Hansen (1988)

REVIEW OF THE STATUS OF THE GIANT GARTER SNAKE

(Thamnophis couchi gigas)

AND ITS SUPPORTING HABITAT

DURING 1986-1987 1/

DRAFT ONLY

Subject to Revision

by

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INTRODUCTION

Fitch (1940) described the original range of the giant garter snake (Thamnophis couchi gigas) as the Central Valley from the vicinity of Sacramento and Antioch southward to Buena Vista Lake near Bakersfield. By 1971, so much wetland habitat of the giant garter snake (GGS) had been reclaimed for other uses, especially agricultural development, that the California Fish and Game Commission classified this snake a rare animal. The GGS was reclassified to threatened by the California Endangered Species Act of 1985. In order to better understand the range and distribution of the GGS, the California Department of Fish and Game (DFG) conducted field surveys in 1973, 1974, and 1976. The results of these surveys indicated that those GGS populations surviving in the northern portion of the range faced no immediate major threats (Hansen and Brode, 1980).

Recently, a resurgence of construction activity in the Sacramento area has resulted in the destruction of habitats known to support GGS. Other habitats known or suspected of supporting GGS are scheduled for development in the near future. In the San Joaquin Valley, GGS may have been lost to flooding within the Tulare Lake Basin and Mendota areas. GGS in the Kesterson area may have suffered losses resulting from high selenium concentrations and from subsequent clean-up efforts. These renewed threats prompted the DFG to undertake this survey in 1986 to investigate the present status and needs of the GGS and its supporting habitat.

An attendant goal of this survey was to develop an evaluation system for assessing potential GGS habitat. Such a system would be useful in predicting and subsequently mitigating the impacts on GGS of future land use changes.

METHODS

Potential GGS habitats were identified on topographic maps and located on the ground by searching from roadways, by boat and on foot. Field surveys were conducted from April, 1986 through January,1988.

Data which might prove useful in future evaluation or assessment of habitats (i.e. stream size and flow, nature of substrate, vegetation type, current land use, evidence of recent flooding or other distrubance) were recorded at each site. Field notes describing verified GGS habitats and the behavior of any GGS observed were recorded on California Native Species Field Survey forms and submitted to the DFG for accession into the Natural Diversity Data Base.

GGS were observed and captured, when possible, while walking, wading or boating along canals, streams, and marshes. Binoculars were helpful in searching potential basking spots and in identifying snakes at a distance. Wire mesh funnel traps were used at several locations., The traps were used mainly where bridges, culverts or other structures served as drift fences and provided protective shade.

GGS were also sought beneath surface objects, especially boards and other debris deposited by floodwaters. Boards were intentionally placed in promising locations and checked on subsequent visits. Visits were often made to sites known to support GGS prior to or after surveying new sites in order to ensure that GGS were active and observable on that particular day. A list of known GGS localities was compiled prior to commensing field work (Table 1, Figure 1).

During all phases of field work, roadways were searched for living and dead GGS. Any GGS captured alive were examined briefly and released at the point of capture. Any specimen found dead but in good condition was preserved and deposited with the DFG.

RESULTS

GGS were observed at 34 sites in the Sacramento Valley region and eastern periphery of the Delta (Figure 1, Table 2). No GGS were observed or trapped in the San Joaquin Valley or Delta proper. Several habitats known to have supported GGS during previous surveys have since been degraded or destroyed (Figure 1). Several hundred sites were visited during this study.

San Joaquin Valley

Southern San Joaquin Valley

Conditions within the Tulare Lake Basin continue to deteriorate, further threatening any GGS that may remain in that region. Levees and canals in this region are maintained almost entirely free of vegetation. However, the Kern River in the vicinity of Lost Hills, the Tule River south and southeast of Corcoran, and the Kings River in the vicinity of Stratford contain habitat that may be suitable for GGS.

Tulare Lake Basin Inundation of the Tulare Lake Basin during 1985 may have removed any GGS remaining in that area, or at least forced them into upstream reaches of the tributaries and canals serving the basin. These waterways, including the portions of the Kings, Kern, and Tule Rivers mentioned above, were subsequently treated with rotenone during September 1987

to eradicate the introduced white bass. While the effects of rotenone on GGS are not known, such a treatment would certainly effect its prey base of aquatic and amphibious vertebrates.

North-Central San Joaquin Valley

No GGS were observed in the north-central San Joaquin Valley. Although survey time was limited in this region, several areas of habitat that supported GGS during previous surveys (Hansen and Brode 1980) have deteriorated with apparent losses of GGS. These areas include the Mendota Wildlife Area (MWA) and the North Grasslands region in the vicinity of the Kesterson National Wildlife Refuge (KNWR). Otherwise, conditions within the northern San Joaquin Valley appear much as they did during the previous surveys.

Mendota Wildlife Area. GGS have not returned, at least to levels of abundance observed during previous surveys, to the northern area of the MWA following inundation of the area during 1985 flooding. This flooding overtopped the railroad grade along the MWA north boundary. In prior years this railroad grade had remained above floodwaters and provided refuge for the GGS during the winter dormant period.

Kesterson National Wildlife Refuge. The impacts on local GGS of past dumping of selenium-laden agricultural wastewater and subsequent cleanup efforts there (including prolonged drying of the region and removal of exposed bottom sediments) are unknown.

Northern San Joaquin Valley

The area from Gustine north to the Mokelumne River contains few habitats suitable for GGS and no GGS were observed here during this study. Most potential supporting habitat here consists of riparian woodlands bordering the San Joaqin, Merced, and Tuolumne Rivers. These environments, similar to those in the Delta, apparently do not support GGS.

Delta

No GGS were observed in the Delta proper during this study. The Delta contains a wide variety of wetland environments, including marshes, swamps, rivers, sloughs, and various agricultural drains and canals. However, most major Delta waterways have been channelized and their banks lined with rock rip-rap. Dense riparian woodlands now line many channels, shading the banks and water surface. Since being protected from flooding, the Delta has been almost completely converted to agricultural uses including cultivation of crops and

livestock grazing.

Many Delta waters have long supported populations of introduced gamefish which may prey on young GGS. Terrestrial competitors such as the valley garter snake and predators such as the striped skunk are now established on levees and islands.

However, agricultural canals and other aquatic environments throughout the Delta provide seemingly favorable habitat for GGS.

Sacramento Valley

Severe flooding of low lying areas during February, 1986 provided an excellent opportunity to observe the effects of high water within GGS habitats. Field searches were conducted at that time along levee tops, railroads, and elevated roads for snakes seeking refuge from floodwaters. Data gathered during this and other independent surveys conducted prior to this study are included here.

Southern Sacramento Valley

Galt. GGS were observed at three sites within this region of rolling grazed grassland, open oak woodland, riparian and marsh habitats (Figure 1, Table 2).

Small marshes persist here in shallow basins along the lower reaches of Badger and Willow Creeks at the eastern edge of the Delta floodplain. During 1986 the marsh located west of Highway 99 at Arno Road flooded to the level of the frontage road (west side of Highway 99) and to the rails atop the railroad grade and trestle bisecting the marsh, thereby inundating known and suspected hibernating spots. Although the floodwaters receeded and the site returned to its usual appearance by late spring, this site produced fewer observations of GGS than in prior years (Hansen field notes).

Most of the habitats remaining along the small streams east of Highway 99 have been degraded by overgrazing. One exception is a small tule-cattail marsh persisting along the North Fork of Badger Creek east of Riley Road that has been protected from grazing livestock. One GGS was observed here and this sighting represents the highest elevation (40 feet) at which GGS were seen in the southern Sacramento Valley.

Elk Grove. This rural area south of Sacramento is known to have supported GGS and its habitats at several sites. No GGS were observed here during this study, although they were observed here as recently as 1982 (Hansen 1982).

Those sites known to have supported GGS west of Franklin Boulevard and south of Morrison Creek were inundated by flooding during February of 1986. Known localities east of Franklin Blvd. were either inundated during these February, 1986 floods (Laguna Creek, Morrison Creek) or urbanized (Elk Grove Creek). Surveys conducted during spring flooding and throughout the remainder of the active period indicate that GGS have been seriously depleted in this area during the past two years.

Although habitats suitable for GGS persist in this area, overgrazing and urbanization pose a very real threat to any GGS remaining.

Woodland-Liberty Farms. West of the Yolo Bypass, one GGS was observed in 1986 and four were observed in 1987. This area contains irrigation and drainage canals serving grazing and other agriculture. Flooding of several areas occurs here most years, and levee tops provide the only stable winter shelter. From Woodland south to Yolano, there are only a small number of irrigation canals and streams that could support GGS.

No GGS were observed between the Yolo Bypass and the Sacramento River. Prior to the construction of the Yolo Bypass much of this area flooded seasonally. Today, this region is protected from flooding and only a few agricultural canals, sloughs and toe drains provide potentially favorable habitats for GGS.

Yolo Bypass. Within the Yolo Bypass, snakes of any kind were rare. Those sighted were usually found in the vicinity of levees or roads and railroad grades that provided refuge from frequent flooding. Irrigation canals, toe drains, and natural sloughs and marshes provide apparently suitable habitats during low water, but no GGS were observed in the Yolo Bypass during this study. However, during the spring of 1985 a dead GGS adult was found on Road 22 where it crosses the north end of the Yolo Bypass. This snake had probably found refuge from floodwaters two months earlier on the earth and rock railroad grade adjacent to Road 22 at this site, and was hit by a vehicle while on Road 22 between the railroad and an adjacent slough.

American Basin. This low lying agricultural region north of Sacramento encompasses 18 of the 34 sites where GGS were observed during this study. Although conditions seemed most favorable in those waterways adjacent to rice fields, most or all waterways here are probably frequented by GGS during the active season.

In recent years, the conversion of this area from agricultural to other uses has increased dramatically. Of the approximately 50 square miles of this area located in Sacramento County, 15 have recently been developed (North and South Natomas, Sacramento Metropolitan Airport) and much of what remains is scheduled for development in the near future. Industrial developments are also being planned within GGS habitats in southern Sutter County. Continued losses of habitat in this region, coupled with the increasing trend towards lining remaining ditches with concrete, may result in the fragmentation of this panmictic population into smaller and increasingly fragile, isolated subpopulations.

Sutter Bypass. Surveys of the Sutter National Wildlife Refuge and other promising potential supporting habitats of GGS south of the Sutter Buttes and east of the Sutter Bypass are incomplete. However, it is probable that GGS inhabits several canals east of the Sutter Bypass.

Sutter Basin. This intensively cultivated region is located west of the Sutter Bypass and east of the Sacramento River south of the Sutter Buttes. It contains irrigation and drainage canals suitable for GGS. During this study, GGS were found at three locations along irrigation canals in the vicinity of Robbins (Figure 1).

Northern Sacramento Valley

Colusa Basin. This agricultural region lies west of the Sutter Buttes between the Sacramento River and the Coast Range. It supports a variety of wetland and agricultural environments suitable for GGS. Canals and drains here are lightly maintained and most support thick annual and perennial vegetation along their banks.

GGS were observed at five locations in this primarily rice-growing region. All GGS observed were associated with man-made or altered channels or canals (Figure 1).

Butte Sink. Surveys of the Sacramento National Wildlife Refuge, Gray Lodge Wildlife Area, and other promising potential supporting habitats of GGS north of the Sutter Buttes both east and west of the Sacramento River are incomplete. However, it is known from previous surveys that GGS inhabits several canals in this region.

HABITAT AND FEEDING REQUIREMENTS

Food

GGS is an aquatic feeder specializing in ambushing small fish

(including the introduced carp, Cyprinis carpio, and mosquitofish, Gambusia affinis) underwater. It will also readily take larvae and young of the widely introduced bullfrog (Rana catesbeiana).

GGS will probably eat a wide variety of small or young native and introduced fish and amphibians. However, the presence of small fish may enable the GGS to compete successfully with the more terrestrial valley garter snake (Thamnophis sirtalis fitchi) which is common throughout the range of GGS.

Water

GGS is a highly aquatic snake, relying upon the aquatic environment both for food and for shelter from enemies. Known habitats contain permanent to seasonal water, usually still or slow moving, with mud bottom and dirt banks. If the waters within GGS habitat are ephemeral, their source is usually from some other permanent water body which supports and supplies aquatic prey of GGS.

Irrigation supply ditches and drains in the vicinity of rice fields and probably the rice fields themselves may be better able to support GGS than other waterways. This is because they harbor small fish that are introduced with the irrigation water throughout much of the summer season, but dry in the fall before any of these fish become large enough to prey on GGS.

Prefered water depth of GGS is not known, although they may require shallow backwaters where they are better able to trap prey while hunting.

Cover

A site must provide GGS protection or shelter (both in and out of the water) from predation and other mortality factors during the active summer season. This shelter may take the form of vegetation, debris or the burrows of rodents and crayfish.

Where emergent stands of tules (Scirpus spp.), or cattails (Typha spp.) occur near shore, GGS were observed to prefer the shelter of tules. Tule stands that survive from year to year become thick with old growth and are particularly favorable for GGS. Large GGS, usually females, often chooser the shelter of grassy banks if tules are sparse and will not support their weight.

Basking Spots

GGS bask during the active season in order to raise the body to activity temperatures. Basking may be an especially important aid to digestion, gestation, healing, and in rewarming the body

following emersion in cool waters (Hansen, field notes). Basking spots must recieve adequate sunlight and therefore must not be shaded by dense riparian growth. However, there needs to be screening vegetation to prevent prolonged exposure of basking GGS to the view of predatores. If too few suitable basking spots are present in an otherwise favorable habitat, avian or other predators may concentrate their activities at those spots to the detriment of the GGS present.

A typical GGS basking site consists of a sunny area of wetland bank or emergent vegetation that contains screening cover within which portions of the snake's body can be concealed or exposed to warming sunlight during thermoregulation. Basking sites are nearly always located directly adjacent to escape cover such as water or vegetation.

Overwintering Habitat

GGS retreating from winter floodwaters are handicapped by slowed reflexes, responses and general movement as a result of lowered body temperatures. For long term survival, GGS need access to upland retreats during runoff or flooding. Vegetation, burrows and other shelter from predators enhance the suitability of the overwintering site. Close proximity of overwintering sites is probably preferred, although GGS at the Arno Road site in southern Sacramento County have been known to move as far as 200 meters from the shoreline of the summer habitat. These GGS had taken shelter under debris deposited by the previous year's floodwaters prior to the onset of the current season's first winter storms or floods.

HABITAT EVALUATION

The occurrance and distribution of GGS is influenced by many factors, several of which can be evaluated and graded on a site by site basis. The suitability of an area for GGS depends on the number and combination of these factors.

The following system is proposed for evaluating the suitability of potential GGS habitats. Steps 1-5 are used to evaluate positive aspects of the environment and are recorded as positive scores. Step 6 is used to evaluate detrimental aspects of the environment and is recorded as a negative score. The sum of positive and negative scores is recorded as the score for a site being evaluated. Sites could earn scores of 0-15, with favorable habitats represented by high scores. As examples, the 34 sites at which GGS were observed during this study were evaluated and the results shown in Table 3.

1. Food:
   - A. Small fish and amphibian larvae present — 3 pts.
   - B. Small fish only present — 2 pts.
   - C. Amphibians and their larvae only present — 1 pt.
   - D. No small fish or amphibian larvae present — 0 pts.

2. Water:
   - A. Still or slow flowing water over a mud or silt substrate available during summer or during both the summer and winter seasons — 3 pts.
   - B. Still or slow flowing water available during the winter season only — 0 pts.
   - C. Flowing water over sand, gravel or rock substrate — 0 pts.

3. Cover:
   - A. Terrestrial and aquatic shelter present — 3 pts.
   - B. Terrestrial shelter only present — 1 pt.
   - C. Aquatic shelter only present — 1 pt.
   - D. No shelter present — 0 pts.

4. Basking Spots:
   - A. sunny expanses of low growing emergent and streamside vegetation present — 3 pts.
   - B. Banks are sunny with little sheltering vegetation present — 1 pt.
   - C. Banks are shaded and only scattered sunlight penetrates a riparian overstory — 1 pt.
   - D. Nearly the entire waterway and substrate are either exposed to sunlight or shaded by riparian overstory — 0 pts.

5. Overwintering Habitat:
   - A. Upland retreats and shelter present adjacent to and uphill from summer habitat — 3 pts.
   - B. Upland retreats present but little shelter provided — 1 pt.
   - C. No upland retreats occur adjacent to summer habitat — 0 pts.

6. Detrimental Factors:
   - A. Large predatory gamefish are present and established — -1 pt.
   - B. Site is inundated by frequent and severe seasonal flooding — -1 pt.
   - C. Site recieves sufficient polluted runoff from nearby urbanized areas to periodically or temporarily affect GGS or prey populations — -1 pt

DISCUSSION

As a result of man's activities, the GGS and its supporting habitat are depleted throughout most of its range. GGS has suffered losses both in numbers and in available habitat since surveys were conducted by the DFG during the 1970's. Many habitats that still support GGS are degraded or threatened. Some probable causes are summarized below.

Habitat Loss

Flood Control/Wetland Reclamation

Rapid urban growth within California's Central Valley has prompted a renewed interest in flood control and wetland reclamation projects. This is especially apparent where the threat of flooding has prevented urban development within low lying areas. A small number of these low lying areas, such as the Natomas area of the American Basin and the Elk Grove/Freeport areas, all in Sacramento County, have served as refugia for GGS.

Measures designed to protect low lying areas from flooding include filling of marshes, levee building, clearing and cleaning of stream channels, lining of banks with rock rip-rap or concrete, and burying streams or drains within concrete pipes. GGS habitats within the Elk Grove/ Freeport and Natomas areas are being lost to these causes at an alarming rate, and as a result GGS may have been recently extirpated within the Elk Grove/Freeport area.

Urbanization

Much habitat is being lost as improved flood control within GGS habitats encourages the development of these habitats into housing and industrial subdivisions. Those wetlands remaining after development are often destroyed immediately by landscaping into greenbelt parkways or degraded over time by polluted runoff and encroachment by humans and their pets.

Increased Mortality

Flooding

Rapid loss of upland areas to development has increased the importance of GGS habitats located within flood-prone low lying areas. Loss of overwintering habitats increases the danger of flooding to GGS as urbanization encroaches within these floodplains. GGS are lost when they are forced into urbanized or other developed areas (including most agricultural areas) while retreating from floodwaters.

Recent apparent declines in GGS numbers in the vicinity of MWA (Fresno County) and Elk Grove/Freeport (Sacramento County) are at least partially attributable to the failure of GGS to return to known habitats following flooding.

Introduced Predators

The replacement of native wetlands by permanent fresh water channels and reservoirs has allowed the establishment of a wide variety of introduced aquatic predators throughout the range of the GGS. Many of the popular game fish species introduced into Central Valley waterways, including catfishes, sunfishes, and basses, may prey upon GGS. This danger is increased by the tendency of GGS to seek shelter from attack by diving into water. Ironically, water management practices on many of the refuges and wildlife areas found within the range of GGS, including the MWA, inadvertantly favor production of introduced gamefishes over protection of the GGS.

Introduced rats and ferel house cats, which are now common within rice growing areas, may pose a threat to GGS.

Pest Control

Certain pest control practices, such as chemical and mechanical weed control along levees and streams (including dredging channels to remove aquatic vegetation and compacting levee surfaces to eliminate rodent burrows and vegetation), destroy or degrade GGS habitats by removing shelter. Landscaped greenbelts that are created along streamcourses (such as in the Natomas area of Sacramento County) require intensive chemical and mechanical (mowing) weed abatement and other management practices detrimental to GGS.

The waterways within the Tulare Lake area of the southern San Joaquin Valley were treated with rotenone during 1987 to eradicate the white bass. This treatment may also have eradicated aquatic prey of GGS.

Pollution

Since toxic substances could eradicate GGS or its prey from a limited habitat, danger to GGS from man-made pollution increases with increased human activity in or near their habitats. Oil, such as that draining from roadways and parking lots during runoff, can interfere with a snake's breathing and lead to suffocation (Hansen field notes).

Once polluted, an area may be further degraded by cleanup efforts. At Kesterson National Wildlife Refuge in Merced

County, dumping of selenium-contaminated water and subsequent clean-up efforts have resulted in the poisoning, drying and disturbance of a large area of GGS habitat.

RECOMMENDATIONS

The following actions should be taken to preserve and enhance GGS populations and to gain needed information for successful management of the GGS.

1. Protect existing GGS populations and their habitats, including dispersal corridors and other support systems.

2. Continue survey efforts to locate unknown GGS populations and identify habitats critical to their survival.

3. Identify sites suitable for aquisition and management as reserves for the GGS. For example, the marsh west of Highway 99 at Arno Road would be a recommended site.

4. Identify suitable sites and conduct life history studies. Such sites must support established, resident GGS populations and be reasonably protected from outside influenses such as habitat disruption and human activity.

   Proposed developments and highway construction projects have prompted further studies within the American Basin of northern Sacramento County. Results of these are to be used in an attempt to identify critical habitats of GGS within the American Basin and formulate a habitat management plan for the GGS.

5. Continue to test and revise as necessary the habitat evaluation system.

6. Study the feasibility of rehabilitating or enhancing present or prior GGS habitats.

7. Study the feasibility of establishing GGS into favorable habitats within its prior range, especially in the southern San Joaquin Valley.

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TABLE 1. Known Localities of the Giant Garter Snake Prior to 1986, Based on Literature, Museum, and California Dept. of Fish and Game Records.

	Locality	County	Reference
1	Near Buttonwillow	Kern	Fitch 1940
2	Buena Vista Lake	Kern	LACM 1/
3	14.8 miles E Fellows, Hwy. 399	Kern	MVZ2/
4	Near Lanare	Fresno	Fitch 1941
5	Fresno Slough, 1 mile W. Burrell	Fresno	CDFG
6	Hwy 180, 0.7 miles E San Mateo Ave, 4 miles ESE Mendota	Fresno	CDFG
7	Mendota Wildlife Management Area	Fresno	MVZ, CDFG
8	Fresno Slough, N Whitesbridge	Fresno	CDFG
9	0.2 miles SE Mendota	Fresno	CDFG
10	San Joaquin River, 1.5 miles N Mendota	Fresno	MVZ
11	Hwy 33 at Douglass Ave., 2 miles NW Firebaugh	Fresno	CDFG
12	Helm Canal Road, 3.5 miles SW Dos Palos	Merced	CDFG
13	2.5 miles SW Dos Palos	Merced	CDFG
14	Near Dos Palos	Merced	MVZ
15	4 miles W Dos Palos	Merced	CDFG
16	3.5 miles N Dos Palos	Merced	CDFG
17	Santa Fe Road, 3 miles NW Britto Road, 6 miles SE Los Banos	Merced	CDFG
18	Gadwall	Merced	MVZ
19	Los Banos	Merced	CAS3/

	Santa Fe Road at Arroyo Canal, 3 miles E Los Banos	Merced	CDFG
	4 miles N Los Banos	Merced	MVZ
	4 miles NE Los Banos (vic. Mud Slough)	Merced	MVZ
	Salt Slough at Wolfsen Road, 7 miles N Los Banos	Merced	CDFG
	Lander Ave., 8 miles N Los Banos	Merced	CDFG
	San Luis NWR, 10 miles NE Los Banos	Merced	CDFG
	Santa Fe Road at San Luis Spillway, 6 miles N Los Banos	Merced	CDFG
	Los Banos Creek at Santa Fe Grade, 6 miles SE Gustine	Merced	CDFG
	3 miles and 4 miles SE Gustine (vic. Los Banos Creek)	Merced	MVZ
	Between Ingomar and Gustine	Merced	MVZ
	Hwy 140, 3 miles NE Gustine	Merced	CDFG
	Merced	Merced	CAS
	Mormon Island (Diverting Canal)	San Joaquin	Fitch 1940
	Stockton, 5 miles N	San Joaquin	MVZ
	Eight Mile Road at WPRR, 3.5 miles W Hwy. 99	San Joaquin	CDFG
	Antioch Bridge	Sacramento	UMMZ4/
	10 miles S Sacramento	Sacramento	Fitch 1940
	Arno Rd., W side Hwy. 99	Sacramento	CDFG
	Snodgrass Slough W. Elliot Road	Sacramento	CDFG
	Franklin Blvd., 0.5 miles S Hood-Franklin Rd.	Sacramento	CDFG
	0.4 miles N Elk Grove Blvd., W side Hwy 99	Sacramento	CDFG
	0.5 miles S Sheldon Rd., 0.2 miles W	Sacramento	CDFG

Hwy 99		
Sheldon Rd., 0.3 miles W Bruceville Rd.	Sacramento	CDFG
Beach Lake Preserve, 1 mile S Freeport	Sacramento	CDFG
West Drainage Canal, 1 mile W to 1 mile S of intersection of El Centro Blvd. and Del Paso Rd.	Sacramento	CDFG
Meister Rd., E Sacto. Metro. Airport	Sacramento	CDFG
Del Paso Rd. at El Centro Blvd.	Sacramento	CDFG
Del Paso Rd. 1.6 miles E El Centro Blvd.	Sacramento	CDFG
Elverta Rd., 1.5 miles E Garden Hwy.	Sacramento	CDFG
Reigo Rd., 0.5 miles W Hwy. 99	Sutter	CDFG
South Fork Putah Creek at Old Davis Rd., Davis	Solano	CDFG
Swan Rd., 1.3 miles W Liberty Island Rd.	Solano	CDFG
Road 22, center of Yolo Causeway	Yolo	CDFG
Husted Road 0.1 mile N of E Street, Williams	Colusa	CDFG
Delevan NWR	Colusa	CDFG
Gray Lodge Waterfowl Management Area	Butte	LSUMZ5/
Butte City Hwy, 0.7 miles E Goodspeed-Watt Road, 10 miles NW Gridley	Butte	CDFG

1/ Los Angeles County Museum

2/ Museum of Vertebvrate Zoology, University of California, Berkeley

3/ California Academy of Sciences

4/ University of Michigan Museum of Zoology

5/ Louisiana State University Museum of Zoology

TABLE 2. Known Localities of the Giant Garter Snake During 1986 and 1987, Based on Observations Recorded During This Study.

Site	Locality	County
1.	Danley Rd. 0.5 miles N Lurline Rd., 7 miles NW Williams	Colusa
2.	Glenn-Colusa Canal at Freshwater Ck., 4 miles WNW Williams	Colusa
3.	Hwy 99 West at Lurline Ck., 0.4 miles S Lurline Rd., 4 miles NNW Williams	Colusa
4.	Hwy 99 West at Freshwater Ck., 1 mile NNW Williams	Colusa
5.	E side Colusa Trough, 1 mile N Hahn Rd., 9 miles SE Williams	Colusa
6.	Everrglade Rd., 1 mile N Pelgar Rd., 6.5 miles N Robbins	Sutter
7.	Seymour Rd., 2 miles W Hwy 113, 2 miles WNW Robbins	Sutter
8.	Reclamation Rd., 0.1 mile S Maddock Rd., 0.5 miles S Robbins	Sutter
9.	Canal N Howsley Rd., 0.8 miles E El Centro Blvd.	Sutter
10.	Canal W side El Centro Blvd., 0.4 miles N Sankey Rd.	Sutter
11.	Canal Crossing Riego Rd. 0.7 miles E Power Line Rd.	Sutter
12.	Power Line Rd., 0.2 miles S canal (0.7 miles S Riego Rd.).	Sutter
13.	Prichard Lake area 1 mile W Power Line Rd., 1 mile N Elverta Rd.	Sacramento
14.	Small drain 0.5 miles N Elverta Rd., 1 mile W Power Line Rd.	Sacramento

15.	Canal crossing Power Line Rd. 0.25 miles N Elverta Rd.	Sacramento
16.	Canal-Marsh 0.3 miles W Power Line Rd., 0.3 miles S Elverta Rd.	Sacramento
17.	Canal N Elkhorn Rd., E East Drainage Canal	Sacramento
18.	Canal E Power Line Rd., 0.9 miles S Elverta Rd.	Sacramento
19.	Meister Rd. at Lone Tree Rd.	Sacramento
20.	Bayou Way, 0.5 miles SW Hwy 99 x I-5 interchange, 1 mile E Power Line Rd.	Sacramento
21.	Power Line Rd., 0.2 miles S Bayou Way	Sacramento
22.	Fisherman's Lake area from El Centro Blvd. to Del Paso Rd.	Sacramento
23.	Del Paso Rd. at El Centro Rd.	Sacramento
24.	Canal N Del Paso Rd., W East Drainage Canal	Sacramento
25.	East Drainage Canal at lateral drain, 0.3 miles S Del Paso Rd.	Sacramento
26.	East Drainage Canal at lateral drain, 1.5 miles S Del Paso Rd.	Sacramento
27.	North Fork Badger Creek at Riley Rd.	Sacramento
28.	Marsh W Hwy 99 at Arno Rd.	Sacramento
29.	Canal-marsh E Hwy 99 at Arno Rd.	Sacramento
30.	Road 25 at Willow Sl., 4 miles ESE Woodland	Yolo
31.	Irrigation canal 1 mile E Rd. 104, 1 mile N Rd. 28H, 7 miles SE Woodland	Yolo
32.	Liberty Island Rd., 1.3 miles S Swan Rd., 9 miles SE Dixon	Solano
33.	Canal crossing Swan Rd., 1.3 miles W Liberty Island Rd.	Solano
34.	Marsh, 0.8 miles W Thornton Rd at Hwy 12	San Joaquin

TABLE 3. Evaluation of Habitats Observed to Support GGS During 1986 and 1987. Site numbers and locations correspond with those shown in Table 2.

Site	Water	Food	Cover	Basking Spots	Overwinter Habitat	Minus Factors	Score
1.	3	3	3	3	3	-?	15
2.	3	3	3	3	3	-?	15
3.	3	3	3	3	3	-?	15
4.	3	3	3	3	3	-?	15
5.	3	3	3	3	3	-?	15
6.	3	3	3	3	1	-1	12
7.	3	3	3	3	1	-1	12
8.	3	3	3	3	1	-1	12
9.	3	3	3	3	3	-?	15
10.	3	3	3	3	3	-?	15
11.	3	3	3	3	3	-1	14
12.	3	3	3	3	3	-1	14
13.	3	3	3	3	3	-1	14
14.	3	3	3	3	3	-?	15
15.	3	3	3	3	3	-1	14
16.	3	3	3	3	3	-?	15
17.	3	3	3	3	3	-?	15
18.	3	3	3	3	3	-?	15
19.	3	3	3	3	3	-?	15
20.	3	3	3	3	3	-1	14
21.	3	3	3	3	3	-?	15

22.	3	3	3	3	3	-1	14
23.	3	3	3	3	3	-1	14
24.	3	3	3	3	3	-?	15
25.	3	3	3	3	3	-1	14
26.	3	3	3	3	3	-1	14
27.	3	3	3	3	3	-?	15
28.	3	3	3	3	1	-2	11
29.	3	3	3	3	1	-2	11
30.	3	3	3	3	3	-1	14
31.	3	3	3	3	3	-?	15
32.	3	3	3	3	1	-1	12
33.	3	3	3	3	1	-2	11
34.	3	3	3	3	3	-1	14

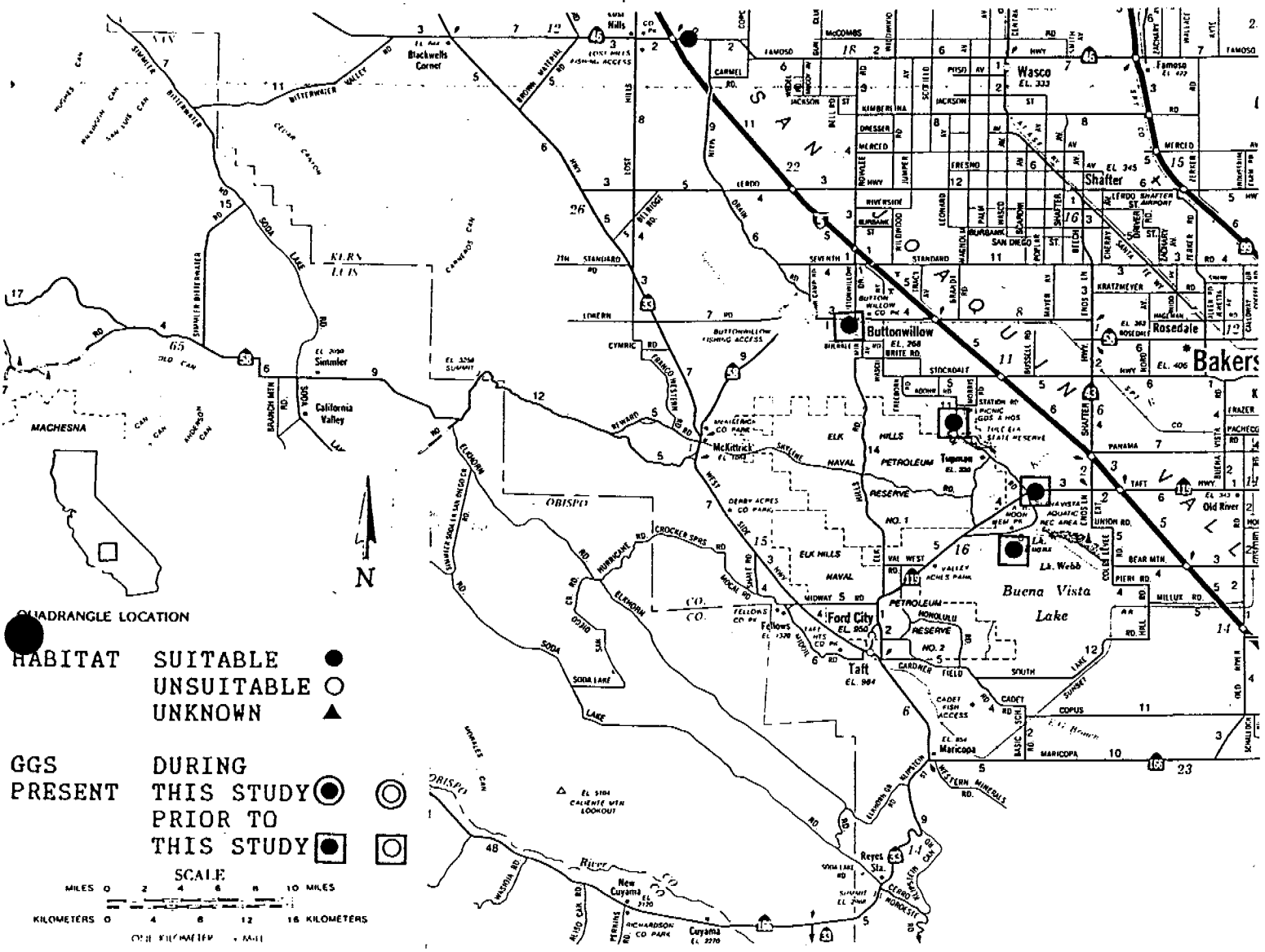

Figure 1a. Distribution of the giant garter snake and its supporting habitat Small solid circles indicate suitable habitat, small open circles indicate unsuitable environments, and small solid triangles environments of unknown value for GGS. The above symbols are enclosed within an open circle to indicate that GGS were sighted here during this study, or within an open square to indicate that GGS were sighted here prior to but not during this study.

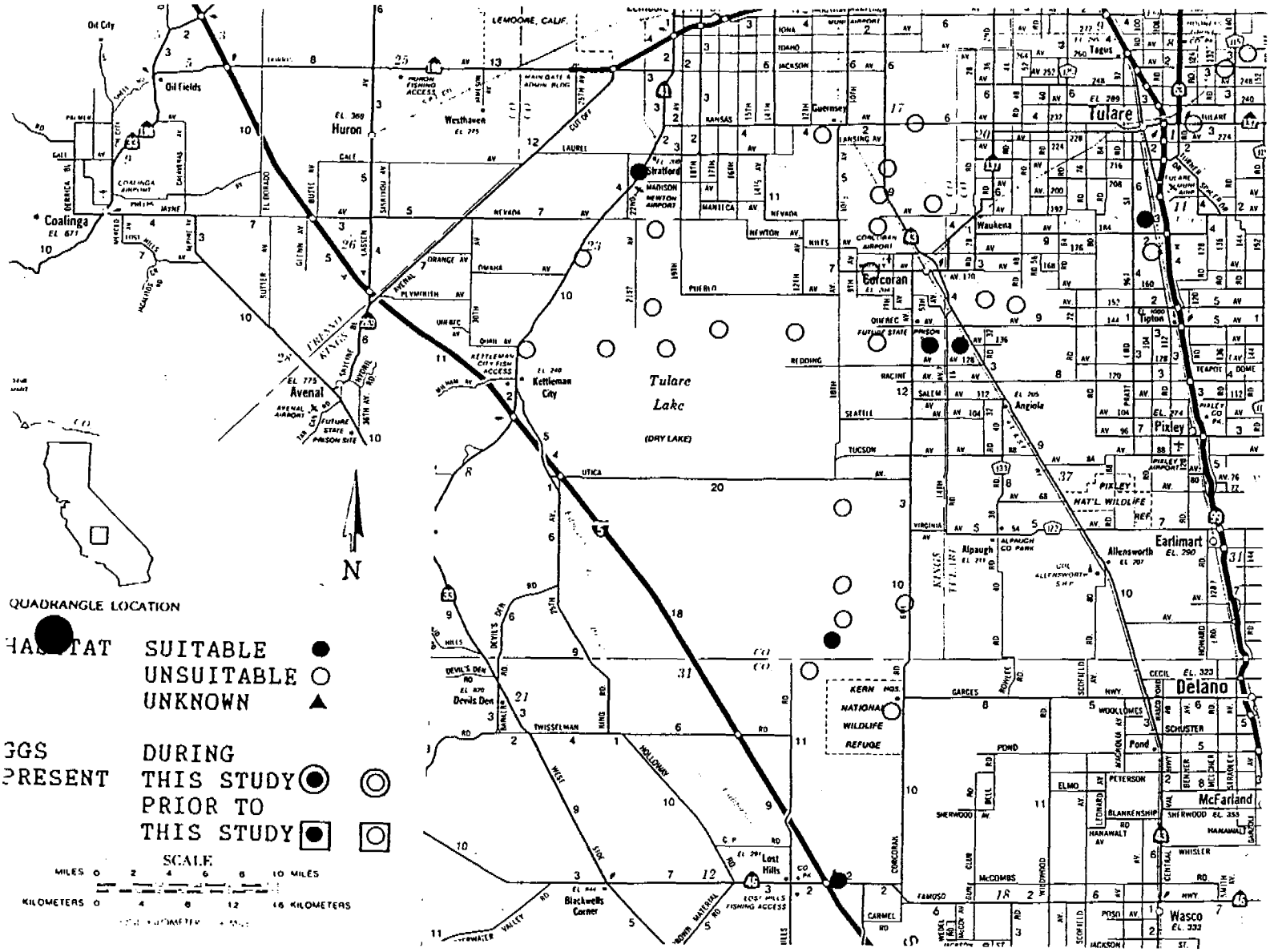

Figure 1b. Distribution of the giant garter snake and its supporting habitat. Small solid circles indicate suitable habitat, small open circles indicate unsuitable environments, and small solid triangles environments of unknown value for GGS. The above symbols are enclosed within an open circle to indicate that GGS were sighted here during this study, or within an open square to indicate that GGS were sighted here prior to but not during this study.

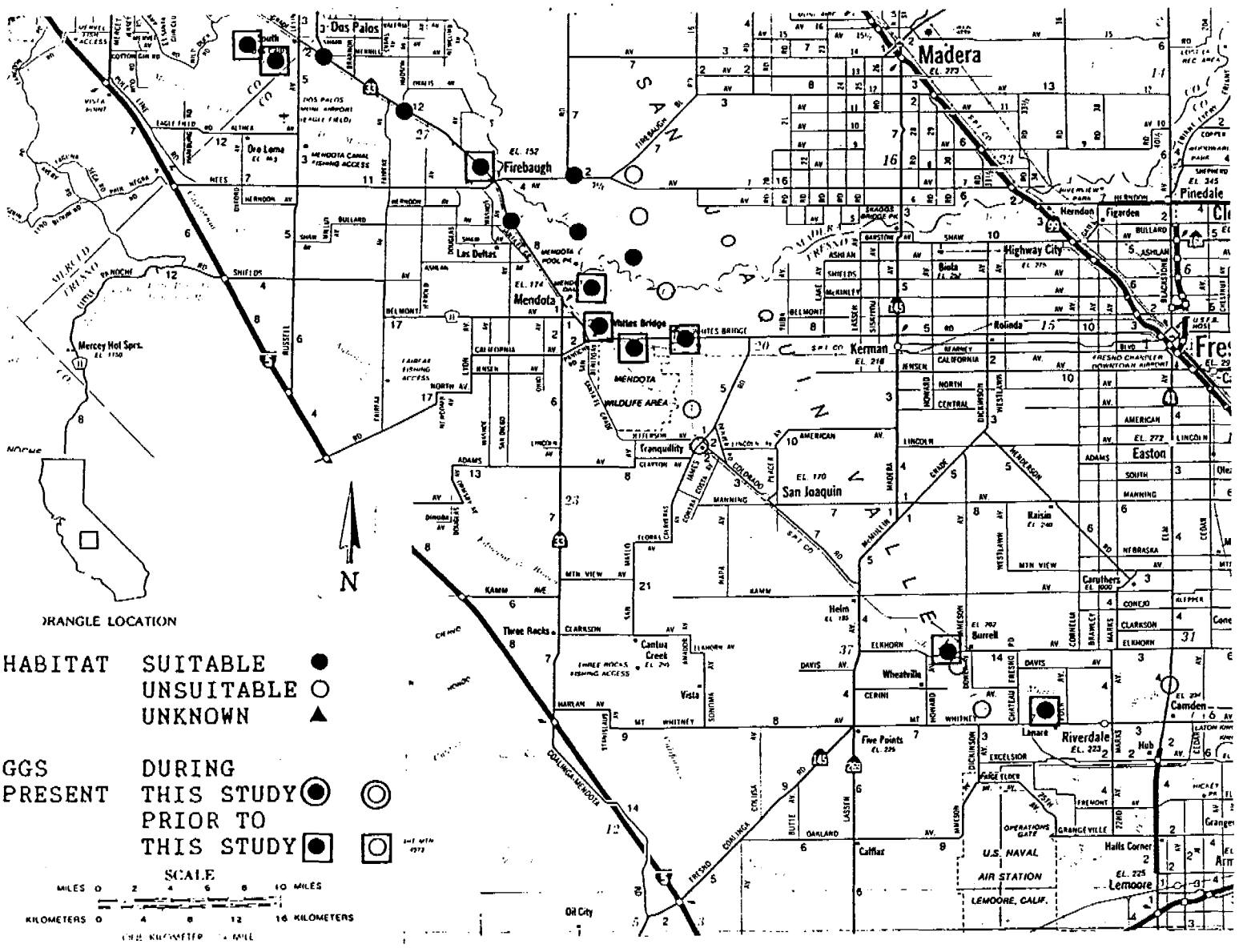

Figure 1c. Distribution of the giant garter snake and its supporting habita
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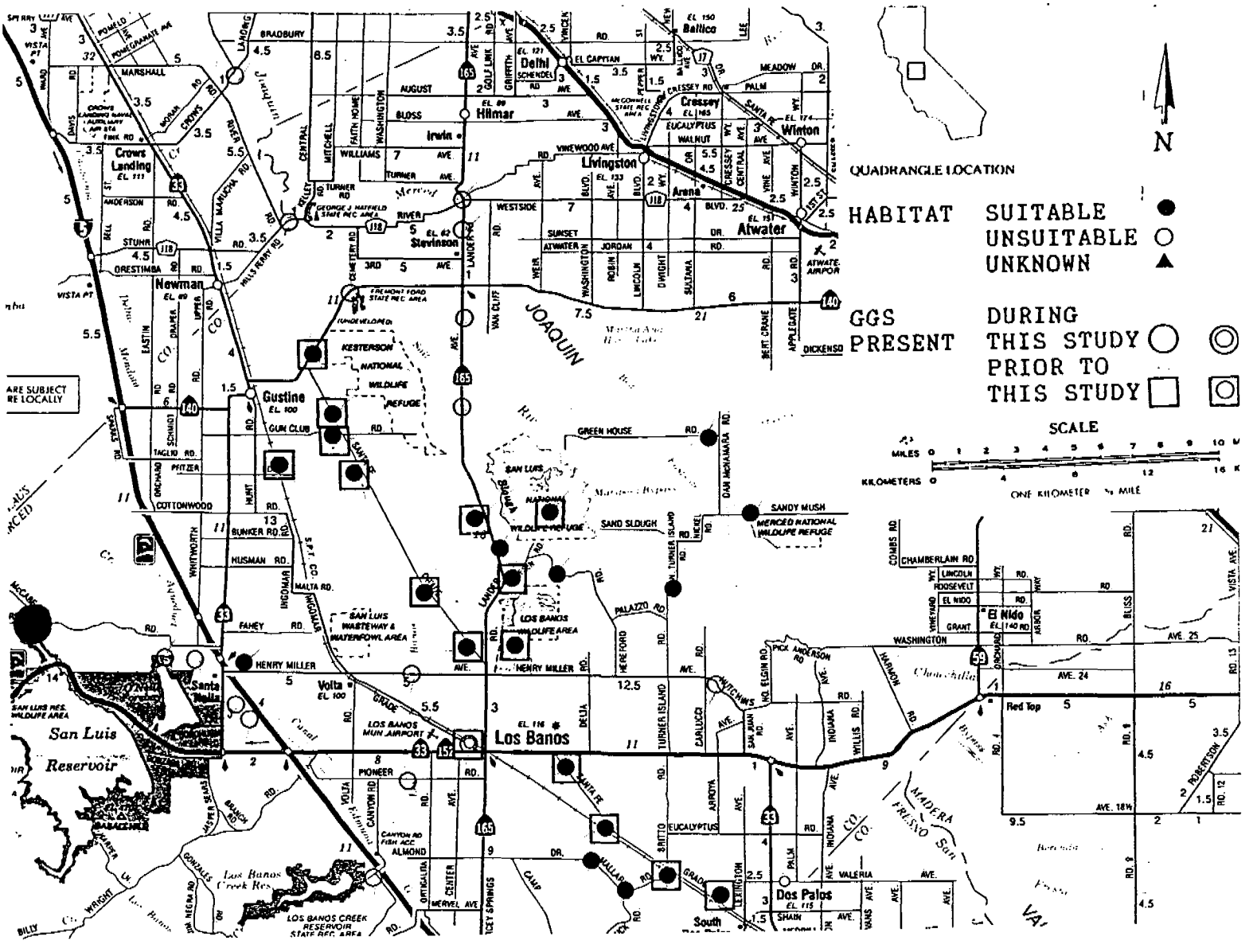

Figure 1d. Distribution of the giant garter snake and its supporting habitat. Small solid circles indicate suitable habitat, small open circles indicate unsuitable environments, and small solid triangles environments of unknown value for GGS. The above symbols are enclosed within an open circle to indicate that GGS were sighted here during this study, or within an open square to indicate that GGS were sighted here prior to but not during this study.

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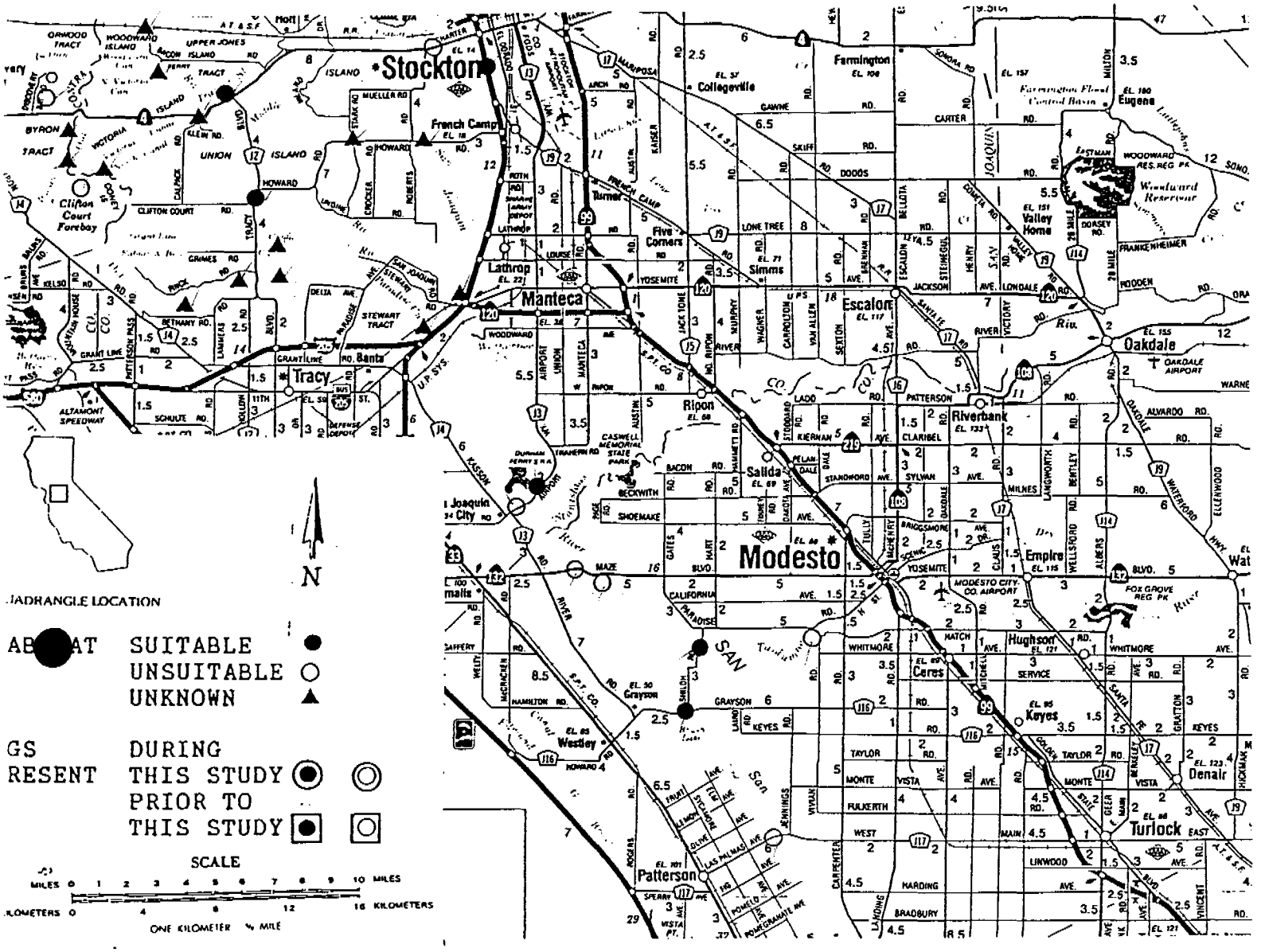

Figure 1e. Distribution of the giant garter snake and its supporting habitat. Small solid circles indicate suitable habitat, small open circles indicate unsuitable environments, and small solid triangles environments of unknown value for GGS. The above symbols are enclosed within an open circle to indicate that GGS were sighted here during this study, or within an open square to indicate that GGS were sighted here prior to but not during this study.

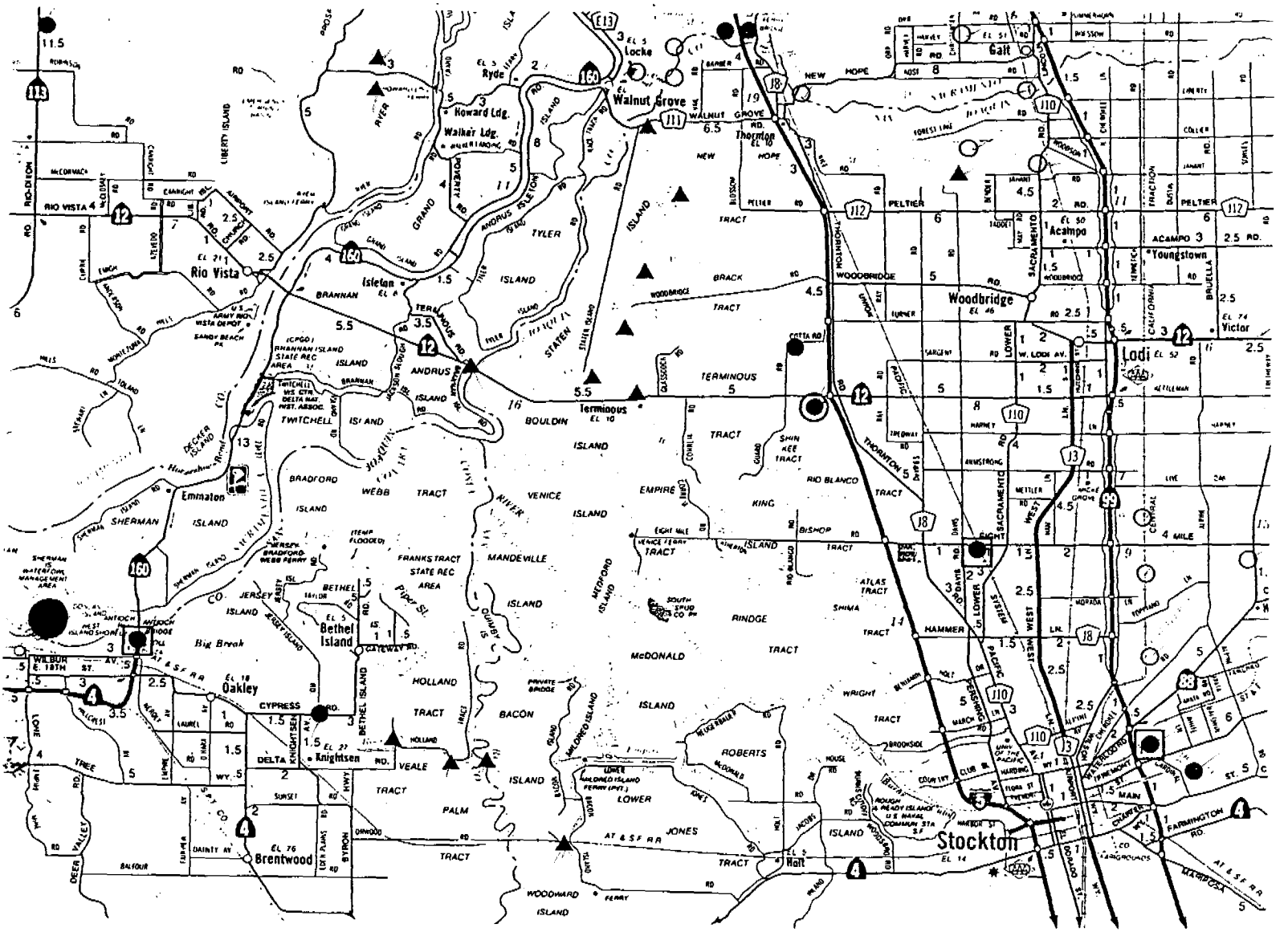

Figure 1f. Distribution of the giant garter snake and its supporting habitat. Small solid circles indicate suitable habitat, small open circles indicate unsuitable environments, and small solid triangles environments of unknown value for GGS. The above symbols are enclosed within an open circle to indicate that GGS were sighted here during this study, or within an open square to indicate that GGS were sighted here prior to but not during this study.

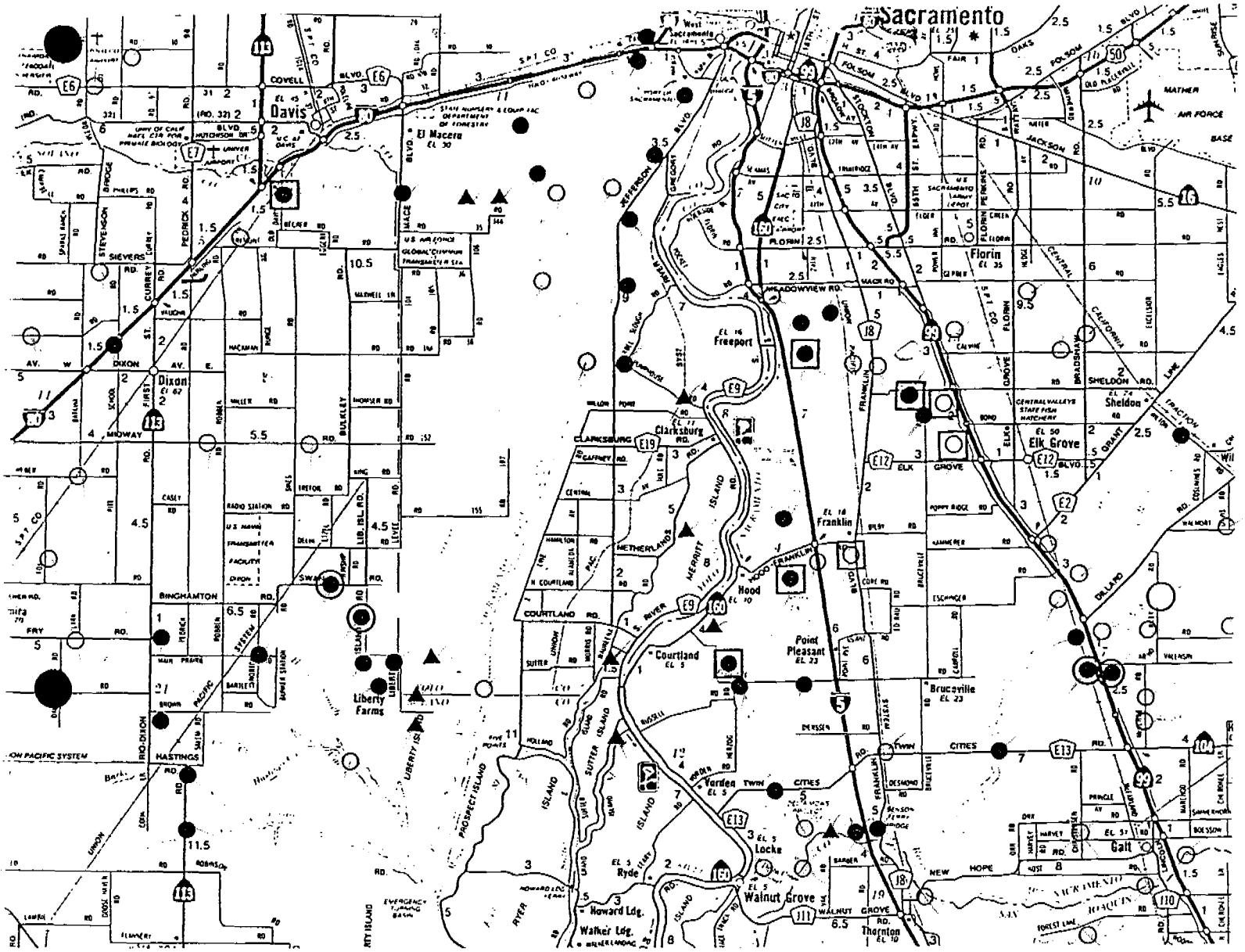

Figure 1g. Distribution of the giant garter snake and its supporting habitat. Small solid circles indicate suitable habitat, small open circles indicate unsuitable environments, and small solid triangles environments of unknown value for GGS. The above symbols are enclosed within an open circle to indicate that GGS were sighted here during this study, or within an open square to indicate that GGS were sighted here prior to but not during this study.

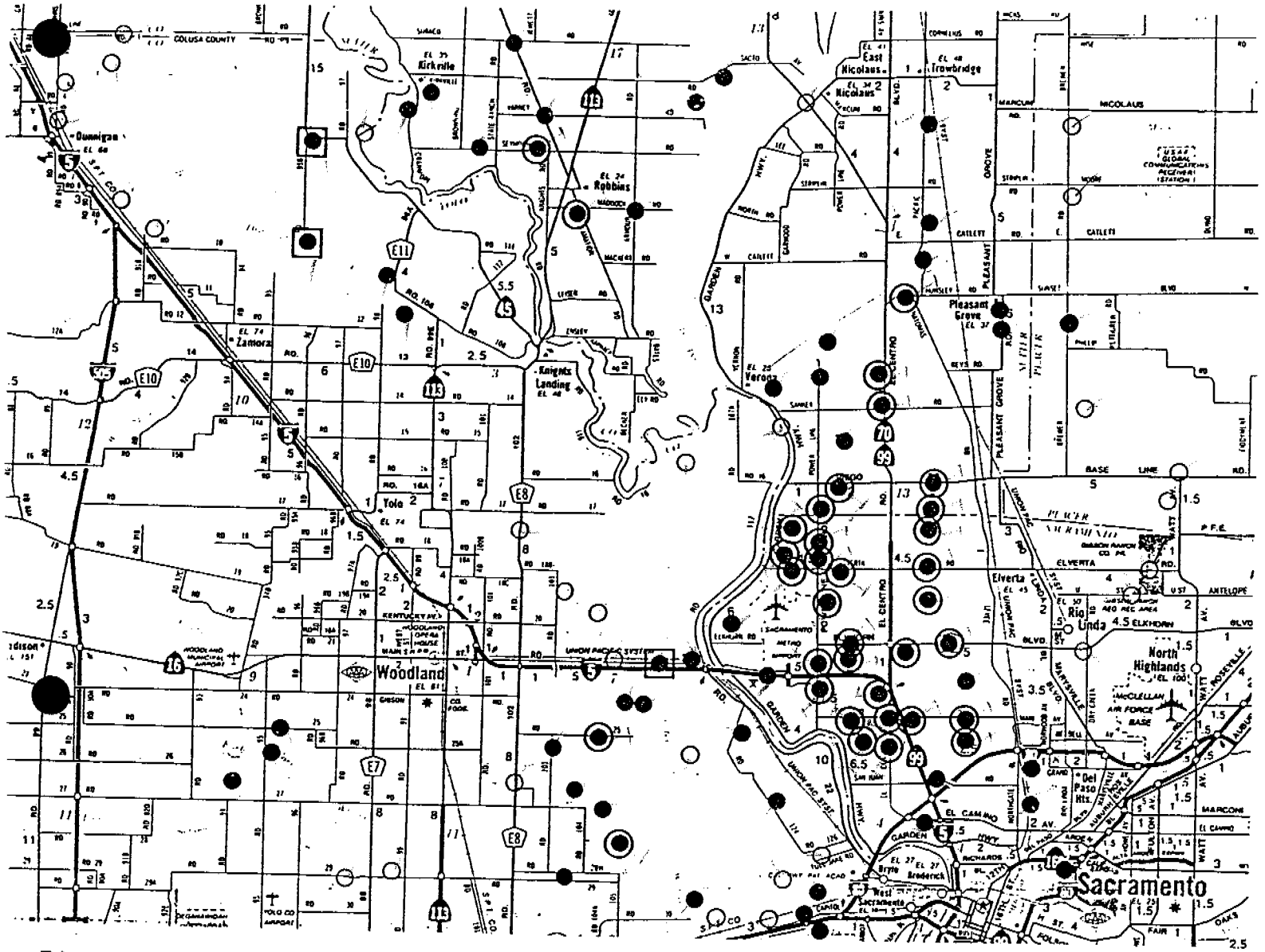

Figure 1h. Distribution of the giant garter snake and its supporting habitat. Small solid circles indicate suitable habitat, small open circles indicate unsuitable environments, and small solid triangles environments of unknown value for GGS. The above symbols are enclosed within an open circle to indicate that GGS were sighted here during this study, or within an open square to indicate that GGS were sighted here prior to but not during this study.

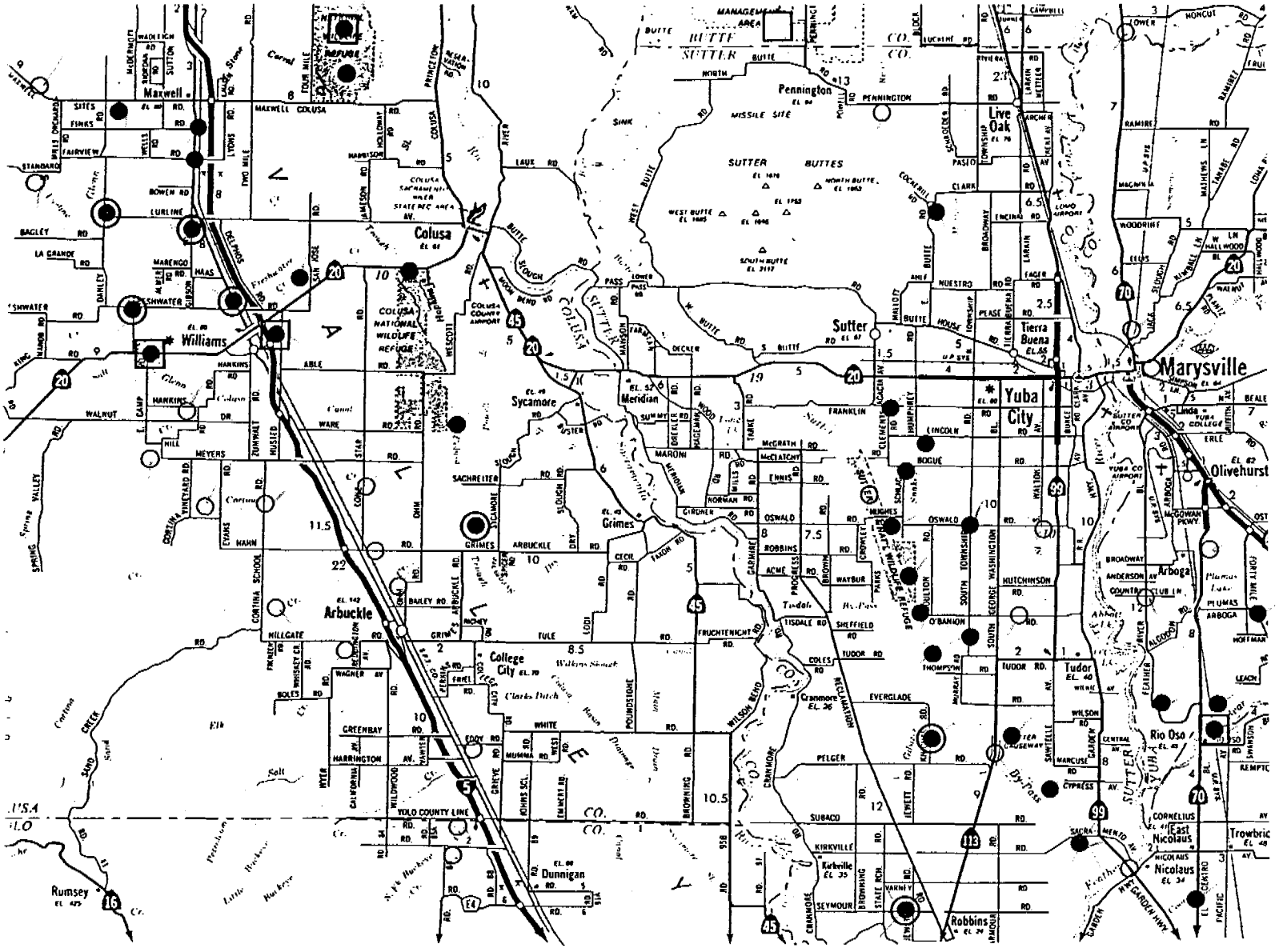

Figure 1i. Distribution of the giant garter snake and its supporting habitat. Small solid circles indicate suitable habitat, small open circles indicate unsuitable environments, and small solid triangles environments of unknown value for GGS. The above symbols are enclosed within an open circle to indicate that GGS were sighted here during this study, or within an open square to indicate that GGS were sighted here prior to but not during this study.

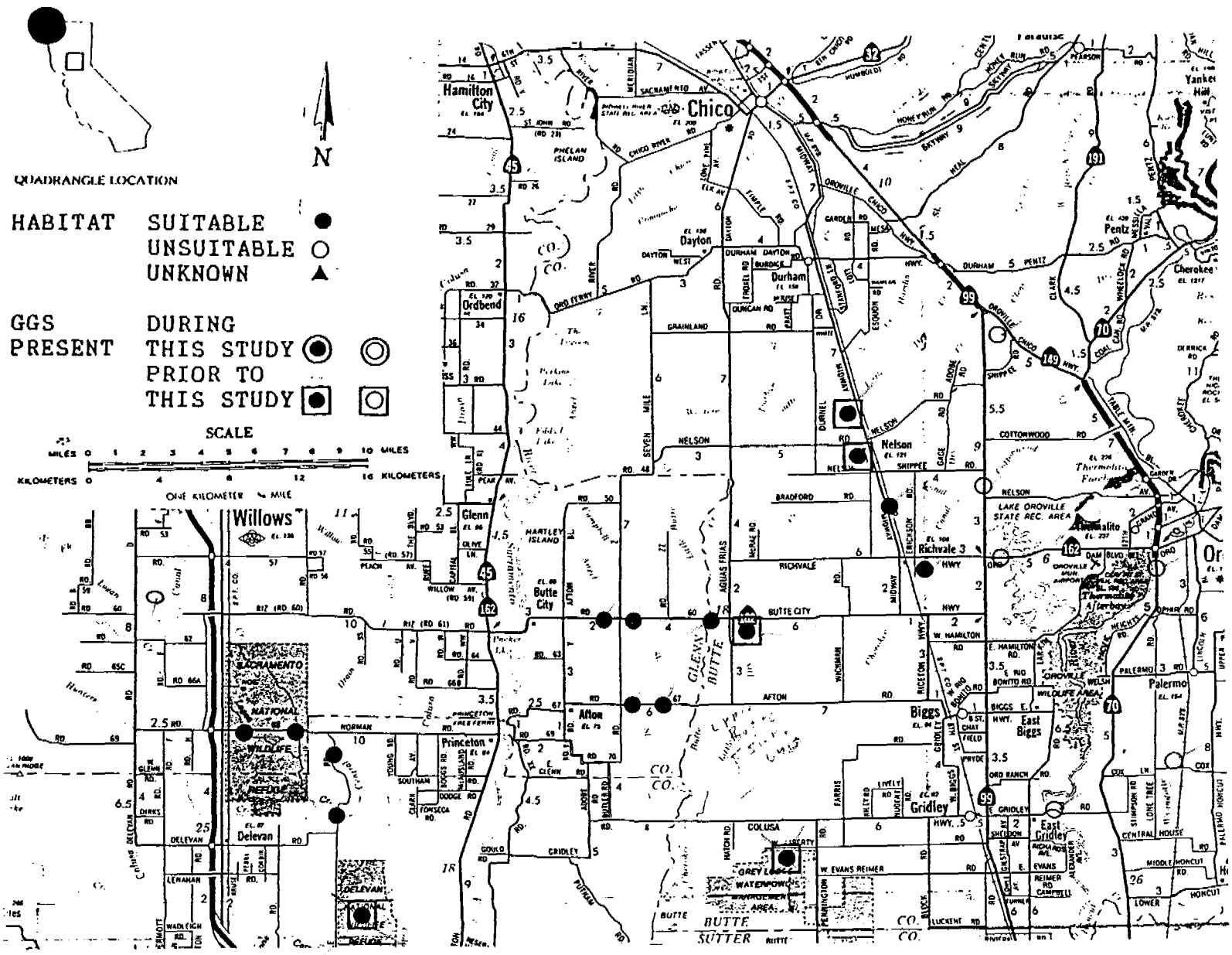

Figure 1j. Distribution of the giant garter snake and its supporting habitat. Small solid circles indicate suitable habitat, small open circles indicate unsuitable environments, and small solid triangles environments of unknown value for GGS. The above symbols are enclosed within an open circle to indicate that GGS were sighted here during this study, or within an open square to indicate that GGS were sighted here prior to but not during this study.

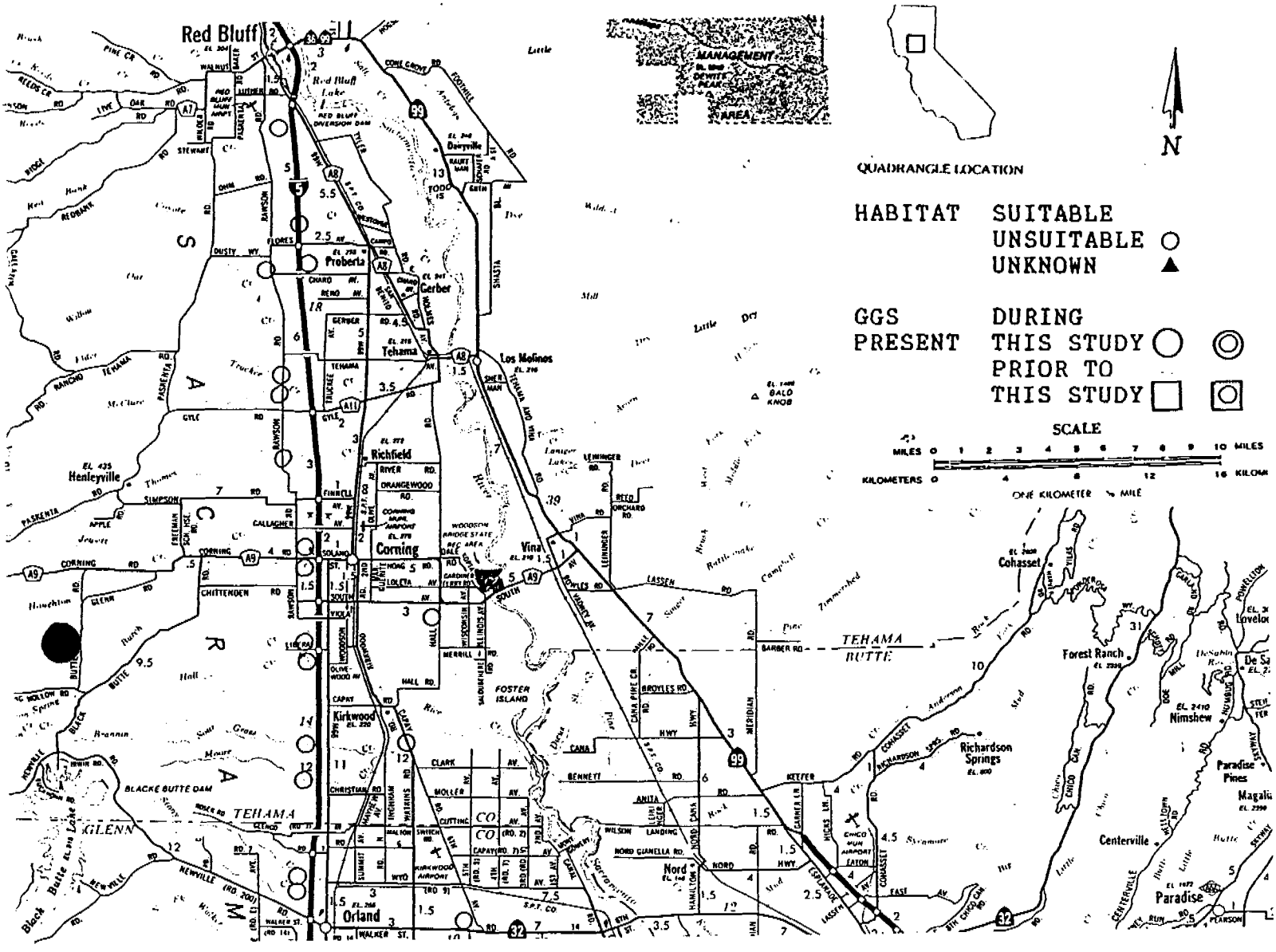

Figure 1k. Distribution of the giant garter snake and its supporting habitat. Small solid circles indicate suitable habitat, small open circles indicate unsuitable environments, and small solid triangles indicate unsuitable environments of unknown value for GGS. The above symbols are enclosed within an open circle to indicate that GGS were sighted here during this study, or within an open square to indicate that GGS were sighted here prior to but not during this study.