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STATUS OF THE SAN FRANCISCO GARTER SNAKE

by

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Inland Fisheries Endangered Species Program

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ABSTRACT

Field studies were conducted on the San Francisco garter snake, *Thamnophis sirtalis tetrataenia*, a reptile endemic to the San Francisco Peninsula in San Mateo County, California. The purposes were to locate surviving populations, ascertain causes for their decline, determine whether the current "endangered" status is justified, and formulate recommendations to preserve the subspecies. Twenty-eight surviving *T. s. tetrataenia* colonies were located, representing 12 populations in discrete creek systems. One formerly large population is believed extinct, due to habitat loss from housing development. The zone of *T. s. tetrataenia-infernalis* intergradation has been largely urbanized, and only two such populations are known to survive. Some *T. s. tetrataenia* populations have declined because of poor land management, freeway construction, and urbanization, all resulting in habitat destruction; overcollecting has depleted at least two colonies. Urban and rural developments are the greatest threats to remaining colonies. Color pattern analysis of the three *T. s. tetrataenia* samples indicates that no hybridization with the allopatric subspecies *T. s. infernalis* has occurred. Although *T. s. tetrataenia* still occupies much of its original range, it warrants "endangered" classification, because most of its known colonies are subject to existing and potential disturbance by man.

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## INTRODUCTION

The San Francisco garter snake, *Thamnophis sirtalis tetrataenia*, a subspecies of the common garter snake, is endemic to the San Francisco Peninsula of California. Populations are known only from San Mateo County. Although apparently suitable habitat exists in San Francisco County, no *T. s. tetrataenia* have been collected there (Banta and Morafka 1966).

Fox (1951) reviewed the complicated taxonomic history of *T. s. tetrataenia*, showing that specimens reported by Cope (in Yarrow 1875; Cope 1892) from the "Pitt" (Pit) River in northeastern California and from the Puget Sound in Washington were actually collected on the San Francisco Peninsula. The subspecific name *tetrataenia* has since been applied only to *T. sirtalis* from San Mateo County.

In recent years, western herpetologists have considered the San Francisco garter snake to be an "endangered species", and it has been so classified by the U. S. Fish and Wildlife Service (50 CFR 17), the International Union for Conservation of Nature and Natural Resources, and by the California Department of Fish and Game. *T. s. tetrataenia*'s decline has been variously attributed to habitat changes due to cultivation (Curry-Lindahl 1972), hybridization with invading individuals of the allopatric subspecies *T. s. infernalis* (Bury 1971), and especially to habitat loss from urbanization (U. S. Bureau of Sport Fisheries and Wildlife 1966; Honegger 1968; Leach and Fisk 1972). Strong statements about the subspecies have appeared in endangered species compendia, suggesting that "...some two-thirds of the distribution area has probably (already) been destroyed" (Honegger 1968), and that *T. s. tetrataenia* is "very rare and endangered" (U. S. Bureau of Sport Fisheries and Wildlife 1966). Such opinions are conjectural, because until 1971 no field studies were conducted to establish the garter snake's status.

From October 1971 through December 1973, and in May 1975, I investigated the distribution and ecology of *T. s. tetrataenia*. This paper evaluates the status of the San Francisco garter snake, discusses apparent reasons for its decline, and recommends measures to insure its preservation. For purposes of this paper, *T. s. tetrataenia* habitat is defined as dense, continuous emergent and bordering vegetation in freshwater marshes. *T. s. tetrataenia* is a semiaquatic snake that seeks refuge in such cover. Its principal food is the red-legged frog, *Rana aurora*, which shares this habitat (Barry, unpubl.). On the San Francisco Peninsula, such habitat occurs at earthquake-fault sag ponds, artificial ponds, coves around large reservoirs, and slow-moving sloughs.

Abbreviations used in this paper are as follows: MVZ - Museum of Vertebrate Zoology, University of California, Berkeley; CAS - California Academy of Sciences, San Francisco; SU - Stanford University Natural History Museum, now deposited but separately catalogued at CAS; LACM - Los Angeles County Natural History Museum, California; CPJM - Coyote Point Junior Museum, San Mateo, California.

## MATERIALS AND METHODS

Fox (1951) stated that *T. s. tetrataenia* favors marshy areas in the vicinity of ponds and lakes. I searched most such habitat in San Mateo County, San Francisco County, and northern Santa Clara County. I first investigated

localities described in the literature, in museum records, and in the late Wade Fox's field notes<sup>3/</sup>. Later, I examined marshes that appeared suitable from maps, photographs, and personal observations.

Personal contacts with people likely to have locality data were unproductive. Most professional herpetologists interviewed had no field experience with the subspecies. Local amateur and professional reptile keepers usually were unable or unwilling to disclose localities. Laymen encountered in the field generally said they had seen "just a garter snake".

I have defined a "population" as all *T. s. tetrataenia* inhabiting a discrete creek system or drainage. *T. s. tetrataenia* located within specific habitats in the population area are defined as "colonies". Although I have no facts to indicate that the snakes in a creek drainage form a single interbreeding community (Mayr 1969), I presume that there is significantly more exchange of snakes between colonies within a creek system than between creeks.

Human land use practices threatening *T. s. tetrataenia* populations were discovered by personal observation, perusal of local newspapers, and interviews with conservation groups, land owners, and administrators. Examination of local pet shops and zoos disclosed the extent of collecting *T. s. tetrataenia*.

Wright and Wright (1957) pointed out that automobiles kill many more snakes yearly than collectors take in the United States. I investigated this factor, nearly every day in July and August 1972, by walking along two highway segments bordering marshes known to contain *T. s. tetrataenia*. The roads were a 0.5 km (0.31 mile) segment of State Highway 35/92 between Lower and Upper Crystal Springs reservoirs, and a 0.4 km (0.25 mile) segment of Canada Road along Upper Crystal Springs Reservoir. The former road connects Half Moon Bay on the coast with East Bay cities via the San Mateo Bridge and receives moderately heavy traffic. The latter road was very heavily traveled by commuters between San Jose and San Francisco, but was superseded in 1973 by the completion of Interstate 280 on the ridge east of the road. Both roads were investigated between 6:00 and 7:00 pm, after the garter snakes' daily activity ceased.

Bury's (1971) suggestion of recent *T. s. tetrataenia-infernalis* hybridization was difficult to evaluate. Stephen B. Ruth (MVZ, pers. commun.), who supplied this information to Bury, said this was based on statements by several well-known Bay Area reptile fanciers who had seen San Mateo County *T. sirtalis* with red *infernalis*-like blotches in the neck region, instead of the continuous red stripes thought typical of *T. s. tetrataenia*. Fox (1951) designated the 216 MVZ specimens he collected at Skyline Boulevard as "pure" *T. s. tetrataenia*. Many specimens in this series have neck patterns similar to the reptile fanciers' idea of "hybrid patterns", and I also collected a few such snakes. My largest samples were from San Andreas and San Gregorio creeks. The percentages of "atypical" patterns in these snakes were compared statistically with those Fox collected.

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<sup>3/</sup> Fox's field notes and journal (1946-47) are deposited at the Museum of Vertebrate Zoology, University of California, Berkeley.

## RESULTS

### Populations

Intense and repeated investigation was required to locate *T. s. tetrataenia*, which is extremely wary. Thus, the locality records (Figure 1, Table 1) probably do not represent all sites where the subspecies occurs.

Only two of the creek systems were previously reported to contain *T. s. tetrataenia*; San Andreas Creek (Fox 1951; Hawken 1951; cf. *T. s. infernalis*), and San Mateo Creek (Fox 1951). Fox (1951) also reported *T. s. tetrataenia* from Sharp Park. Most other nonurbanized creeks in San Mateo County contain seemingly suitable *T. s. tetrataenia* habitat. The gaps in distribution may be due not to lack of habitat, but to lack of intensive investigation.

One population described by Fox (1951) now appears to be extirpated. This was the extensive population along Skyline Boulevard (State Highway 35) between San Francisco and the north boundary of the San Francisco Fish and Game Refuge (Figures 1 and 2). The five colonies were distributed among about a dozen sag ponds known locally as the "Skyline Ponds". Judged by the many museum specimens (MVZ 222 specimens, mostly collected by Fox; SU 25; LACM 1), these were the best-known *T. s. tetrataenia* localities. They were also the only ones consistently reported in the literature (Banta and Morafka 1966; Fox 1951, 1954; Wright and Wright 1957, cf. "2½ miles west of San Bruno").

The Skyline Ponds were destroyed by housing construction between about 1959 and 1966 (Banta and Morafka 1966). However, a new sag pond started to form in mid-1972 on the west side of Skyline Boulevard at the head of Milagra Canyon, 0.5 km (0.31 mile) north of Sharp Park Road. In time, it may become suitable for *T. s. tetrataenia*, because Milagra Canyon is the only remaining natural area in the Skyline Ponds region.

One specimen not mentioned in Table 1 was delivered to Steinhart Aquarium in San Francisco in May 1971. This small male was collected in a vacant lot in urban San Francisco. Since there is no suitable *T. s. tetrataenia* habitat nearby, and no other San Francisco specimens have been recorded, this specimen likely was collected by a pet fancier in San Mateo County and escaped or was released into the vacant lot.

Lake Merced in southwestern San Francisco County seems suitable for *T. s. tetrataenia*, but no museum or literature records exist (Banta and Morafka 1966), and I observed none at the lake. *T. s. tetrataenia* formerly occurred only 6.4 km (4 miles) south of Lake Merced, at the Skyline Ponds. As Fox (1951) stated, there is no obvious reason why these highly mobile snakes should not have found and colonized the lake. However, I feel that because Lake Merced receives heavy public use, colonization by *T. s. tetrataenia* has been discouraged.

Five known *T. s. tetrataenia* populations occur entirely or in part on public lands. The San Andreas Creek, San Mateo Creek, and Upper Crystal Springs Reservoir populations are on the 9,308 ha (23,000 acre) San Francisco Fish and Game Refuge. This refuge is administered by the San Francisco Water Department and contains the large reservoirs that constitute most of the Peninsula water supply. The Ano Nuevo and part of the Pescadero Creek populations are the only ones on State Park property.

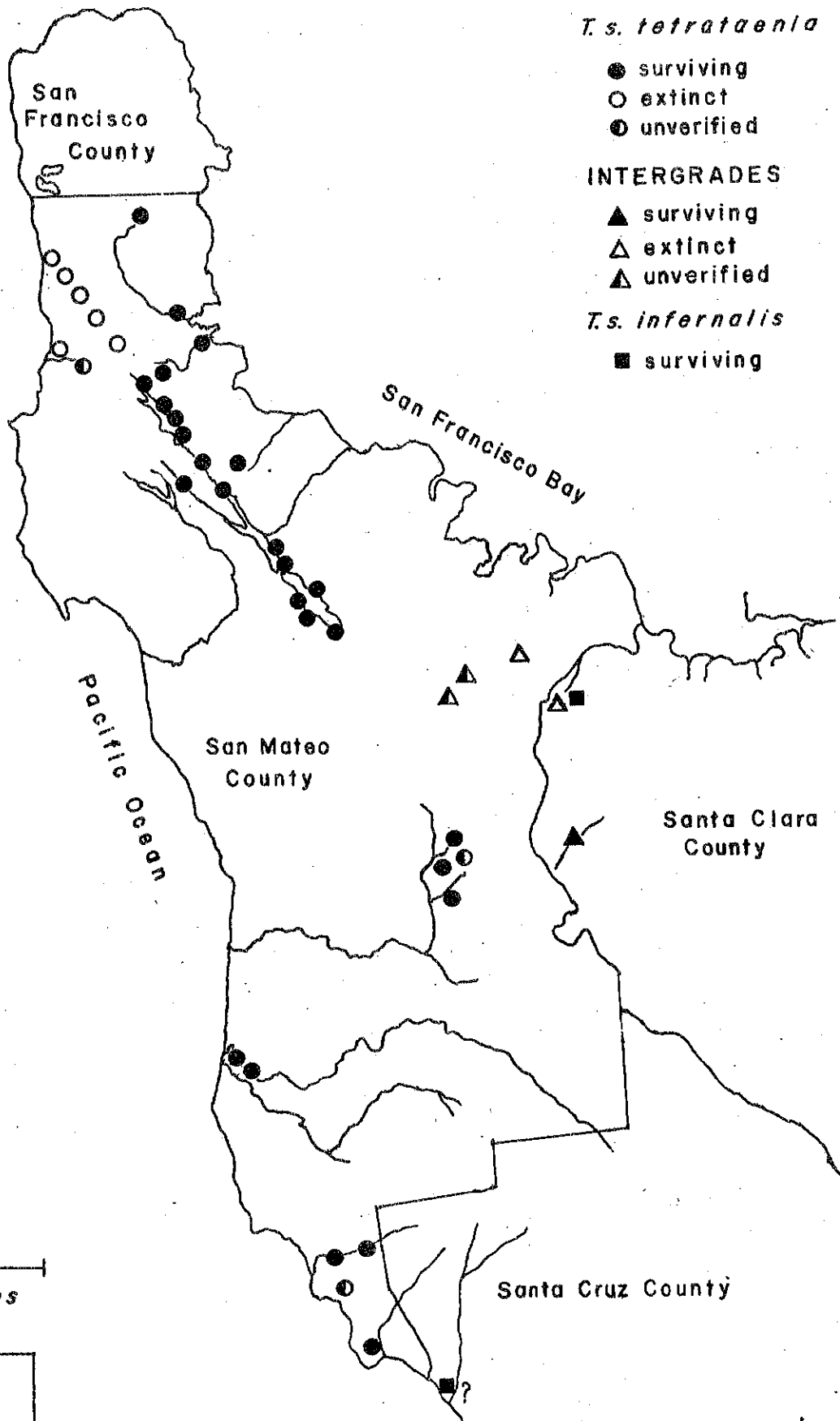


FIGURE 1. Occurrence of *Thamnophis sirtalis* colonies on the San Francisco Peninsula. The questioned Santa Cruz County *infernalis* locality is the Shapovalov and Taft (1954) record, possibly based on *tetrataenia*. Unverified localities after Fox (1951).

TABLE 1. Known Populations of *T. s. tetrataenia* in San Mateo County, California, May 1975.

Creek system	Number observed	Number colonies	Museum vouchers*
Ano Nuevo	10	1	----
Colma	3	2	CPJM 1
Denniston	5	1	----
Pescadero	2	2	LACM 6
San Andreas	81	6	MVZ 3; SU 11; CAS 1; LACM 19
San Bruno	2	2	----
San Gregorio	24	3	----
San Mateo	15	3	MVZ 1
Sanchez	1	1	SU 1
Sharp Park	2	1	MVZ 44
Upper Crystal Springs Reservoir†	17	4	----
Whitehouse	2	2	----
Total	12	164	28
			MVZ 48; SU 12; CAS 1; LACM 25; CPJM 1

\*Vouchers collected before 1969.

†Not impounded in a creek system.

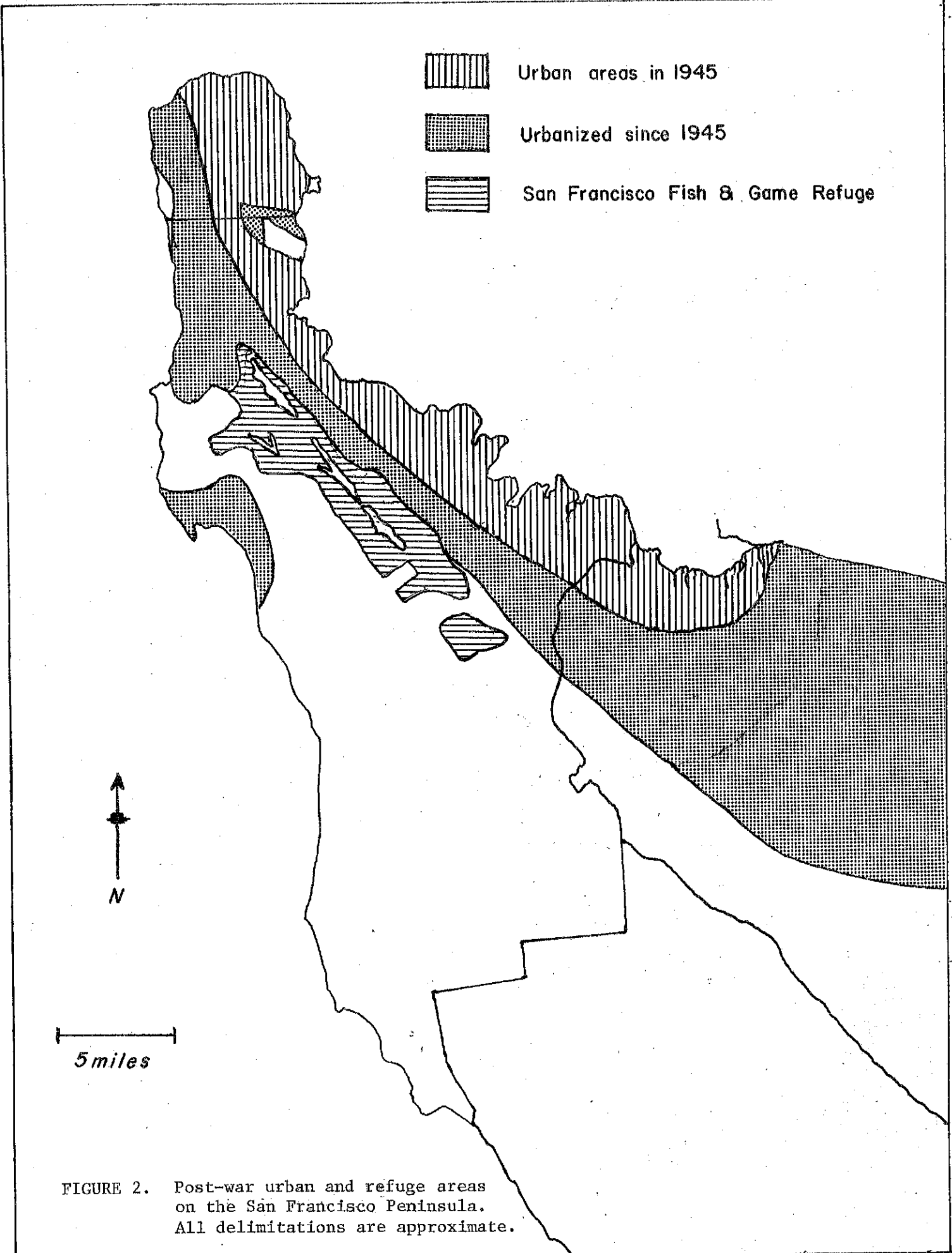


FIGURE 2. Post-war urban and refuge areas on the San Francisco Peninsula. All delimitations are approximate.



Unverified localities (Figure 1) are those reported by Fox (1951) which were impossible to investigate, either because several suitable habitats were within the reported area, or landmarks given were imprecise. These localities are: 1.6 km (1 mile) southeast of Sharp Park (MVZ 10), 3.2 km (2 miles) north of Point Ano Nuevo (MVZ 1), and 8.0 km (5 miles) east of La Honda (MVZ 1). According to Fox's range map, specimens were found near all three localities.

Ano Nuevo Creek constitutes the southernmost known population of *T. s. tetrataenia*. I could detect no intergradation with *T. s. infernalis*, which has been recorded only 3 miles to the south in Waddell Creek, Santa Cruz County (Shapovalov and Taft 1954). The two subspecies appear to be genetically isolated by precipitous cliffs rising from the sea between the mouths of the two streams.

However, intergradation between *T. s. tetrataenia* and *T. s. infernalis* occurs along the boundary between San Mateo and Santa Clara counties (Figure 1). In the past, intergrade populations apparently were more numerous in this area than at present. Only two such populations may now exist (Table 2). The Boronda Creek population is only tentatively included, since it is based on one specimen collected near the headwaters and photographed in 1970 (H. Halstead, Palo Alto Foothills Park, pers. commun.). The specimen is identical to Fox's (1951) description of an intergrade, but the five snakes I found at Boronda Creek were *T. s. infernalis*. All snakes I observed at Lake Lagunita on the Stanford University Campus were *T. s. infernalis*, but the former occurrence of intergrades there is well documented (Fox 1951; Pickwell 1947).

The zone of intergradation has been largely urbanized (Figures 1 and 2), and *T. s. tetrataenia* is now almost completely isolated from *T. s. infernalis*. Lake Lagunita and Boronda Creek were at the southern periphery of intergrade occurrence. Because these intergrade populations became isolated from *T. s. tetrataenia* to the north, but not from *T. s. infernalis* to the south, the latter genotype became predominant.

#### Factors Threatening *T. s. tetrataenia* Populations

All factors threatening the garter snake are man-caused, and all but two existing populations are threatened (Table 3). There is no evidence that natural phenomena have adversely influenced *T. s. tetrataenia*.

#### Freeway Construction

Freeway construction has not eliminated any known *T. s. tetrataenia* populations, but soon may. Two new east-west Peninsula freeways are under construction (Interstate 380) or planned (State Highway 92). Interstate 380 will traverse the northern edge of the San Francisco Fish and Game Refuge (Figure 2), the only large ecological reserve on the Peninsula. To keep siltation from freeway construction from entering San Andreas Reservoir on San Andreas Creek, an earthen catch-basin was planned for the marsh at the north end of the lake. This marsh is the most extensive *T. s. tetrataenia* habitat on the refuge, and its destruction would seriously deplete the subspecies. However, a revised plan has been developed which should remove this threat (J. M. Brode, Calif. Dep. Fish and Game, pers. commun.). State Highway 92 will bridge Upper Crystal Springs Reservoir on the refuge, and unless special measures are taken, may eliminate much *T. s. tetrataenia* habitat (R. C. Rosen, S. F. Water Dep., pers. commun.).

TABLE 2. Localities of Intergrades Between  
*T. s. tetrataenia* and *T. s. infernalis*

(SM = San Mateo County; SC = Santa Clara County)

Locality	Number observed	Number colonies	Museum vouchers*
<u>Surviving</u>			
Boronda Creek (SC)	0 <sup>†</sup>	1	--
8 km south of Pulgas Water Temple (SM)	5	1	--
<u>Extinct</u> <sup>‡</sup>			
Walsh Road, Menlo Park (SM)	0	1 (?)	SU 1
<u>Genetically altered</u>			
Lake Lagunita, Stanford University Campus (SC)	0 <sup>§</sup>	1	SU 22; CAS 2
<u>Unverified</u>			
Hetch-Hetchy water line near Woodside Road (SM)	0	1 (?)	SU 1
4 km north of Stone Circle, Woodside Road (SM)	0	1 (?)	SU 2
Total	6	5	6 (?) SU 26; CAS 2

\*MVZ and LACM material not included.

<sup>†</sup>Five *T. s. infernalis* observed.

<sup>‡</sup>Extinct because of urbanization.

<sup>§</sup>Twelve *T. s. infernalis* observed.

TABLE 3. Factors Threatening *T. s. tetrataenia* Colonies

Population (number colonies)	Number of colonies threatened by*					Total colonies threatened†
	F	U	H	E	C	
Ano Nuevo (1)	-	-	-	-	-	0
Colma (2)	-	1	-	-	1	2
Denniston (1)	-	1	1	-	-	1
Pescadero (2)	-	-	2	-	-	2
San Andreas (6)	1	-	6	1	-	6
San Bruno (2)	-	?	?	-	1	1
San Gregorio (3)	-	-	-	-	-	0
San Mateo (3)	-	-	3	1	1	3
Sanchez (1)	-	1	-	-	-	1
Sharp Park (1)	-	-	?	-	1	1
Upper Crystal Springs (4)	2	-	4	?	?	4
Whitehouse (2)	-	2	-	-	-	2
<b>Total (28)</b>	<b>3</b>	<b>5</b>	<b>16</b>	<b>2</b>	<b>4</b>	<b>23</b>

\*F = Freeway construction; U = Urbanization; H = Temporary habitat loss; E = Extermination by equestrians; C = Collecting pressure

†Since some colonies are threatened by more than one factor, the data in this column are not summations of those in the preceding columns.

### Habitat Management Problems on the San Francisco Fish and Game Refuge

While most management practices on this refuge are not harmful, certain practices adversely affect *T. s. tetrataenia*. The yearly drop in reservoir water levels apparently causes snakes occupying peripheral marshes to disperse, though they recolonize when normal levels are restored. Larval *Rana aurora*, which occupy the shallowest reservoir areas, become isolated in puddles and die before they can metamorphose. However, these water level fluctuations are unavoidable, and both species have survived them for over 100 years.

Emergent growth in certain areas is periodically cut in an effort to control siltation. *T. s. tetrataenia* will not recolonize such areas until at least one generation of new plant growth has died and formed thick mats about the base of a second, living plant generation. My observations indicate that this process takes slightly over a year. This dispersal-recolonization phenomenon was noted in five refuge colonies.

Although the refuge is officially closed to public access, over 1,000 equestrians have permission to enter and ride along established trails. The trails all closely approach *T. s. tetrataenia* colonies. I found two gravid female snakes that had been crushed and decapitated along these trails, presumably trampled by horses.

The *T. s. tetrataenia* colonies on the refuge are mostly small and scattered, approaching continuity only on Upper Crystal Springs and San Andreas reservoirs. Mass dispersal caused by repeated (though temporary) habitat destruction probably exposes the snakes to more hazards than usual. This is reflected by the fact that there are many fewer snakes than the available habitat could support.

### Collecting Pressure

*T. s. tetrataenia* has been in demand as a pet, particularly by Bay Area reptile dealers and collectors. The 17 such people I interviewed generally agreed that this snake was popular for three reasons: the subspecies is distinctive and strikingly beautiful, it was, until 1966, easily obtained at the Skyline Ponds, and it does well in captivity. For these reasons, probably several hundred *T. s. tetrataenia* were removed from the Skyline Ponds between 1956 and 1965 (K. Switak, Steinhart Aquarium, S. F., pers. commun.). One dealer shipped a few dozen specimens to the east coast, Canada, and Germany, but the majority were sold and kept in the Bay Area. The Skyline population apparently withstood these inroads, as the snakes were still abundant until the ponds themselves were destroyed in the mid-1960's (R. Drewes, CAS, pers. commun.).

*T. s. tetrataenia*'s inclusion on endangered species lists has stimulated demand among collectors. As the Skyline population became extirpated, collectors directed their efforts elsewhere. At least two colonies, that at Laguna Salada of the Sharp Park Golf Course and one on Lower Crystal Springs Reservoir (San Francisco Fish and Game Refuge), were affected by these activities. Two reptile dealers referred to the Sharp Park locality as formerly a popular haunt for collectors "...until the snakes got so scarce there that it wasn't worthwhile." The Crystal Springs colony was also consistently mentioned as a collecting site. Access to the latter colony was not allowed; but, according

to the dealers, the fence, signs, and regulations were ignored. Both colonies still reflect these depredations. Despite the continued presence of large areas of suitable habitat, my success in finding *T. s. tetrataenia* at each site was notably low: two snakes in 350 man-hours of search at Sharp Park, and one snake in 50 man-hours at Crystal Springs. Elsewhere, in remote habitats on Lower Crystal Springs, the snakes are abundant (nine snakes in 5 man-hours of search). Sharp Park cannot be so compared because there are no nearby habitats.

The Skyline population was able to withstand strong collecting pressure, unlike the Sharp Park and Crystal Springs populations, because the sag pond habitat was optimal for the subspecies. If the few remaining Peninsula sag ponds can be compared to the Skyline Ponds (which were much larger), the numbers of *T. s. tetrataenia* once present along Skyline Boulevard were sufficient to withstand the removal, over a period of about 10 years, of even hundreds of specimens. The Sharp Park and Crystal Springs populations were unable to tolerate such pressure for four reasons: the collecting pressure was more intense, these habitats were much smaller, the population levels were relatively lower to begin with, and other detrimental factors (such as the habitat management at Crystal Springs and the daily presence of golfers at Sharp Park). Since the latter three factors are still operating (Table 3), *T. s. tetrataenia* colonies cannot withstand future intense collecting pressure.

Collectors continue to illegally take *T. s. tetrataenia*. I know of 21 adult snakes taken from various localities since 1969; seven went to zoos, and the rest were kept by collectors or dealers. One gravid female given to Steinhart Aquarium in San Francisco bore 24 young.

#### Urbanization

There has been a tremendous post-World War II proliferation of housing and related projects in formerly undisturbed Peninsula regions. Nearly all of San Francisco County and Peninsular Santa Clara County and about 35% of San Mateo County have been urbanized (Figure 2). As stated earlier this has eliminated the large *T. s. tetrataenia* population at Skyline Ponds and also most of the intergrade populations. Urbanization is still the major threat to the subspecies.

The Colma, San Bruno, and Sanchez Creek populations are completely surrounded by urban sprawl, and any interchange between those and other populations, or even between colonies on those creeks, now seems unlikely. The Denniston Creek population is threatened by the proposed dredging and deepening of the existing reservoir to provide more water for coastal developments, which in turn will eventually threaten other *T. s. tetrataenia* populations. The Whitehouse Creek population is threatened by the proposed development of a campground (Hollis 1972). Mitigation measures have been proposed only for the Denniston project, but are not adequate to preserve the *T. s. tetrataenia* population (J. M. Brode, pers. commun.).

The San Mateo County Conservation and Open Space Plan (San Mateo County Planning Department 1973) proposed that most new urbanization be confined to the limits shown in Figure 2 of this paper. If this is adhered to, some of the threat to *T. s. tetrataenia* will be negated. However, the county's proposal also includes long-term acquisition of large tracts for use as county parks. The decline of

*T. s. tetrataenia* in "natural areas" subjected to unrestricted human use, such as at Sharp Park and perhaps historically at Lake Merced, indicates that such use is detrimental to the garter snake. Unless *T. s. tetrataenia* colonies within these proposed parks are partially or completely protected from human disturbance, the garter snakes will suffer additional mortality.

#### Factors not Threatening *T. s. tetrataenia* Populations

The following three factors seemingly have not adversely affected *T. s. tetrataenia* populations: road kills, hybridization, and agricultural practices.

##### Road Kills

The results of the search for road-killed *T. s. tetrataenia* are as follows: 39 road-killed snakes were found on the sections of highways mentioned earlier, including 18 racers (*Coluber constrictor*), 1 striped racer (*Masticophis lateralis*), 7 gopher snakes (*Pituophis melanoleucus*), 12 western terrestrial garter snakes (*Thamnophis elegans*), and 1 western rattlesnake (*Crotalus viridis*). No *T. s. tetrataenia* were found, very likely because of its wariness and tendency to remain near riparian cover.

Robert Rosen (pers. commun.) reported one road-killed *T. s. tetrataenia* from Canada Road in June 1972, and at least three of the 216 MVZ Skyline Pond specimens collected by Fox were road kills. However, road kills are apparently a minor mortality factor.

##### Hybridization With *T. s. infernalis*

The continuous lateral red pattern of *T. s. tetrataenia* (Figure 3A) is quite distinct from the blotched pattern of *T. s. infernalis* (Figure 3D). The pattern of an intergrade from the southeastern Peninsula (Fox 1951) consists of smaller but more numerous and scattered red blotches (Figure 3C). The blotched pattern considered by Bury (1971) to be that of a "hybrid", "intergrade", or "swamped-out *T. s. tetrataenia*" is apparently only a variation of the true *T. s. tetrataenia* (Figure 3B). The blotches persist only in the neck region; posteriorly, the diagnostic red stripe of *T. s. tetrataenia* is present in all individuals.

As stated earlier, Fox (1951) and I collected such "atypical" specimens, and the results of the percentage comparisons revealed lower percentages of atypically patterned (similar or identical to Figure 3B) specimens in my series, with no statistically significant differences among the samples (Table 4). Since Fox's sample was collected in 1946-48 and mine in 1972-73, the lack of significant differences between the samples, combined with lower percentages of aberrants in my series, suggests that hybridization with *T. s. infernalis* has not occurred. Since these series were collected 26 years apart, it appears that the atypical pattern is simply a balanced polymorphism within the subspecies rather than an effect of recent hybridization with invading *T. s. infernalis*.

##### Agricultural Practices

Agricultural practices generally have not threatened *T. s. tetrataenia* for the following reasons: (1) Peninsula ranches require ponds or reservoirs for

← ANTERIOR



A. *T.s.tetrataenia*



B. *T.s.tetrataenia*  
Variation



C. Intergrade



D. *T.s.infernalis*

*C. van Dyke*

FIGURE 3. Lateral arrangement of red markings (light areas) on Peninsula *Thamophis sirtalis*. The anterior edge of pattern B corresponds to the 11th ventral scale.

TABLE 4. Percentage Comparison of Atypical Color Patterns in Three *T. s. tetrataenia* Populations

Population	Number "atypical"	Number "typical"	Total	% atypical
<u>1946-48 (Fox)</u>				
Skyline Ponds	27	189	216	12.5
<u>1972-73 (Barry)</u>				
San Andreas Creek	8	73	81	9.8
San Gregorio Creek	2	22	24	8.3
$\chi^2$ tests				
Skyline Ponds	27	189	216	$\bar{p} = 0.125$
San Andreas Creek	8	73	81	$\bar{p} = 0.098$
$\chi^2 = 0.38; \chi^2 p \approx 0.4^*$				
Skyline Ponds	27	189	216	$\bar{p} = 0.125$
San Gregorio Creek	2	22	24	$\bar{p} = 0.083$
$\chi^2 = 0.35; \chi^2 p \approx 0.4^*$				

\*  $\chi^2$  table estimates of probability (from Simpson, Roe, and Lewontin 1960) indicate that there are no significant differences between the Skyline Ponds and San Andreas and San Gregorio populations, at one degree of freedom and the 0.05 significance level.



irrigation and livestock, and such impoundments have provided new *T. s. tetrataenia* habitat; (2) none of the 15 ranchers interviewed considered garter snakes "vermin"; (3) most upland Peninsula ranches are devoted to livestock production and do not use pesticides (San Mateo County Planning Department, 1973); (4) all ranchers contacted controlled mosquitos with the mosquitofish, *Gambusia affinis*. Further, in this well-drained, ruggedly contoured peninsula, it is doubtful that pesticides long remain in terrestrial or freshwater habitats. The continued existence of such land has benefited *T. s. tetrataenia*. However, some Peninsula ranchers have complained recently of diminishing profits and wish to subdivide their lands for urban and resort developments (Hollis 1972).

Marsh reclamation projects are the only obviously inimical agricultural practices. For example, portions of the largest garter snake habitat remaining, Pescadero-Butano marsh, are being converted to cultivation; this is also true of some other coastal marshes. The accompanying removal of emergent vegetation will certainly reduce the *T. s. tetrataenia* populations in these areas.

#### STATUS

The status of the San Francisco garter snake as a threatened taxon is not clear-cut. *T. s. tetrataenia* is on endangered species lists solely because the prime Skyline Ponds habitat was destroyed, and no other colonies were definitely known to exist at the time (R. C. Stebbins, MVZ, pers. commun.). In light of its actual widespread occurrence, the extinction of this one population is no longer sufficient reason to consider this garter snake endangered. Nor does *T. s. tetrataenia* easily fit criteria for the "endangered" category of the California Fish and Game Commission. The Commission requires that, to be considered endangered, a taxon as a whole be affected by at least one of several detrimental influences (Leach and Fisk 1972). At some localities, this snake is currently abundant and not threatened; at others, its situation is extremely precarious.

Much better evidence for "endangered" status is that the subspecies has a very limited range which is nearly surrounded by dense human population centers. These can only be expected to enlarge and place more pressure on *T. s. tetrataenia* populations, inadvertently or not. Further, 23 of the 28 known colonies are already subject to human disturbance or are threatened with destruction (Table 3).

The San Francisco Fish and Game Refuge cannot be considered guaranteed habitat for *T. s. tetrataenia*. The refuge exists to provide water for Peninsula residents and is secondly a wildlife refuge.

Since there are no refugia specifically set aside for *T. s. tetrataenia* on the San Francisco Peninsula, and since there is every chance that more habitat will be destroyed to make way for human activities, I feel that the San Francisco garter snake warrants "endangered" classification. The subspecies should be considered endangered until sufficient refugia are set aside to insure protection and are managed solely for the biota.

#### CONCLUSIONS AND RECOMMENDATIONS

The San Francisco garter snake is not yet so endangered that extreme measures are required to preserve it. This garter snake can be perpetuated by (1) judicious

Peninsula land planning; (2) creation of reserves at freshwater habitats; and (3) enforcement of protective laws. These are hardly extreme measures, and their institution would protect all Peninsula wildlife.

Of special concern should be the protection of the three largest *T. s. tetrataenia* habitats: Pescadero-Butano marsh, Laguna Salada at Sharp Park Golf Course, and the northern periphery of San Andreas Reservoir on San Andreas Creek. If current human disturbances are diminished substantially, these habitats could each support hundreds of *T. s. tetrataenia*. Those colonies now subject to multiple detrimental influences also require immediate attention (Table 3).

Refuge status for the San Mateo County coastal creek marshes would protect many unique life forms besides *T. s. tetrataenia*, and preserve an extremely valuable and fast-declining ecosystem. Peninsula sag ponds are now unique habitats, and should be identified, acquired, and protected. Sloughs near the San Francisco International Airport, which contain part of the Colma and San Bruno Creek populations, are on land reserved for power line right-of-way. This important habitat should remain undisturbed and the snakes protected from collectors.

Agencies administering public lands should be advised of *T. s. tetrataenia*'s legal status and the need to prevent further habitat disturbance. Environmental Impact Reports for Peninsula developments should consider possible adverse consequences to *T. s. tetrataenia* habitat, and should propose mitigation measures.

Land owners and agencies should allow bordering and emergent vegetation to persist around impoundments. The San Francisco Water Department should be requested to alter its vegetation removal procedures as follows: the plants should be cut only as required to prevent siltation, and the cut vegetation should be piled on the margins of the reservoirs where it was cut. This will serve Water Department and habitat preservation interests equally.

Existing protective laws need enforcement. More time should be allotted to patrolling vulnerable colonies. Local prosecutors should be advised of the importance of protecting this garter snake from collectors. Administrators should inform all visitors to the San Francisco Fish and Game Refuge and other public lands that *T. s. tetrataenia* is endangered and is protected by State and federal laws.

Many problems could be averted with better public education about the subspecies, emphasizing its rarity and endemic status. Most Peninsula residents are unaware of the existence of this distinctive reptile. Knowledge that a unique animal occurs in San Mateo County might foster better appreciation of the rapidly disappearing Peninsula natural areas.

More information needs to be obtained about *T. s. tetrataenia* distribution and habits. Fox (1954) found only *T. s. infernalis* in Marin County, north of the Golden Gate, but some *T. s. tetrataenia* were introduced near Point Reyes National Seashore in the early 1960's (J. Kipping, Strybing Arboretum, San Francisco, pers. commun.). The status of this introduction should be ascertained. The status of *T. s. tetrataenia* in northern Santa Cruz County creeks should also be investigated.

Population interchange, dispersal patterns, and other life history data are needed if biologically meaningful refuges are to be created.

Relocation and transplantation are often suggested as means of preserving endangered taxa, but, in *T. s. tetrataenia*'s case, they are unsound and inadvisable.

Relocation of *T. s. tetrataenia* away from the San Francisco Peninsula would be biologically unsound because other *T. sirtalis* subspecies, with which *T. s. tetrataenia* can presumably interbreed, are present throughout the United States and most of Canada (Wright and Wright 1957). Since the subspecies evolved only on the Peninsula, logically it can survive in the wild only there, at least as a taxonomic entity.

It is currently unnecessary to transplant *T. s. tetrataenia* from one habitat to another within the Peninsula, because no locality is in immediate danger of destruction. Further, many of the populations are quite distinct in terms of size of individual snakes, meristics, and color intensity. Thus, it would be undesirable to mix the populations.

Captive breeding is a frequently suggested method to preserve *T. s. tetrataenia* (U. S. Bureau of Sport Fisheries and Wildlife 1966; Honegger 1968; Leach and Fisk 1972). However, such projects are best reserved as last-resort measures, to be employed only when extinction in the wild is certain. Breeding projects furthermore entail certain risks: (1) removal of healthy animals from the wild may adversely affect the populations, accelerating local or total extinction; (2) captive conditions in which unfavorable genotypes are permitted to survive may increase the frequency of detrimental genes, and if animals with these genotypes were reintroduced to the wild, they probably would not survive; and (3) captive animal colonies are subject to epidemics.

A *T. s. tetrataenia* breeding project was undertaken in 1972 by Steinhart Aquarium in San Francisco. The announced intention was to preserve the "purity" of the subspecies by mating, producing, and inbreeding only the "best-looking" specimens (K. Switak, pers. commun.). Five adults and a litter of 24 were accumulated for the project, but the specimens died in a protozoan epidemic. Such typological projects are obviously inappropriate and the risks outweigh the benefits. The best argument against captive breeding projects remains that *T. s. tetrataenia* can readily be preserved in the wild.

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