratorius*), bluebirds (*Sialia* sp.), sparrows, and finches may forage on burned areas immediately following fire (Stoddard 1963). Komarek (1969) noted many instances of birds and mammals consuming ash following fire, presumably as a dietary supplement, and Chandler *et al.* (1983) suggested that many herbivores also wallow in fresh ashes to rid themselves of external parasites.

Fire Effects on Birds and Mammals

These groups have received the most attention in wildlife fire studies. The benefits of fire in game management have been especially well covered. In attempting to summarize the effects of wildland fire on wildlife, Pyne (1984) stated that, in general, there tends to be a slight increase in avifauna and a relatively constant number of mammal species following fire; in both birds and mammals, there tends to be an increase in the size of individual organisms. Without specifying habitats, Biswell (1989) claimed that one can expect an increase in bird numbers the first year after fire, especially seed-eating birds. Komarek (1969) pointed out that birds and mammals are often attracted to a "greening" burn, where they feed on tender shoots unavailable elsewhere. Chandler *et al.* (1983) note that infestations of external and internal parasites may be reduced after a fire.

Studying chaparral in the Sierra Nevada, Lawrence (1966) found that many species were severely exposed to predation in the bare ash following fire, and most small mammals and some brush dwelling birds decreased rapidly; predatory birds and mammals were found to increase. Further, with time brush-dwelling species declined as forbs and grasses increased, while grass-dwelling species increased; no species were eliminated altogether.

The results of two relatively long-term studies of bird response to fire in chaparral are presented by Lawrence (1966) and Wirtz (1982). Lawrence found mourning doves and western meadowlarks (*Sturnella neglecta*) to be among the earliest users of burned areas at his Sierra Nevada study site, and the degree of habitat recovery in the first year following fire was sufficient to allow accelerated reproductive rates in these species. He documented an overall increase in nesting bird density following fire, especially among seed-eating birds. Increased numbers of predators following the fire included sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperi*), red-tailed hawk (*Buteo jamaicensis*), American kestrel (*Falco sparverius*), great horned owl (*Bubo virginianus*), and common raven (*Corvus corax*).

Wirtz (1982) found both species richness and species diversity to increase in the 42 months following fire at his study site in the foothills of the San Gabriel Mountains. No increase was noted in the number of omnivorous birds or birds that take insects from the air, but increases were noted in the number of seed-eating and insect- and seed-eating birds. These differences were most pronounced in the first year following the fire. Species that glean insects from vegetation and insect and fruit-eating species exhibited a decrease in use of burned areas.

Moriarty *et al.* (1985) and Stanton (1986) compared bird communities on a burned coastal sage scrub site and control site in Pomona, California. The initial study showed greater species richness on the control site, but similar numbers of individuals on both sites, due in large part to the presence of ground-feeding finches. Substantial similarity between the two sites was evident within one year of the fire. Wrentits (*Chamaea fasciata*), California thrashers (*Toxostoma redivivum*), and California towhees were more common on the control site, while mourning doves, scrub jays (*Aphelocoma coerulescens*), house finches (*Carpodacus mexicanus*), lesser goldfinches (*Carduelis psaltria*), and American goldfinches (*C. tristis*) were more common on the burned site.

The follow-up study by Stanton (1986) was completed less than three years following the fire. Reduced species richness was again found on the burned site, with similar numbers of individuals on the two sites. Most species preferred the control site, with the following species among the exceptions: American kestrel, Say's phoebe (*Sayornis saya*), western kingbird (*Tyrannus verticalis*), yellow-rumped warbler (*Dendroica coronata*), lazuli bunting (*Passerina amoena*), house finch, and lesser goldfinch. Greater heterogeneity of habitat was offered as the explanation for greater bird use of the control site, and it was suggested that coastal sage scrub may not fit the general pattern of increased bird use following fire in chaparral.

Coastal cactus wrens and coastal California gnatcatchers can show negative correlations to fire. Benson (1969) and Rea and Weaver (1990) emphasize that fire is apparently the primary limiting factor in the distribution of cactus in southern California. In coastal California, cactus wrens are restricted to coastal sage scrub with tall cactus. On Camp Pendleton, San Diego County, Tutton *et al.* (1991) found that 80 percent of known coastal California gnatcatcher locations were in areas that had not burned in at least 16 years. However, in other areas unburned in many years, such as the San Joaquin Hills, fire may increase habitat suitability for gnatcatchers by temporarily returning dense chaparral to more open early successional stages, including coastal sage scrub.

Wildlife/Vegetation Interaction

In a summary paper at a symposium on Mediterranean-type ecosystems, Quinn (1982) stressed the interactions of plants and animals in shaping

developing communities. Animals respond to the nature of plant communities and, in turn, affect the development of those plant communities through such activities as herbivory, pollination, seed dispersal, burrowing, and trampling. Such interactions are especially important in communities redeveloping after fire.

FIRE ASSESSMENT

Vegetation

According to the County of Orange's GIS, approximately 13,000 acres of natural vegetation burned in the Laguna Beach fire. About half of the vegetation, approximately 6,800 acres, was classified as coastal sage scrub. Approximately 2,600 acres of chaparral and 3,100 acres of grassland were also consumed. Figure 2 shows the fire "footprint" and the plant communities affected.

Not all areas within the fire perimeter burned with equal intensity. This mosaic pattern of impact on the vegetation is the result of at least four factors: 1) terrain; 2) position of the vegetation relative to wind direction at the time of burning; 3) the use of controlled "backlighting" of the fire in certain areas; and 4) the makeup of the vegetation at any given site. Post-fire conditions varied from simple ash and charred snags in some intensively burned areas formerly heavily vegetated to lightly burned areas where grasses and forbs burned beneath scrubs that were only singed; elsewhere, there were pockets of vegetation that were completely untouched by the fire. Impacts to most areas fell somewhere between these extremes. Many cactus patches burned completely, but those of sufficient size tended to dampen the intensity of the fire, allowing some vegetation within these patches to survive the event unharmed. In general geographic terms, Laguna Canyon and other coastal canyons burned hotter than areas on the north and west flanks of the fire, and consequently experienced greater loss of vegetation.

Existing soil moisture and what limited rain fell in the months following the fire aided in the initial recovery of vegetation in burned portions of the San Joaquin Hills. By the end of the year, many areas were green with the growth of grasses and cardoon (*Cynara cardunculus*). More important, desirable native shrub species such as California sagebrush (*Artemisia californica*), California encelia (*Encelia californica*), lemonade berry (*Rhus integrifolia*), and laurel sumac (*Malosma laurina*) showed considerable crown sprouting in many areas. Where the fire was more severe, however, some areas still showed no signs of recovery.

Coastal California Gnatcatcher and Coastal Cactus Wren

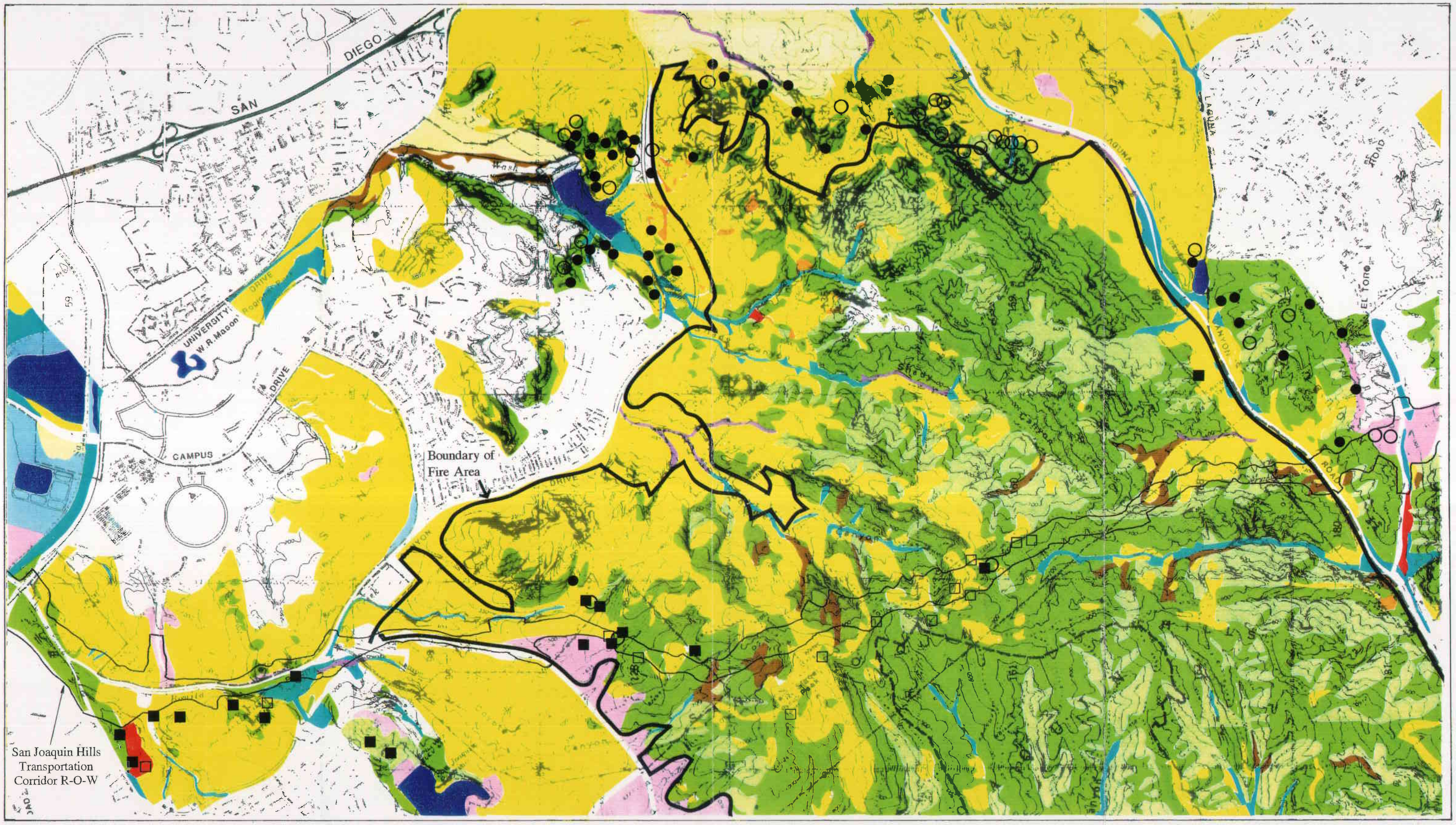
Immediate Effect

Typical press coverage of the Laguna Beach fire claimed that, in affected areas, most or all of these birds perished in the blaze. Surveys conducted by LSA in the first days following the fire strongly indicate otherwise, however. These observations are supported by the literature summary above. Birds were widespread within the burned area, primarily in remnant patches of scrub and cactus where some cover remained, but also in more devastated areas. All groups of birds were represented, including those species whose terrestrial or skulking nature might be expected to put them at greater risk in such a situation. The latter group included California quail (*Callipepla californica*), Bewick's wren (*Thryomanes bewickii*), hermit thrush (*Catharus guttatus*), wrentit (*Chamaea fasciata*), California thrasher (*Toxostoma redivivum*), and rufous-sided towhee (*Pipilo erythrophthalmus*), as well as California gnatcatcher and cactus wren. The number of gnatcatchers observed along the San Joaquin Hills Transportation Corridor route on October 30 and 31 was actually greater than recorded on more lengthy surveys previously conducted by LSA. This was primarily the result of increased conspicuousness of the birds due to the lack of cover, but does argue against the notion of widespread mortality in the fire itself. Post-fire surveys did not produce numbers of wrens as impressive as those of gnatcatchers, but wrens were more inconspicuous and difficult to detect. The numbers and locations of gnatcatchers and wrens found immediately following the fire are shown on Figures 5 and 6.

Short-Term Effect

Although substantial numbers of gnatcatchers and wrens were observed on October 30 and 31, the local populations were certainly impacted. By the end of the first week following the fire, bird numbers had dropped dramatically in the same areas that were surveyed days earlier. Refugia of unburned and lightly burned scrub were still occupied by a small number of California gnatcatchers, cactus wrens, and other species at year's end, however.

Based on the 1991 surveys conducted by Jones and Stokes, Associates and Ed Almanza and Associates, locations for 442 California gnatcatchers in the San Joaquin Hills and vicinity have been entered in the County GIS (Gary Medeiros *in litt.* June 1994). The mapped localities for 233 (53 percent) of these birds burned in the fire (Figure 2; GIS printout dated 4 April 1994). In the same area, locations for 709 cactus wrens have been entered in the County GIS. The mapped localities for 529 (75 percent) of these birds are within the perimeter of the fire (Figure 2). Most of these birds will probably never again occupy their former territories. An increased mortality rate is expected among displaced birds as they are forced to search for food and shelter in poor and marginal habitat. Reduced reproductive potential in the first nesting seasons following the fire is even more significant. More cactus



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LEGEND:

Scrub	Marsh	Pools, Seeps, Meadows	■	Pairs - 28 Oct. - 3 Nov. 1993
Chaparral	Riparian	Cliff and Rock	□	Singles - 28 Oct. - 3 Nov. 1993
Grassland	Lakes, Res., Basins	Agriculture	●	Pairs - 1+ Week Postfire
Woodland	Watercourses	Disturbed Areas	○	Singles - 1+ Week Postfire

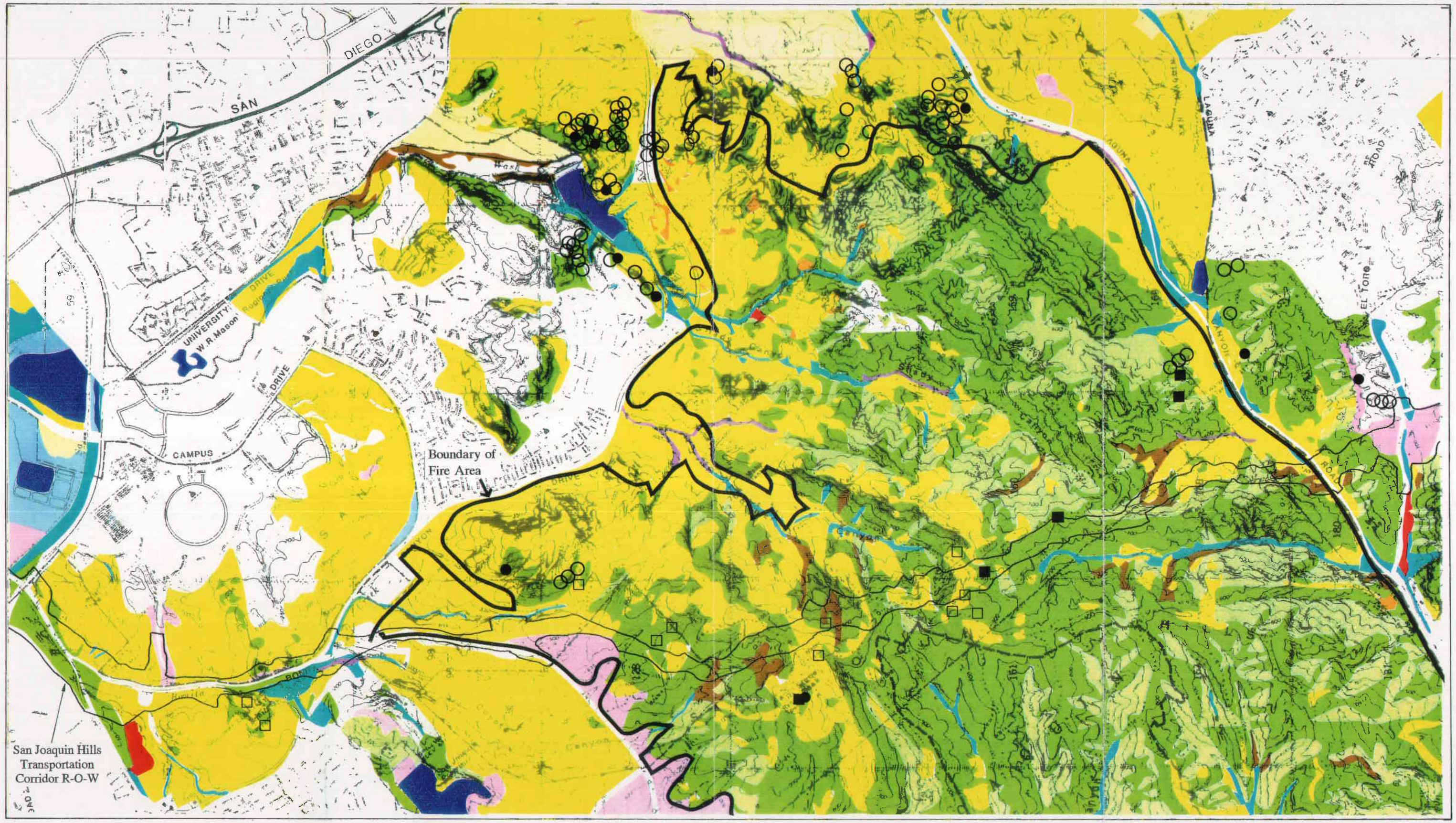
N

LSA

Approximate
Scale in Feet
0 1350 2700

Figure 5

Postfire Gnatcatcher Locations - 1993
(Northern Half of Burn Area and Perimeter)



5/5/94

LEGEND:

Scrub	Marsh	Pools, Seeps, Meadows	■	Pairs - 28 Oct. - 3 Nov. 1993
Chaparral	Riparian	Cliff and Rock	□	Singles - 28 Oct. - 3 Nov. 1993
Grassland	Lakes, Res., Basins	Agriculture	●	Pairs - 1+ Week Postfire
Woodland	Watercourses	Disturbed Areas	○	Singles - 1+ Week Postfire

N

LSA

Approximate
Scale in Feet
0 1350 2700

Figure 6

Postfire Wren Locations - 1993
(Northern Half of Burn Area and Perimeter)

wrens than gnatcatchers may manage to inhabit the immediate post-fire landscape, as remaining vegetation is disproportionately represented by cactus.

Surveys of potential habitat on the periphery of the fire "footprint" were conducted by LSA within the first two and a half weeks following the fire. This was an effort to determine what role these areas might play for fire-displaced birds. Surveys were conducted in the Bonita Canyon area on October 28 (as the last of the fire was still burning along Newport Coast Drive, and access to burned areas was still not possible), Sycamore Hills on November 3-5; Laguna Laurel on October 31-November 9; and Sand Canyon Reservoir and eastward on November 9-13. The results of these surveys are shown on Figures 5 and 6. Additional surveys were conducted for similar reasons in November and December by Bontrager (1994b), and covered all of these sites except Bonita Canyon.

Comparing the fall 1993 LSA surveys to the GIS database and previous LSA surveys suggests there were no increases in gnatcatcher or wren numbers in the Bonita Canyon area or Sycamore Hills. This was not the case in the Sand Canyon Reservoir area, north Laguna Laurel, and areas in between. Numbers there far exceeded those in the GIS database. The best evidence of the fire dispersing these birds was on the edge of the agricultural fields. Gnatcatchers and, to a lesser extent, wrens were present there in small patches of marginal habitat, in numbers far exceeding what would be expected. Gnatcatchers were also behaving abnormally there, being especially restive and moving over great distances. Gnatcatcher and wren densities did not seem unusually high in good quality scrub habitat in these areas.

In his studies of post-fire gnatcatcher response, Bontrager (1994b) observed some phenomena that were consistent with LSA's observations and some that were somewhat inconsistent with LSA's. His conclusions are based on far more field time than LSA's, and access to 1992 and 1993 survey results from several important study areas in the San Joaquin Hills (Syacmore Hills, North Laguna Laurel, Sand Canyon Reservoir, Sand Canyon Wash and Turtle Rock/Ridgeline). In contrast to LSA's findings, Bontrager observed increased numbers in all areas (including the Sycamore Hills, where LSA did not observe unusually high gnatcatcher numbers) during November/December 1993. LSA's work in the Sycamore Hills was completed only nine days following the fire, possibly before the influx documented by Bontrager. As on the LSA surveys, Bontrager commonly noted unusual gnatcatcher behavior, further suggesting that many birds were displaced by the fire.

Cactus wrens were found by Bontrager (1994b) in greater numbers than gnatcatchers in burned areas. In adjacent areas, in contrast to the LSA findings, Bontrager found "almost no sign of fire dispersed cactus wrens." He suggested three possible explanations for this: 1) wrens suffered greater losses either in the fire or through predation immediately following the fire; 2) wrens were less easily detected following the fire, especially in unfamiliar habitat; and 3) wrens dispersed farther away than did gnatcatchers.

RECOVERY

Vegetation

Fire has long been a major factor influencing plant communities in Southern California. In particular, coastal sage scrub is a fire dependent community (Zedler 1977). Most of the common shrub species in coastal areas commonly recolonize burned areas by sprouting from intact root crowns (Keeley 1987); however, shrubs species at inland locales regenerate primarily from seed (Westman and O'Leary 1986, O'Leary 1990). Seeds of the dominant shrubs of coastal sage scrub often endure fire, but do not require fire to germinate (Hanes 1971, Kirkpatrick and Hutchinson 1980). Shrub seedling establishment is poor during the first season after fire (Freudenberger *et al.* 1987). Westman *et al.* (1981) determined that fire intensity influences post-fire vegetative recovery to a greater degree than aspect or substrate. Several researchers observed that plant species diversity in coastal sage scrub is typically highest during the first few years after fire, decreasing thereafter. Most of the dominant annual herbs found in the first growing season after fire "are believed to arise from dormant pools of seed for which germination requires the stimulatory effect of heat, charred wood, and light in varying combinations" (Keeley and Keeley 1984, Keeley *et al.* 1985, O'Leary 1988, *in* Fleishman and Murphy 1993, p. 16). Troeger (1982) found that most fire following annuals are eliminated after seven years. Bowler (1990) reported on a "second pulse in the number of species (mostly understory herbs that are not fire-successional species) 15-25 years after burning" (pp. 78-79).

The leading natural cause of fire is lightning, and the natural fire frequency in coastal sage scrub is estimated at approximately 20 years (Westman 1982, O'Leary 1990). Most of the San Joaquin Hills have not burned in over 20 years. Keeley (1982) drew several correlations between human habitation and increased incidence of man caused fires. Fires at high frequency and/or intensity can result in the local extirpation of weak resprouters (Westman *et al.* 1981, Zedler 1981, Malanson and O'Leary 1982, Zedler *et al.* 1983, Anderson 1991). Freudenberger *et al.* (1987) determined that coastal sage scrub is "intermediate between grassland and chaparral in its resilience to disturbance" (*in* Fleishman and Murphy 1993, p. 12). Some coastal sage scrub species typically colonize chaparral areas following fire, but are eventually displaced by chaparral dominants (Gray 1983, O'Leary *et al.* 1992); however, fires at five to ten year intervals may result in type conversion from chaparral to coastal sage scrub (O'Leary *et al.* 1992). Zedler *et al.* (1983) determined that "fires in successive or alternate years [are] highly destructive to coastal sage scrub species" (*in* Fleishman and Murphy 1993, p. 13). Type conversion from coastal sage scrub or chaparral to grassland may be accomplished by repeated burning (Sampson 1944, Arnold *et al.* 1951, Freudenberger *et al.* 1987). Ryegrass seeding and other "erosion control measures undertaken after fire can deter recovery of coastal sage scrub" (Fleisman and Murphy 1993, based on Keeley *et al.* 1981, Zedler *et al.* 1983, and O'Leary 1988; also Keeley and Scott in review).

Coastal California Gnatcatcher

Due to the combined effects of an increased mortality rate and reduced reproductive rate, a short-term decline is probably under way in the coastal California gnatcatcher population of the San Joaquin Hills. This decline may last less than a year, and may be followed by a brief period of stability during which the population adjusts to a reduced amount of habitat. Within a year or two the population is expected to increase again in response to recovering scrub habitat. It is not difficult to imagine the gnatcatcher population eventually exceeding pre-fire levels as coastal sage scrub reestablishes itself and temporarily expands into areas that will ultimately return to chaparral. This would, in turn, be followed by a gradual population decline to pre-fire levels as chaparral recovery continued, reducing habitat quality for gnatcatchers.

The optimistic scenario offered in the previous paragraph is possible only because significant gnatcatcher strongholds in five areas around the periphery of the San Joaquin Hills were essentially unaffected by the fire: Bonita Reservoir area, Sand Canyon Reservoir area, north Laguna Laurel, Sycamore Hills, and coastal Crystal Cove State Park. In addition to these birds, the small number of gnatcatchers occupying scrub refugia within the burn are expected to help facilitate recolonization of burned portions of the San Joaquin Hills.

Recent studies of color-banded gnatcatchers have shown that dispersal of young birds over distances needed to recolonize the San Joaquin Hills are not unexpected. In the San Joaquin Hills, one gnatcatcher banded as a nestling in Laguna Canyon in spring, 1993, was seen approximately 2.8 miles away at Signal Peak in September, 1993 (D.R. Bontrager *pers. comm.*, LSA unpublished data). Proven dispersal distances of 6.1 miles have been documented in San Diego County (Ogden 1992) and western Riverside County (USFWS *unpublished data*). Using all dispersal data available, a maximum dispersal capacity of 14 miles has been estimated (P.J. Mock *pers. comm.*). Recent sightings of gnatcatchers in isolated coastal sage scrub on Pt. Loma in San Diego County suggest that even greater distances may be covered. Also significant is the fact that limited movement over open natural and ruderal vegetation is well documented in dispersing birds. Movement over roads the size of those separating burned areas from remaining concentrations of gnatcatchers is also known to be possible (LSA unpublished data; this study).

Coastal Cactus Wren

Lacking restoration efforts, the outlook for coastal cactus wrens following the fire is less promising than for gnatcatchers. Because cactus wrens are less numerous in the low elevation grassland/coastal sage scrub interface of the San Joaquin Hills, they experienced a proportionally greater impact in the fire than did gnatcatchers. For the same reason, the Bonita Reservoir area, and especially coastal Crystal Cove State Park, does not support significant

numbers of birds to aid in recovery of the population. Cactus wrens are not expected to recover their losses so readily as gnatcatchers. In the long run, the greater number of wrens expected to still be occupying habitat refugia within the burn[1] is more than offset by the relatively poor ability of cactus to recover following fire. Furthermore, cactus wrens are generally limited to cactus a meter or more in height. Such heights are not quickly attained by these relatively slow-growing plants. Consequently, it will probably take cactus wrens longer than gnatcatchers to match pre-fire numbers in the San Joaquin Hills.

Dispersal throughout the San Joaquin Hills area is not expected to be a significant barrier to recovery. Much less is known of cactus wren dispersal capabilities than gnatcatchers, but anecdotal observations suggest their capabilities are similar. In San Diego County, individuals have been seen at Mission Bay and Point Loma, far from occupied habitat (Unitt 1984).

The limited cactus recovery prospects outlined above may be reduced to some extent if cactus restoration is attempted in burned-out patches.

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1 Subsequently confirmed by LSA's 1994 surveys (Bontrager *et al.* in review).

LIST OF PREPARERS

LSA biologists Richard Erickson and Robb Hamilton were the primary authors of this document; additional input was provided by Art Homrighausen and Bill O'Connell. Laura Coley Eisenberg (TCA) and Margo Griswold (Chambers Group) provided helpful comments on the text.

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APPENDIX A

APPENDIX A - SURVEY EFFORT, 1988 - 1993

This table summarizes the dates, locations and personnel related to biological field work that have been conducted, both in the vicinity of the San Joaquin Hills Transportation Corridor alignment and elsewhere in the San Joaquin Hills. Reconnaissance surveys by P&D Technologies and others prior to 1988 are not fully documented and have not been included.

Observers: Alan Barron (AB); Richard Erickson (RE); Robb Hamilton (RH); Barry Jones (BJ); Bill O'Connell (BO); Rob Meade (RM); Steve Morris (SM); Jim Pike (JP);

Survey/Dates	Location	Observer(s)
1988 - California Gnatcatcher and Cactus Wren Spring Surveys by Sweetwater Environmental Biologists		
April 8	El Toro Road to Bonita Canyon Road	BJ
April 9	Bommer Canyon to Laguna Canyon Road	BJ
April 13	Aliso Creek, Bonita Reservoir, Wood Canyon and the area to the south	BJ
April 20	Bommer Canyon to Bonita Canyon Road	BJ
April 28	El Toro Road going south	BJ
May 17	Laguna Canyon Road to Bommer Canyon	BJ
May 24	Bonita Reservoir, Aliso Creek and El Toro Creek	BJ
June 21	Bonita Reservoir, Aliso Creek and El Toro Creek	BJ
1990 - General Spring Surveys by LSA		
May 18	Surveyed from El Toro Road crossing to about station 9860	RE, RH, BO
May 21	Surveyed from about station 9860 to about station 9900	RE
	Surveyed the proposed Culver Drive crossing	BO
May 22	Surveyed from about station 9900 to the proposed	RE
	Sand Canyon Avenue crossing Incidental observations in the vicinity of Bonita Reservoir	BO
May 25	Surveyed from the proposed Sand Canyon Avenue crossing to the proposed Pelican Hill Road crossing	RE
May 29	Surveyed from proposed Pelican Hill Road crossing to MacArthur Boulevard	RE

Survey/Dates	Location	Observer(s)
1991 - General Spring Surveys by LSA		
March 6	Brief California gnatcatcher search of *Atriplex* scrub between La Paz and Pacific Park Drive in Laguna Niguel	RE
April 3	Overview visit to all sites south of El Toro Road	RE
April 5	Brief visit to Bonita Reservoir	RE
April 8	Brief visit to Bonita Reservoir	RE
April 11	General survey below Bonita Reservoir	RE
May 23	General survey in Laguna Canyon	RE
May 25	General survey in Laguna Canyon	RE
May 29	General survey northwest of Laguna Canyon	RE
May 31	General survey northwest of Laguna Canyon	RE
June 4	General survey northwest of Laguna Canyon	RE
June 10	General survey along the head of Bommer Canyon	RE
June 11	General survey near Signal Peak	RE
June 12	General survey from Signal Peak to the Coyote Canyon landfill	RE
June 18	General survey in the Sycamore Hills	RE
June 21	General survey in the vicinity of Bonita Reservoir	RE
1992 - California Gnatcatcher and Cactus Wren Spring Surveys by Jones & Stokes Associates and Ed Almanza & Associates		
Data not available		
1993 This Study and Related Surveys		
March 20	Bommer Canyon ridge, upper Laguna Canyon	RE, RH, SM
March 21	Signal Peak to Bommer Canyon	RH, SM
March 23	Bommer Canyon area	RE, SM
March 25	Bommer Canyon ridge	SM
March 27	Signal Peak	SM
March 28	Signal Peak to El Moro Canyon	RH, SM
March 30	Coastal canyons southeast of Signal Peak	SM
March 31	Bommer Canyon ridge	SM
April 2	Bommer Canyon ridge	SM
April 3	Bommer Canyon ridge	SM
April 4	Bommer Canyon ridge	SM
April 7	Bommer Canyon ridge	SM
April 8	Bommer Canyon ridge	SM
April 9	Bommer Canyon ridge	SM
April 10	Bommer Canyon ridge	RH,SM

Survey/Dates	Location	Observer(s)
April 14	upper El Moro Canyon	SM
April 17	Bommer Canyon ridge and north of Signal Peak	SM
April 18	Bommer Canyon ridge	SM
April 21	Bommer Canyon ridge	SM
April 24	Bommer Canyon ridge	SM
April 25	Bommer Canyon ridge	SM
May 2	Bommer Canyon ridge	SM
May 5	Bommer Canyon ridge	SM
May 7	Signal Peak and vicinity	SM
May 8	Bommer Canyon ridge	SM
May 9	Bommer Canyon ridge	SM
May 19	Bommer Canyon ridge	SM
May 21	Bommer Canyon ridge	SM
May 23	Bommer Canyon ridge	SM
May 26	Bommer Canyon ridge	SM
June 2	Bommer Canyon ridge and Signal Peak	SM
June 3	Bommer Canyon ridge and Signal Peak	SM
June 8	Bommer Canyon ridge and Signal Peak	SM
June 9	Bommer Canyon ridge	SM
June 11	Bommer Canyon ridge	SM
June 21	Bommer Canyon ridge	AB,RE
June 22	Bommer Canyon ridge	AB
June 23	Between Signal Peak and Upper Shady Canyon	AB
June 24	Bommer Canyon ridge	AB
June 25	Bonita Reservoir area	AB
June 26	Bommer Canyon ridge	AB
June 28	Bonita Reservoir to Coyote Canyon	AB
June 29	Bommer Canyon ridge to Laguna Canyon	AB
June 30	Bonita Reservoir area	AB
July 1	Northwest of Signal Peak and El Toro Road area	AB
July 2	El Toro Road area and lower Bonita Canyon	AB
September 20	MacArthur Boulevard to Bonita Canyon Reservoir area	RH
September 21	east Bonita Reservoir area	RH
September 22	west Bonita Reservoir area	RH
September 23	Signal Peak area	RH
October 18	Bommer Canyon ridge to western Shady Canyon ridge	RH
October 20	Saltbush scrub near MacArthur Boulevard x Bison Avenue	RH
October 22	Shady Canyon ridge to bottom of Laguna Canyon	RH
October 29	MacArthur Boulevard to Bonita Reservoir area	RE, RH

Survey/Dates	Location	Observer(s)
October 30	Corridor alignment, from near Coyote Canyon to Shady Canyon ridge	RE, RH
October 31	Signal Peak to Shady Canyon ridge; and Laguna Canyon, starting in the Corridor alignment and moving north along the lower hills	RE, RH
November 3	Sycamore Hills and Bommer Canyon ridge	RE, RH, RM
November 4	Sycamore Hills	RM, JP
November 5	Sycamore Hills	RM, JP
November 6	Laguna Laurel	RM
November 8	Laguna Laurel	RM, JP
November 9	Hills east of Sand Canyon Reservoir	RM, JP
November 10	Sand Canyon Reservoir and vicinity	RM, JP
November 12	Sand Canyon Reservoir and vicinity	RM, JP
November 13	Sand Canyon Reservoir and vicinity	RM
November 22	Saltbush scrub near MacArthur Boulevard x Bison Avenue	RH
December 2	Corridor alignment near Coyote Canyon	RE
December 5	Bommer Canyon ridge	RE
December 8	Saltbush scrub near MacArthur Boulevard x Bison Avenue	RE