

MOVEMENT AND DISPERSAL OF  
CALIFORNIA GNATCATCHERS AND CACTUS WRENS  
IN THE SAN JOAQUIN HILLS, ORANGE COUNTY, CALIFORNIA

DAVID R. BONTRAGER\*

AND

AMY L. GOROSPE\*\*

PREPARED FOR  
ED ALMANZA & ASSOCIATES  
422 GLENNEYRE  
LAGUNA BEACH, CA 92651

JANUARY 1995

\* 80645 Lost Creek Road, Dexter, OR 97431

\*\* 2909 Maple Avenue, Manhattan Beach, CA 90266

## Introduction

Since the spring of 1992 the Southern California Edison Company has funded field research on various aspects of the biology of coastal California gnatcatchers (*Poliioptila californica californica*) and coastal cactus wrens (coastal southern California populations of *Campylorhynchus brunneicapillus*) in the San Joaquin Hills of Orange County, California. This report presents data compiled to date (resightings through December 1994) concerning movement and dispersal of these two species. During the 1994 breeding season the principal author color-banded large numbers of California gnatcatchers and cactus wrens under a subcontract with the consulting company LSA. This was in support of their research within the 1993 Laguna fire area. Post-breeding sightings of some of these birds are also included in this report.

Statistical analysis of movement/dispersal data was not attempted. Analysis will be provided in a future report(s) combining this dispersal data with that from concurrent research on the Palos Verdes Peninsula, Los Angeles County, California conducted by the Manomet Observatory for Conservation Biology.

As with many aspects of coastal California gnatcatcher (hereafter referred to as the gnatcatcher) and coastal cactus wren biology, little is known about the dynamics of dispersal. But understanding dispersal mechanisms and capabilities is critical to conservation strategy (Verner 1992). Dispersal patterns influence population dynamics and the genetic makeup of populations (Arcese 1989), important factors when considering population viability and reserve design.

Ogden (1992) reported on the dispersal of 28 juvenile San Diego County gnatcatchers banded on their natal territories. At least 25 of these birds were established on territories and were seen many times during the period October through December. The mean dispersal distance was  $1.75 \pm 0.26$  SE mi (2.82 km). The range of distances was 0.55 - 6.1 mi (0.89 - 9.82 km). These distances were derived by selecting routes based on the assumption that, when possible, dispersing gnatcatchers select natural vegetation and "natural topography" as opposed to man-made or altered landscapes. If straight line routes are substituted the mean dispersal distance becomes 1.59 mi (2.56 km) with a range of 0.28 - 4.92 mi (0.45 - 7.92 km) (Pat Mock pers. comm.). Ogden (1992) related nine instances of juveniles crossing major highways (> 100 feet wide) and three moving through "man-modified" areas 1,000 to 3,000 feet wide.

Braden (1992) mentioned several long distance movements by juvenile gnatcatchers in Riverside County. Two were found 6.3 mi (10.1 km) and one was found almost 8.9 mi (14.3 km) away from their natal areas.

Atwood et. al. (1994) found the mean dispersal distance for a sample of 19 juvenile gnatcatchers on the Palos Verdes Peninsula in Los Angeles County to be 0.47 km (SD = 1.61 km, range = 0 - 6.5 km). To date the only data available for cactus wren movement is Atwood et. al. (1994). They found the mean dispersal distance for 14 juvenile cactus wrens to be 0.69 km (S.D. = 1.56, range = 0 - 5.9 km). A sample of 23 adult cactus wrens moved a mean distance of 0.33 km (SD = 0.61, range = 0 - 2.6 km). Atwood et. al. (1994) suggested that these preliminary data most likely reflected the limited dispersal capabilities of gnatcatchers and cactus wrens.

## **Methods**

The project area is located in the San Joaquin Hills between the 405 Freeway on the north and the Pacific Ocean on the south and between the city of Irvine to the west and the cities of Laguna Beach and Aliso Viejo on the east. Much of this area is already either city (city of Laguna Beach James Dilley Preserve also called Sycamore Hills Park), county (Laguna Coast Wilderness Park) or state (Crystal Cove State Park) parkland. Other privately owned portions have been designated as future parkland additions. Collectively the area is referred to as the Superpark. Several study sites are also located in the city of Irvine. Over the course of the study, field work has been distributed throughout the area but time and funding constraints have necessitated concentration of the most intensive effort in the Sycamore Hills, Laguna Laurel, North Laguna Laurel, Ridgeline, Turtle Rock Ridgeline, Sand Canyon Wash, Sand Canyon Reservoir, Turtle Rock Reservoir, Shady Canyon Tributary and Turtle Rock Fragments sections of the research area (see maps in Appendix).

Plant cover is diverse and includes a range of riparian, grassland and chaparral communities plus a wide variety of scrub habitat types. When using the Orange County EMA habitat classification system (Jones and Stokes 1993) 18 scrub habitat types are identifiable in the study area. A substantial portion of Superpark vegetative cover (approximately 13,000 acres) was destroyed in the October 1993 Laguna fire (Bontrager et. al. 1994). This included approximately 6,800 acres of coastal sage scrub, 3,100 acres of grassland and 2,600 acres of chaparral. Spring 1994 surveys of the burn area revealed approximate declines of 90% and 70% in gnatcatcher and cactus wren numbers respectively. This is compared to 1992 surveys reported in Sweetwater Environmental Biologists (1994). Much of our area of concentrated field activity fell outside of the burn. Of the sites listed in the preceeding paragraph only Laguna Laurel, Shady Canyon Tributary and small portions of North Laguna Laurel and Sand Canyon Reservoir were burned.

During the period March 1991 through December 1994, California gnatcatchers and cactus wrens were banded at many localities throughout the Superpark plus several sites in the city of Irvine. Adult and fledgling cactus wrens were captured by erecting nets in areas of concentrated activity (typically but not always near cactus cover). Birds were lured to the nets by a tape of wren

vocalizations. Usually, adult and fledgling gnatcatchers were captured by luring them to the vicinity of a net or nets and then gently "herding" them into the nets. Considerable time was spent locating and monitoring nests of both species so nestlings could be banded. Gnatcatcher nestlings were banded around day 8 and nestling wrens were banded from day 8 through day 12. For individual identification each bird was given a unique combination of two colored plastic leg bands and the USFWS metal band. Table 1 presents a record of banding dates. Tables 2 and 3 show the distribution of banding throughout the project area.

Since 1992, color marked birds have been relocated by directed resurvey and during the course of other field activities such as nest searching, annual population inventories and banding. This has included the occasional recapture of banded birds. Many useful resightings were provided by Richard Erickson, Robb Hamilton, Robb Meade and James Pike, biologists with or working for the consulting company LSA. Dana Kamada, working for The Nature Conservancy, supplied additional sightings.

Several periods of work were devoted exclusively to searches for banded birds. The level of field effort varied over time. Resurveys were conducted from Dec 16-29, 1992 (83 hrs), Mar 2-13, 1993 (88 hrs) and July 14, 1993 - Feb 25, 1994 (276 hrs). Areas for resurvey were not selected in a random manner. Rather, time constraints limited resurveys to the primary study sites listed previously. Thus, large portions of the Superpark were not searched. Each resurvey site was methodically searched utilizing pishing and tape recordings. All gnatcatchers and cactus wrens were followed until identified or lost.

Howard (1960) defined dispersal as "the movement the animal makes from its point of origin to the place where it reproduces or would have reproduced if it had survived and found a mate." According to his definition a dispersal was a permanent movement. Greenwood (1980) preferred calling such a movement a *natal dispersal*. Movement by an established adult from one breeding site to another would be a *breeding dispersal*. We have adopted these distinctions in this study. Greenwood (1980) went on to further refine these definitions. He defined an *effective dispersal* as one after which a successful reproduction takes place. A *gross dispersal* is a movement to a new location regardless of whether reproduction follows.

According to Ogden (1992), young gnatcatchers are generally dispersed and established on new territories by the month of October. For the purposes of this study a juvenile gnatcatcher located in October or later was considered as having completed a dispersal, i.e., a natal dispersal. On numerous occasions, dispersing juvenile gnatcatchers were found away from their natal territories prior to October. In each of these instances they were never found again, i.e., it was possible they were not permanently established. To distinguish these movements from natal dispersals, i.e., completed dispersals, we call these movements *incomplete dispersals*. We realize that some of these movements

Table 1. Orange County Superpark Study Banding Dates

	CAGN				CACW			
	AHY	HY	L	U	AHY	HY	L	U
Mar-May 91	9	2	0	0	0	0	0	0
Nov 91	2	0	0	0	0	0	0	2
July-Aug 92	4	1	0	0	50	85	2	0
Apr-June 93	12	3	45	0	2	0	78	0
July-Aug 93	0	0	0	0	20	51	13	0
Dec 93	0	0	0	40	0	0	0	0
Jan-Feb 94	25	0	0	0	2	0	0	0
Apr-June 94	10	5	75	0	18	7	179	0
July-Aug 94	2	3	3	1	25	33	40	0
	64	14	123	41	117	176	312	2

Total CAGNs banded = 242

Total CACWs banded = 607

Total birds banded = 849

Table 2. Superpark Study CAGN Banding Distribution

	AHY	HY	L	U
Bommer Canyon	0	0	3	0
Church Canyon	3	0	3	0
Freeway Ridge	1	0	2	0
Laguna Laurel	0	1	11	0
North Laguna Laurel	10	0	6	0
Ridgeline	0	2	13	0
Sand Canyon Reservoir	11	2	24	24
Sand Canyon Wash	2	0	2	7
Shady Canyon	1	0	1	0
Shady Canyon Tributary	4	0	7	0
Sycamore Hills	21	0	30	1
Turtle Rock Fragments	0	0	6	0
Turtle Rock Reservoir	1	1	7	9
Turtle Rock Ridgeline	0	0	3	0
UCI Campus	10	8	5	0
Totals	64	14	123	41

Total CAGNs banded = 242

Table 3. Superpark Study CACW Banding Distribution

	AHY	HY	L	U
Aliso-Wood Canyon	4	9	0	0
Bommer Canyon	5	9	27	0
Church Canyon	7	1	21	0
Crystal Cove	4	2	4	0
Freeway Ridge	6	13	6	0
Irvine Coast Wild. Park	2	4	4	0
Laguna Laurel	7	17	15	0
North Laguna Laurel	8	7	11	0
Ridgeline	5	14	5	0
Sand Canyon Reservoir	26	46	86	0
Sand Canyon Wash	0	0	5	0
Shady Canyon	12	17	20	0
Shady Canyon Tributary	14	16	43	0
Signal Peak	4	3	4	0
Sycamore Hills	8	15	25	0
Turtle Rock Fragments	0	0	7	0
Turtle Rock Reservoir	1	1	6	0
Turtle Rock Ridgeline	0	0	16	0
UCI Campus	0	0	3	2
Upper Laguna Laurel	4	2	4	0
Totals	117	176	312	2

Total CACWs banded = 607

may have been completed natal dispersals by birds that died shortly thereafter before the site was revisited.

In determining the length of cactus wren and gnatcatcher movements we did not attempt to predict the most likely route taken, i.e., always selecting natural habitat over man-altered habitat. All of our dispersal distances are the straightline distances between the place of banding and the resighting location(s).

Although we are aware of the potential influence the October 1993 Laguna fire may have had on bird movement (Bontrager 1994), we have lumped movements recorded prior to the fire with those discovered after the fire. The origin and pattern of the fire, as well as varying burn intensities throughout the fire area presumably influenced where and how far some birds moved. Also, the fire potentially effected our rate of banded bird recoveries by either killing some birds or forcing them out of our sampling area.

## **Results and Discussion**

As expected, the number of resightings and confirmed dispersals increased as the sample size of banded birds increased. Relatively few birds, particularly gnatcatchers, were banded in 1991 and 1992 (Table 1). Banding effort increased in 1993. Considerably more resightings were made in 1994 than 1993. But sample size was not the only factor influencing our rate of data recovery. Resurvey effort and the size of the sample area limit the rate of bird resightings. Time constraints have always limited our resurvey time and resurvey area. Large parts of the Superpark have gone unsurveyed, particularly some southern regions including Crystal Cove State Park and adjacent areas. Portions of some private lands have been inaccessible. For these reasons, our results presumably underestimate the rate of successful dispersal and the maximum dispersal distances attained.

Juvenile Inheritance of Natal Territory. We have seven records of juvenile cactus wrens inheriting their natal territory after the disappearance of their parents. Four of these birds were males and the sex of the other three was undetermined. None of the 14 adults initially associated with these territories was ever found on a different territory. Fall and early winter observation has not been intense enough to determine if the adults disappeared singly or both at the same time. With the exception of one male adult still present in December the adults on the other territories disappeared during the period August through November.

We have no records of juvenile gnatcatchers inheriting their natal territory. In San Diego County, gnatcatchers "often" found mates on neighboring territories (Pat Mock pers. comm.). Thus far we have not seen this.



Dispersal Distance. The mean dispersal distance for 23 cactus wren natal dispersals was 1.3 km (S.D. = 2.0, range = 0.0 to 5.6 km). This sample includes the seven individuals that did not disperse from their natal territories. The mean distance for 12 males was 1.3 km (S.D. = 2.0, range = 0.0 to 5.6 km). The mean distance for 5 females was 1.7 km (S.D. = 1.7, range = 0.2 to 5.0 km). Thirteen incomplete cactus wren dispersals (all sex unknown) had a mean of 1.4 km (S.D. = 0.8, range = 0.3 to 2.7 km). Twelve of the 13 birds were seen once in July of their natal year and never seen again. The other individual was found in December with a family of wrens and then never resighted.

Combining the wren natal and incomplete dispersals (N=36) the mean dispersal distance was 1.3 km (S.D. = 1.7, range = 0.0 to 5.6 km). Thus, the longest movement recorded to date for a dispersing juvenile cactus wren is 5.6 km (3.5 mi).

As expected, established adult gnatcatchers and wrens moved less frequently than juveniles. When they did move, dispersal distances were usually relatively short. This is typical of most passerine species (Greenwood and Harvey 1992). Established adults are more or less sedentary and tend to display strong site tenacity. We have recorded three instances of established adult cactus wrens dispersing short distances to new territories, i.e., breeding dispersals. All three moved distances of 0.3 km. Combining these individuals with 17 adults known to have not dispersed, the mean wren breeding dispersal distance was 0.05 km (S.D. = 0.1, range = 0.0 to 0.3 km).

The mean dispersal distance for 8 gnatcatcher natal dispersals was 1.1 km (S.D. = 0.6, range = 0.5 to 1.9 km). The mean distance for 5 males was 1.2 km (S.D. = 0.7, range = 0.5 to 1.9 km). The mean distance for 3 females was 1.1 km (S.D. = 0.6, range = 0.5 to 1.6 km). Seven incomplete gnatcatcher dispersals (all sex unknown) had a mean of 1.5 km (S.D. = 1.3, range = 0.6 to 4.3 km). Six of the seven were seen away from their natal territories once in July. The other bird was seen once in September. None were seen again.

Combining the gnatcatcher natal and incomplete dispersals (N=15) the mean dispersal distance was 1.3 km (S.D. = 0.9, range = 0.5 to 4.3 km). The 4.3 km (2.7 mi) movement is the longest to date for a dispersing juvenile gnatcatcher.

Ogden (1992) found "several" widowed adult females that left established territories to join widower males on adjacent territories. They recorded only one adult male leaving his territory. This came after losing his mate and not obtaining a new one by the following breeding season. We confirmed three gnatcatcher breeding dispersals. Two adult females moved 0.2 km and 1.3 km respectively. An adult male moved 0.8 km. Combining these three birds with 11 other adults known to have not dispersed, the mean gnatcatcher breeding dispersal distance was 0.2 km (S.D. = 0.3, range = 0.0 to 1.3 km).

In addition to the above dispersals we have also recorded movements by 10 gnatcatchers of unknown age. Thus, they do not fit into either the natal or breeding dispersal category. These birds were banded in December (one in November) when aging is difficult. The mean distance moved by this group was 0.4 km (S.D. = 0.3, range = 0.2 to 1.1 km).

Timing of Natal Dispersal. Once their parents are occupied with a second nest, first brood fledgling cactus wrens may begin wandering to and from adjacent territories. Although neighboring adults discourage these intrusions, chases do not appear intense or prolonged. This is presumably because they are busy caring for their own young. Some young wrens began leaving their natal territories in July while others remained with their parents well beyond the conclusion of the breeding season. Fall and early winter groups of three or more wrens were observed regularly during previous surveys conducted at many sites throughout Orange County (Bontrager pers. obs. and Sweetwater Environmental Biologists 1994). For example, 51 groups of 3 to 5 cactus wrens were found on 122 territories at Casper's Regional Park during surveys conducted in December (27 groups) 1991 and January (19 groups) 1992 and February (5 groups) 1992. These were suspected to be family groups. We confirmed this behavior with our color marked Superpark cactus wrens. We have 15 records of one or more banded young with their parents in December and 2 in January (January 13 and 14, 1994). We have many more observations of various sized groups of unbanded wrens seen in the month of December and presume that these too are family groups.

Sibling cactus wrens may leave the natal territory at the same approximate time or at widely differing times. Our sample sizes are too small to even guess which occurs most commonly. On November 10, 1993 a female wren was found paired on a territory 5.0 km from her natal territory. Two of her siblings remained with their parents until at least December 8, 1993. Three juveniles were found together on their Sand Canyon Reservoir territory on July 14, 1994. Shortly thereafter each was seen at a different location. Resightings were made on July 20, 22, and 25, 1994. This suggests that the young left their natal territory at the same approximate time if not together. We have two other similar records including one instance when two siblings were found together on July 20, 1993 four territories away (0.7 km) from their natal territory.

Because of field work priorities we have determined little concerning the timing of initiation of gnatcatcher dispersal. Ogden (1992) found that juveniles are independent of their parents 3 to 5 weeks after fledging. Despite antagonistic behavior from the adults they may attempt to remain on their natal territory for a longer period. We have six observations of juvenile gnatcatchers away from their natal territories during the month of July. The dates of these sightings range from approximately 47 to 57 days after fledging, i.e., approximately 7 to 8 weeks. They of course could have been away from their natal areas for many days prior to these sightings.

Dispersal behavior. The observation of two sibling cactus wrens together away from their natal territory on July 20, 1993 indicates that sibling cactus wrens may disperse together for at least a short period. We also have limited evidence that unrelated dispersing wrens may form at least loose assemblages. On July 22, 1994 three unrelated banded juvenile wrens were observed together in an open area southeast of Sand Canyon Reservoir. These birds had moved 0.3 km, 1.1 km and 1.3 km from their respective natal territories. When first located (without pishing or the use of a tape recorder) they were separated by distances of less than 10 meters and were considered to be a group. In fact, before the individuals were identified it was assumed that they were part of the resident wren family. Vegetation at this location was heavily disturbed grassland (grazing) with widely scattered shrubs and artichoke thistle (*Cynara cardunculus*). Perhaps dispersing young are able to occupy such marginal habitats with a minimum of interference from adults. In this instance the resident adults were found approximately 100 m away where they were tending their second successful brood of fledglings.

We have no positive records of sibling gnatcatchers dispersing together or of unrelated juveniles forming any type of group but we spent very little time observing gnatcatchers during the late summer and early fall months.

On eight occasions dispersing color banded cactus wrens have been found in association with other family groups. In each of these encounters a tape recorder was used to bring birds to the observer or into mist nets. Thus it is impossible to know if the dispersing birds were actually foraging with the family group or if they were off on their own nearby prior to the tape playing. Family groups typically respond strongly to a recording and collectively make considerable noise. This commotion could attract a wandering bird to the location.

On one occasion a dispersing juvenile gnatcatcher was found with a family of four banded birds, two adults and two fledglings. Tape recordings or pishing were not involved in this observation. The group was followed for approximately 30 minutes. During most of the period the two banded fledglings foraged near their parents rarely straying more than 10 to 15 m away. The dispersing bird regularly foraged 15 to 25 m away from the group. On several occasions when it did move closer it was chased by an adult. These chases were short in distance and duration and the young bird was not driven from the area.

Other movements. The October 1993 Laguna fire destroyed large amounts of cactus wren and gnatcatcher habitat. The fire had the potential to cause mass movement of birds both during the fire as they attempted to escape flames, heat and smoke and eventually as they sought areas of cover for food and protection. A week after the fire a banded adult male wren and his presumed mate (unbanded) were observed together in unburned habitat 0.4 km from their former territory whose cover had been severely damaged. Their postfire location had been occupied by other wrens during the 1993 breeding

season but only the banded male and his mate were seen a week after the fire. Eventually they moved back into his former territory and nested successfully in the only undamaged cactus patch.

Several major highways and streets are located in the study area. These include Pacific Coast Highway (PCH), Laguna Canyon Road, Ridgeline Drive and Turtle Rock Drive. Prior to the 1994 breeding season very few birds were banded in the southwest portion of the study area in the vicinity of PCH and, with the exception of Crystal Cove State Park surveys by California Department of Parks and Recreation on the ocean side of PCH, no directed searches for banded birds have been conducted. A small number of gnatcatchers have been banded on the bluffs above the beach. To date there are no records of banded wrens or gnatcatchers moving in either direction across PCH. The gnatcatcher population on the ocean side of PCH nearly doubled to 44 pairs from the 1993 to 1994 breeding season (Hirsch 1994). To reach this area the new birds would have had to cross PCH. It seems reasonable to presume that the stimulus for this movement was the loss of habitat due to the fire although loss of habitat from various development related projects in the general area could also play an important role.

We have recorded four instances of cactus wrens and one instance of a gnatcatcher dispersing across Laguna Canyon Road. Three wrens and four gnatcatchers have moved across Ridgeline Drive. During 1993 the home range of one pair of gnatcatchers was bisected by Ridgeline Drive. We have located two dispersed wrens in the Turtle Rock Fragments. These birds would have had to cross Turtle Rock Drive, some smaller residential streets and an unknown amount of housing to get to their respective localities.

These examples of movement across highways and through residential areas are interesting but at this point in our research they answer few questions. They also leave important questions unanswered. We have no idea what proportion of birds attempting these kinds of movements succeed and of those that do we do not know how many complete an effective dispersal, i.e., obtain a mate and territory and then successfully reproduce. We do not know the value of dispersing through residential areas into fragmented habitat. Do birds in residential fragments adjacent to housing and busy streets have as high a rate of survival and reproductive success as those in relatively undisturbed larger blocks of habitat? Until we begin to achieve some answers to these questions we should treat such movements with caution and not attempt bold conclusions.

## **SUMMARY**

Since 1991, we have color banded 242 California gnatcatchers and 607 cactus wrens in the Orange County Superpark study area and its surroundings. The accumulation of resightings of many of these birds has provided information on movement and dispersal of the two species. Banding effort has increased annually and the resulting number of resightings has risen accordingly. Over

400 birds were banded in 1994. The 1995 field season should therefore produce the highest number of confirmed dispersals to date.

The mean dispersal distance for 36 cactus wren natal and incomplete dispersals was 1.3 km (range = 0.0 to 5.6 km = 0.0 to 3.5 mi). The mean distance for 15 gnatcatcher natal and incomplete dispersals was also 1.3 km (range = 0.5 to 4.3 km = 0.3 to 2.7 mi).

As expected, adult cactus wrens and gnatcatchers displayed a high degree of site tenacity. Only 3 adult wrens dispersed from established territories. The mean wren breeding dispersal distance was 0.05 km (range = 0.0 to 0.3 km = 0.0 to 0.2 mi). This sample included 17 adults that did not leave their territories. We also recorded 3 adult gnatcatcher dispersals. The mean breeding dispersal distance for these birds plus 11 non-dispersing adults was 0.2 km (range = 0.0 to 1.3 km = 0.0 to 0.8 mi).

Juvenile gnatcatchers tend to leave their natal territories within several weeks of fledging but the timing of dispersal of young cactus wrens is wide ranging. Some wrens leave within several weeks of fledging while others may remain with their parents for 6 to 7 months. Birds within the same brood may leave at widely differing times. Groups of 3 or more wrens (family groups) are not unusual in December.

We are beginning to accumulate records of dispersing cactus wrens and gnatcatchers crossing major streets and highways and moving through residential areas but recommend caution in interpreting these observations. They need to be analyzed over a long term and within the greater context of population dynamics (survival rates, reproductive success, sink vs. source populations, etc.). To this date, limited funding has prevented us from properly examining the full spectrum of cactus wren and California gnatcatcher population demographics.

### Literature Cited

Arcese, P. 1989. Intrasexual competition, mating system and natal dispersal in song sparrows. *Anim. Behav.* 38:958-979.

Atwood, J.L., M.R. Fugagli, J.C. Luttrell, and N.C. Nicolai. 1994. California gnatcatchers, cactus wrens, and conservation of coastal sage scrub on the Palos Verdes Peninsula: progress report no. 1 (1993). Unpublished technical report, Manomet Observatory for Conservation Sciences, Manomet, Massachusetts. 52 pp. + appendices.

Bontrager, D.R. 1994. A preliminary assessment of the effects of the October 1993 Laguna Beach fire on California gnatcatcher and cactus wren populations in the Orange County Superpark. Unpublished technical report prepared for Ed Almanza & Associates, Laguna Beach, California. 7 pp. + maps.

Bontrager, D.R., R.A. Erickson, and R.A. Hamilton. In press. Impacts of the October 1993 Laguna fire on California gnatcatchers and cactus wrens. *In* *Brushfires in California Wildlands: Ecology and Resource Management* (J.E. Keeley and T.A. Scott, editors). Southern California Academy of Sciences, Los Angeles.

Braden, G. 1992. Unpublished draft report: California Gnatcatchers (*Poliophtila californica*) at three sites in western Riverside County. Prepared for the Metropolitan Water District by the U.S. Fish and Wildlife Service, Carlsbad, California.

Greenwood, P.J. 1980. Mating systems, philopatry and dispersal in birds and mammals. *Anim. Behav.* 28:1140-1162.

Greenwood, P.J. and P.H. Harvey. 1982. The natal and breeding dispersal of birds. *Ann. Rev. Ecol. Syst.* 13:1-21.

Hirsch, R. 1994. Crystal Cove State Park gnatcatcher study. Unpublished report prepared for California State Parks Department. 3 pp. + maps.

Howard, W.E. 1960. Innate and environmental dispersal of individual vertebrates. *Am. Midl. Nat.* 63:152-161.

Jones and Stokes Associates, Inc. 1993. Methods used to survey the vegetation of Orange County Parks and open space areas and the Irvine Company Property. Unpublished technical report prepared for the Environmental Management Agency, Environmental Planning Division, County of Orange, Santa Ana, California.

Ogden Environmental and Energy Services. 1992. Ecology of the California Gnatcatcher for Rancho San Diego. Unpublished technical report prepared for Home Capital Development Corporation, San Diego, California. 54 pp. + appendices.

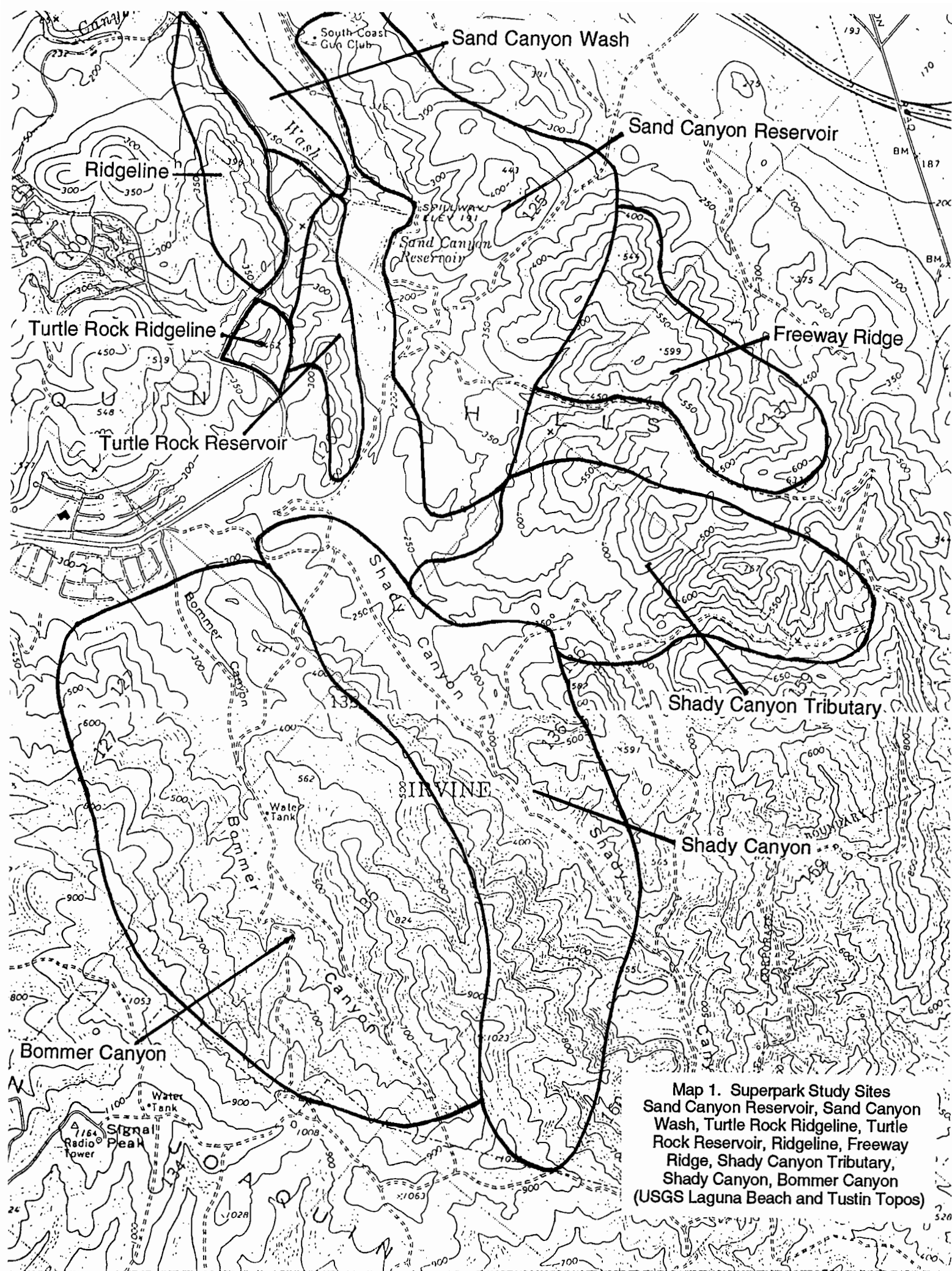
Sweetwater Environmental Biologists, Inc. 1994. Orange County Parks coastal California gnatcatcher and San Diego cactus wren survey report. Unpublished technical report prepared for the Environmental Management Agency, Environmental Planning Division, County of Orange, Santa Ana, California. 30 pp.

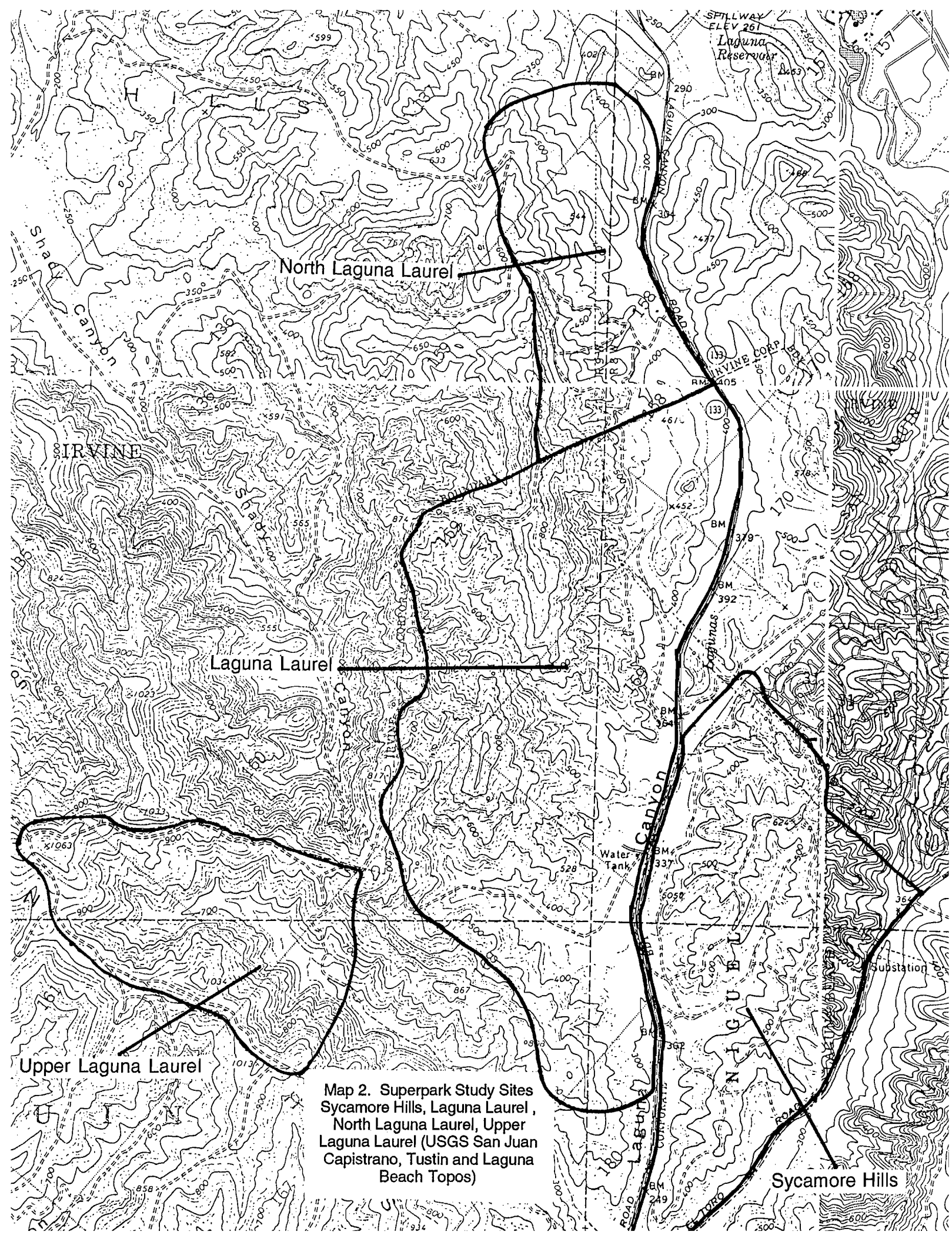
Verner, J. 1992. Data needs for avian conservation biology: have we avoided critical research? *Condor* 94:301-303.

**APPENDIX:**

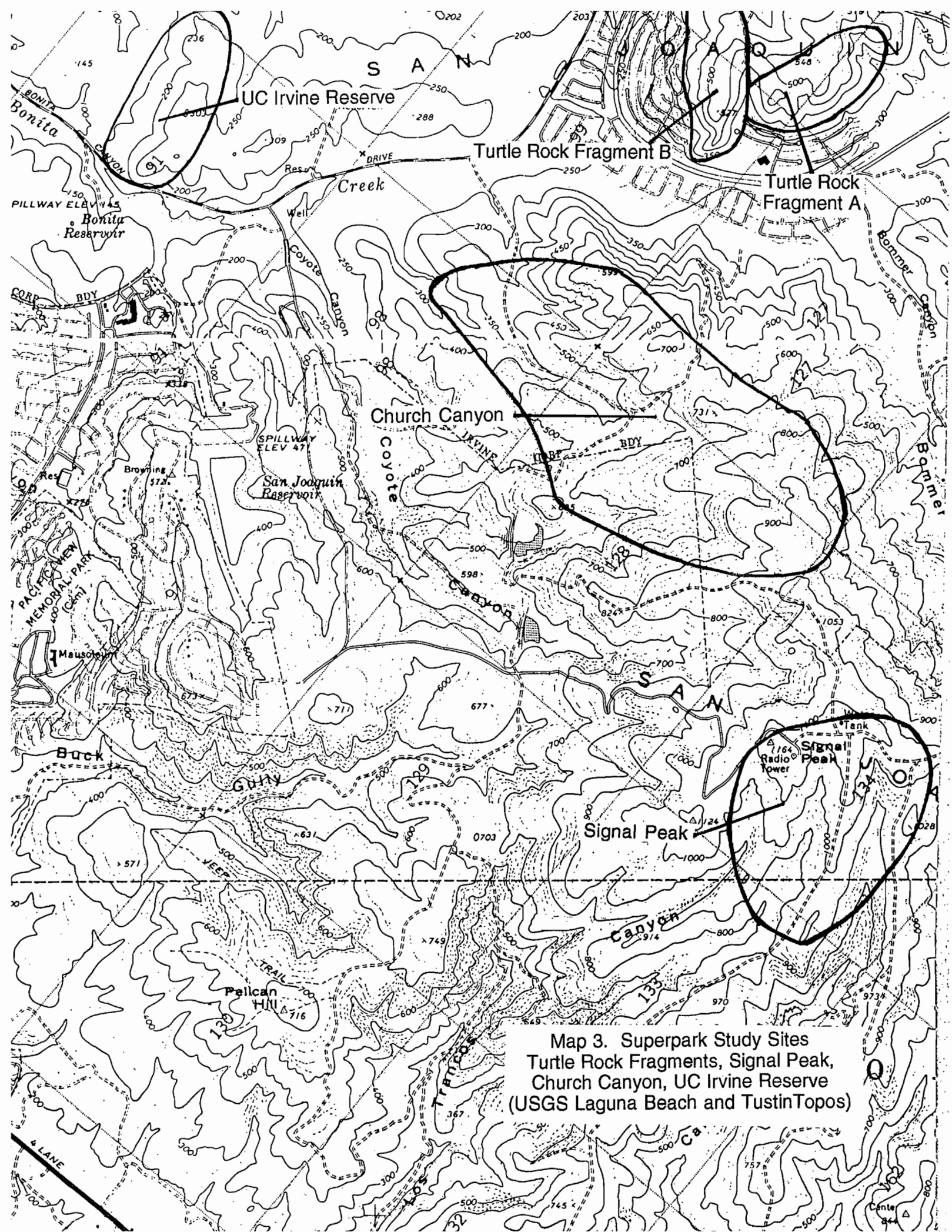
**STUDY AREA MAPS**



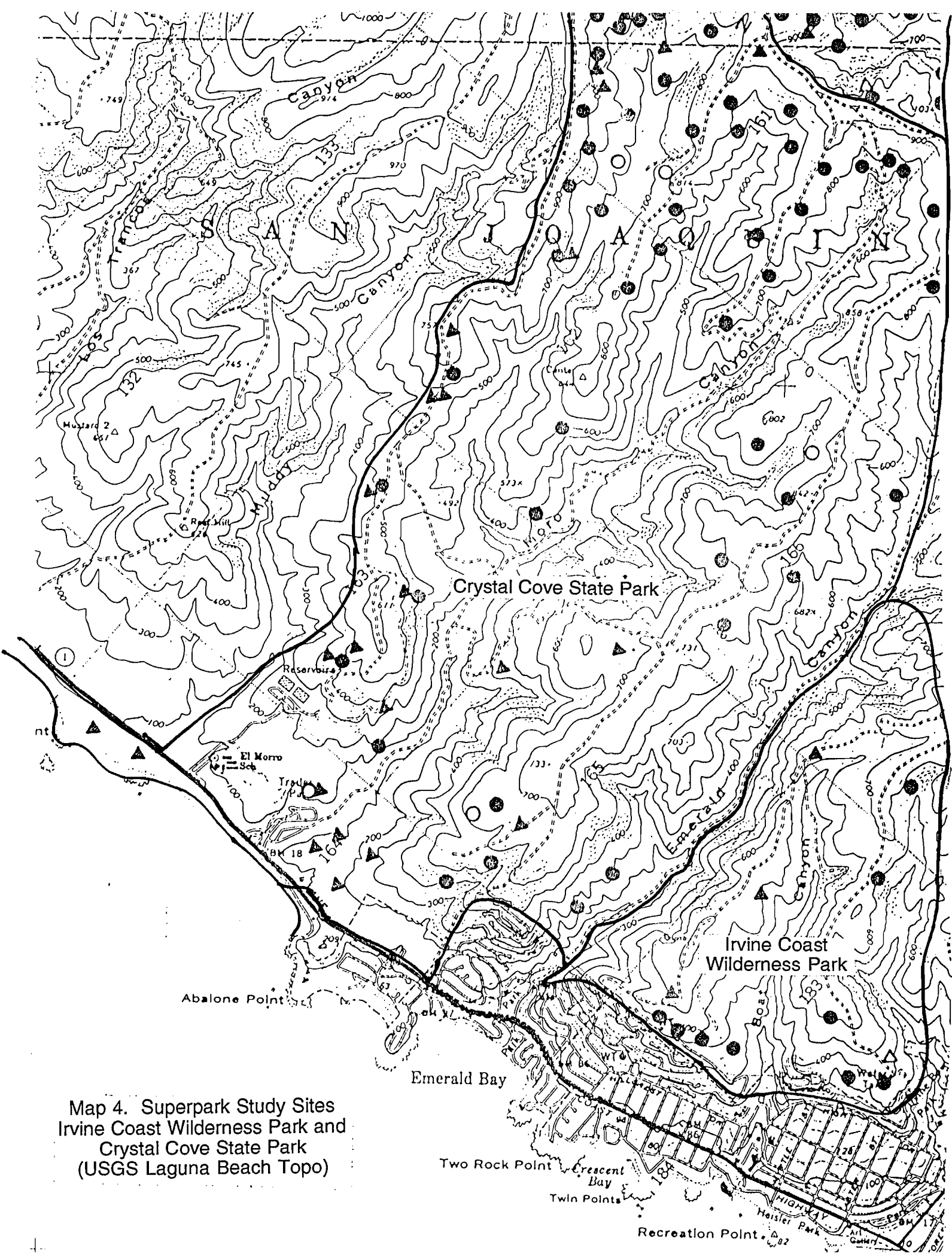




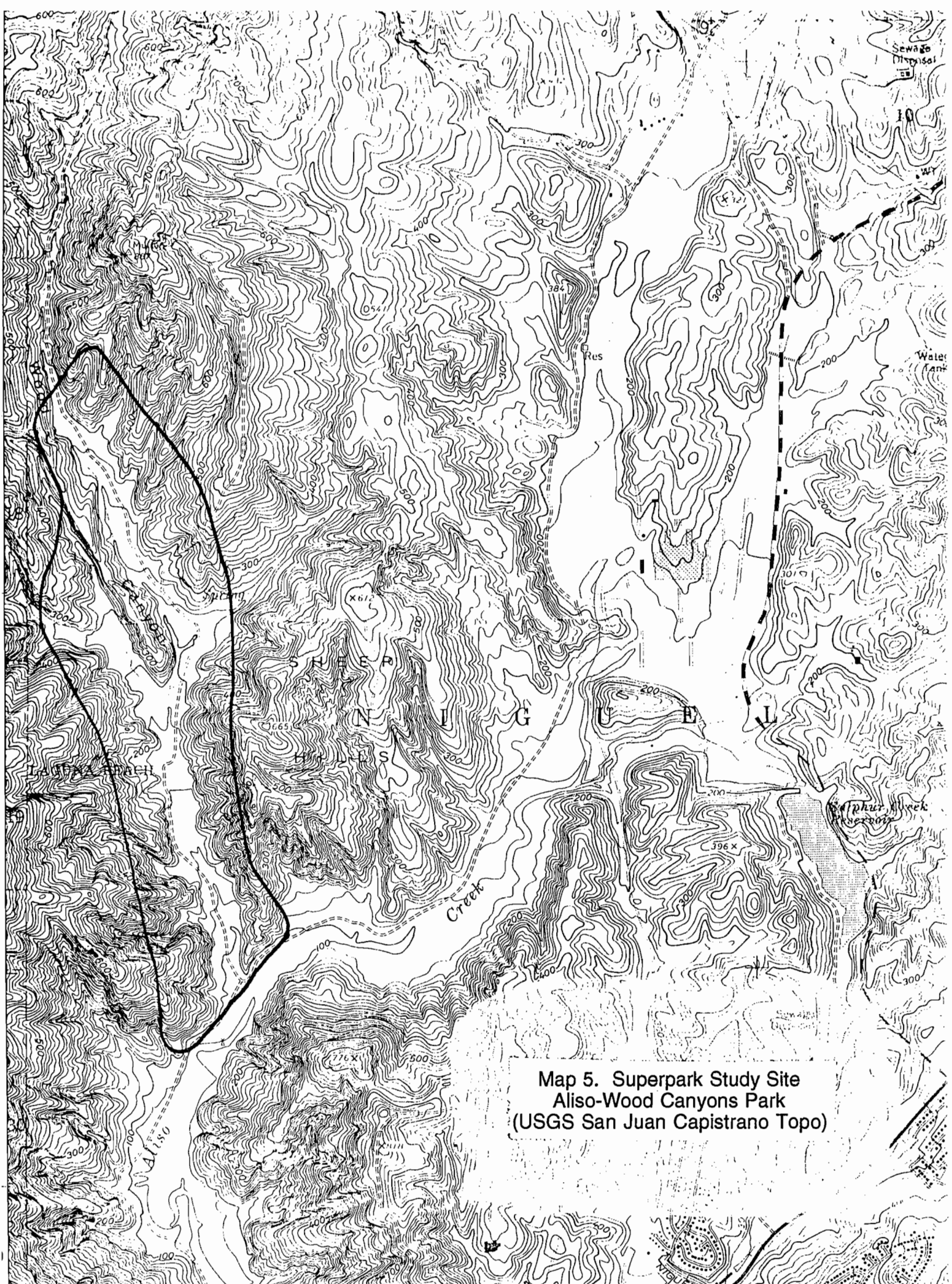
Map 2. Superpark Study Sites  
Sycamore Hills, Laguna Laurel,  
North Laguna Laurel, Upper  
Laguna Laurel (USGS San Juan  
Capistrano, Tustin and Laguna  
Beach Topos)







Map 4. Superpark Study Sites  
Irvine Coast Wilderness Park and  
Crystal Cove State Park  
(USGS Laguna Beach Topo)



Map 5. Superpark Study Site  
Aliso-Wood Canyons Park  
(USGS San Juan Capistrano Topo)