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INVESTIGATIONS ON THE OCCURRENCE OF THE SAN FRANCISCO GARTER SNAKE AT THE STANFORD LINEAR ACCELERATOR CENTER

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INTRODUCTION

The San Francisco garter snake (*Thamnophis sirtalis tetrataenia*) is a subspecies of the common garter snake restricted to the San Francisco Peninsula of central California. It occurs through much of San Mateo County, and intergrades with the California red-sided garter snake (*Thamnophis sirtalis infernalis*) in the southeastern Peninsula (Figure 1). *T. s. tetrataenia* is fully protected as an "endangered species" by the state and federal governments (Leach et al. 1976; U. S. Bureau of Sport Fisheries and Wildlife 1973).

The Stanford Linear Accelerator Center (SLAC) contains a two-mile linear tube and associated structures, located in the southeastern San Mateo County. Recently, a major addition to the facility, the Positron-Electron Project (PEP), has been authorized for construction. This

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facility will be a tube and associated apparatus originating and terminating at the eastern end of the linear accelerator, and describing enroute a hexagon 700 meters in diameter (Figure 2). The PEP project is funded by the Energy Research and Development Administration (ERDA), formerly the Atomic Energy Commission.

The federal Endangered Species Act of 1973 provides that any construction or other development supported by federal funds shall have minimal impact on any species federally classified as "endangered." It was therefore necessary to determine if *T. s. tetrataenia* inhabits the proposed PEP site or any other area of SLAC. This paper reports investigations into this problem, undertaken during July 1976.

TAXONOMIC AND DISTRIBUTIONAL CONSIDERATIONS

The common garter snake (*Thamnophis sirtalis*) is the most widely-ranging reptile in the United States. It occurs from the Atlantic to the Pacific Coasts, and from the Gulf Coast to northern Canada. About 11 subspecies are currently recognized, of which *T. s. tetrataenia* is the most restricted. *T. s. tetrataenia* is closely related to the California red-sided garter snake, *T. s. infernalis*, which occupies most of coastal California except for San Mateo County. The vicinity of Stanford University and Palo Alto is commonly recognized as a "zone of intergradation" of these two subspecies. Such intergradation areas usually contain animals that combine characteristics of the parent subspecies, although various modifying genes may produce animals unlike either progenitor. *T. s. tetrataenia-infernalis* intergrades thus resemble both subspecies, yet are obviously different.

The principal character used to differentiate the various genetic morphs of coastal *T. sirtalis* is the condition of the lateral red markings. *T. s. tetrataenia* (Figure 3A) usually possesses a lateral red stripe. *T. s. infernalis* (Figure 3C) is uniformly blotched with red. The most common intergrade pattern (Figure 3B) is one of random blotches.

Although the Stanford vicinity was formerly a well-known intergrade locality, *T. s. infernalis* has apparently replaced intergrade snakes in this area, particularly at Lake Lagunita on the Stanford Campus (Barry, in prep.). The genetic status of snakes possibly occurring at Searsville Lake near SLAC is unknown. The nearest known true intergrade population to SLAC is in the vicinity of the junction of Edgewood and Cañada Roads in Redwood City, some five miles northwest of SLAC. Any *T. sirtalis* at or near SLAC are probably *T. s. infernalis*, although a few *T. s. tetrataenia* genes certainly persist in the population.

Peninsula *T. sirtalis* most commonly occupy marshy areas around ponds, lakes, and along streams and sloughs. Typical associated plant species are tules (*Scirpus* species), cattails (*Typha* species), and various rushes and sedges. Such vegetation provides ample cover, particularly for San Francisco garter snakes, which are very brightly colored, and such marshes often contain frogs, which *T. sirtalis* commonly eats.

METHODS AND RESULTS

Five areas of SLAC appear to contain possible *T. sirtalis* habi-

tat; three of these are in the area of the proposed PEP site. These habitats are small drainage gullies on gently sloping hills. Three of these drain directly into San Francisquito Creek (Figure 2); the other two terminate in sumps. Ordinarily, they would contain water only during the winter months, at the height of the rainy season. However, these streams remain wet all year because they drain coolant water from the SLAC facility.

These drainages were investigated from 23 to 26 July 1976, after preliminary evaluation on 16 July 1976. The best search technique is to walk slowly along the outside edge of the marsh habitat, and attempt to flush the snakes. The undersides of boards and other such surface objects are also investigated.

No *T. sirtalis* were observed at any of the five drainages. It was furthermore deemed that only drainage number four, which is well away from the PEP site, has adequate *T. sirtalis* habitat (Figure 2). However, the junction of drainages two and three, in the middle of a horse exercise ring south of the PEP site, also contains suitable habitat. Ground temperatures during the four days at the SLAC facility ranged from 25° C. to well over 50° C. Temperatures over 30° C. approach the maximum permissible level for *T. sirtalis* activity on the Peninsula (Barry, in prep.). Such levels were often attained by 1100 hours, suggesting that failure to find specimens was perhaps due to inconducive temperatures. To check this possibility, a slough further north on the Peninsula, near Millbrae, was investigated on the afternoon of 24 July, when the ground temperature ranged from 27 to 34.5° C.

Nine *T. s. tetrataenia* were observed at this habitat, which, though far removed from SLAC, is somewhat similar to the SLAC drainages.

T. sirtalis is most readily observed in the morning during the summer; the notable afternoon results at the Millbrae habitat suggest that failure to find snakes in the morning at SLAC was due to their absence.

The major difference between the SLAC drainages and other known Peninsula *T. sirtalis* habitats is the absence at SLAC of red-legged frogs (*Rana aurora*), the principal food of adult *T. s. tetrataenia* (Barry, in prep.). Numerous Pacific treefrog tadpoles (*Hyla regilla*) were noted at the junction of drainages two and three, and in drainage four, but these frogs are too small to be an important food source for these snakes. *Rana aurora* is abundant in nearby San Francisquito Creek, but has not penetrated the SLAC drainages, probably because there are no areas on SLAC with enough deep water and dense cover for these frogs. *Hyla regilla* can breed in very shallow water; I have noted its tadpoles in tire imprint puddles along roads. The absence of a reliable food source has probably discouraged colonization of SLAC by *T. sirtalis*.

During the early spring and late autumn, *T. sirtalis* probably sometimes enters SLAC grounds along the drainages. This species is highly migratory during those seasons, and observations further north and west on the Peninsula indicate that it commonly follows small creeks. However, there is certainly no great reason for such dispersing snakes to long remain at SLAC, simply because the habitat is marginal to inadequate. Furthermore, the habitats at Lake Lagunita, San Francisquito

Creek, and near Searsville Lake, all close to SLAC, are extensive and of much higher quality.

CONCLUSIONS AND RECOMMENDATIONS

If *T. sirtalis* occurs on the Stanford Linear Accelerator Center site, it does so extremely rarely and with high seasonality. The areas it is then most likely to occupy are not within the sphere of the proposed PEP site.

T. sirtalis in the vicinity of SLAC are most likely California red-sided garter snakes, *T. s. infernalis*, which are not endangered and are not protected by law. However, it is possible that *T. s. tetrataenia-infernalis* intergrades occur nearby; these presumably receive the same full protection as does *T. s. tetrataenia*. Intergrade occurrence at any time on SLAC property is nonetheless extremely unlikely.

Because of the remaining uncertainty concerning *T. sirtalis* occurrence at SLAC, it is recommended that the junction of drainages two and three, and the entirety of drainage four, be resurveyed in April or May 1977. If, at that time, no *T. sirtalis* are found, it will be virtually certain that they do not occupy those habitats at any time. This applies only to the SLAC property in general; the PEP site is not considered to contain *T. sirtalis* at any time.

In summary, the construction of PEP will have no impact on San Francisco garter snakes, because these snakes do not occur in the area. The same is true of intergrades. PEP may have slight impact on California red-sided garter snakes, bur such impact will be negligible

and unimportant from a biological or conservation standpoint. Remaining scientific uncertainty concerning these points is not sufficient to delay the proposed construction.

ACKNOWLEDGEMENTS

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APPENDIX 1

Vertebrate Species Observed at SLAC During this Study

Fish
None

Amphibians
Pacific treefrog (*Hyla regilla*)

Reptiles
Western fence lizard (*Sceloporus occidentalis*)
Southern alligator lizard (*Gerrhonotus multicarinatus*)
Racer (snake) (*Coluber constrictor*)
Western terrestrial garter snake (*Thamnophis elegans*)
Gopher snake (*Pituophis melanoleucus*)

Birds
Mallard duck (*Anas platyrhinos*)
Red-tailed hawk (*Buteo jamaicensis*)
Turkey vulture (*Cathartes aura*)
California quail (*Lophortyx californicus*)
Mourning dove (*Zenaidura macroura*)
Hummingbird (*Trochilidae*)
Violet-green swallow (*Tachycineta thalassina*)
Scrub jay (*Aphelocoma coerulescens*)
Mockingbird (*Mimus polyglottos*)
California thrasher (*Toxostoma redivivum*)
House finch (*Carpodacus mexicanus*)
English sparrow (*Passer domesticus*)

Mammals
Shrew (*Sorex* sp.)
Red Fox (*Vulpes fulva*) (introduced species)
Gray fox (*Urocyon cinereoargenteus*)
Coyote (*Canis latrans*)
Long-tailed weasel (*Mustela frenata*)
Striped skunk (*Mephitis mephitis*)
Feral house cat (*Felis domesticus*)
California ground squirrel (*Spermophilus=Otospermophilus=Citellus beecheyi*)
Valley pocket gopher (*Thomomys bottae=T. umbrinus*)
California meadow vole (*Microtus californicus*)
Mule deer (*Odocoileus hemionus*)

APPENDIX 2

Key to the Garter Snakes of the San Francisco Peninsula

This key is to be used in the field when confronted with a questionable specimen, as most garter snakes tend to be. Consult "A Field Guide to the Western Reptiles and Amphibians," by Robert C. Stebbins (1966, Houghton Mifflin Co.) for proper use of a dichotomous key. All Peninsula *Thamnophis* have a prominent dorsal stripe.

1. Top of head red, or bright reddish brown.

   Common garter snake, *Thamnophis sirtalis* (see 3 for subspecies).

2. Top of head not red or bright reddish brown.

   A. Scattered red spots evident on ventrum (belly); brick-red lateral markings usually evident.

      Western terrestrial garter snake, subspecies "Coast garter snake," *Thamnophis elegans terrestris*.

   B. No red markings on ventrum; lateral region black or dark olive-black, sometimes with very small whitish markings.

      Western aquatic garter snake, subspecies "Santa Cruz garter snake," *Thamnophis couchi atratus*.

3. A. Lateral red markings fused into a continuous red stripe, which may be interrupted in the neck region.

      San Francisco garter snake, *Thamnophis sirtalis tetrataenia*.

   B. Lateral red markings well-separated into blotches, which contact the ventrum.

      California red-sided garter snake, *Thamnophis sirtalis infernalis*.

   C. Lateral red markings randomly broken into short stripes and blotches.

      Intergrades, *Thamnophis sirtalis tetrataenia-infernalis*.

Captions for Figures

1. Occurrence of Thamnophis sirtalis populations on the San Francisco Peninsula. Note the SLAC location in extreme southeastern San Mateo County.

2. Area of SLAC considered in this study. Numbers denote the drainages discussed in this report.

3. Lateral red markings (light areas) of San Francisco Peninsula Thamnophis sirtalis. In life, dark areas are black.

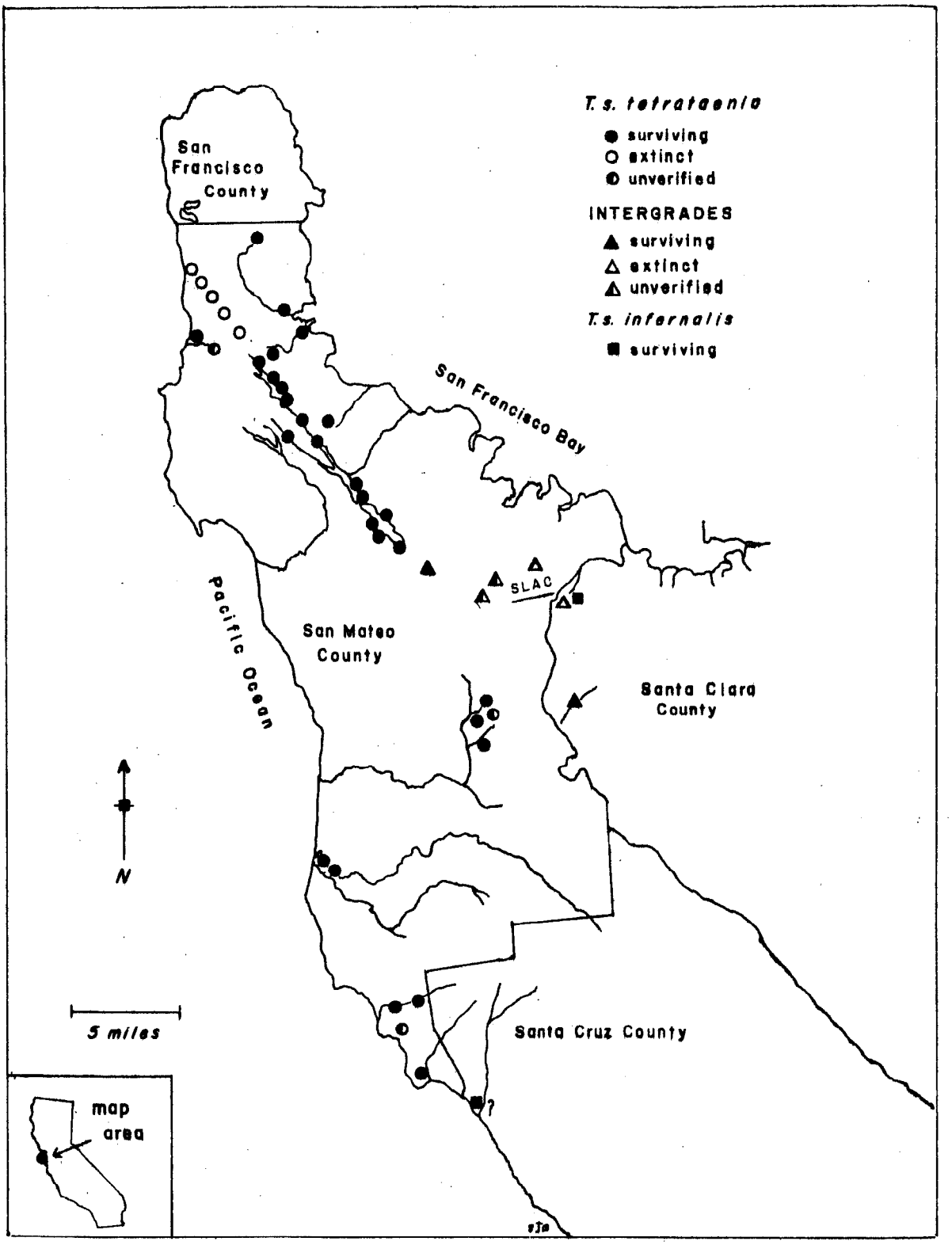

Figure 1. Occurrence of Thamnophis sirtalis populations on the San Francisco Peninsula. Note the SLAC location in extreme southeastern San Mateo County.

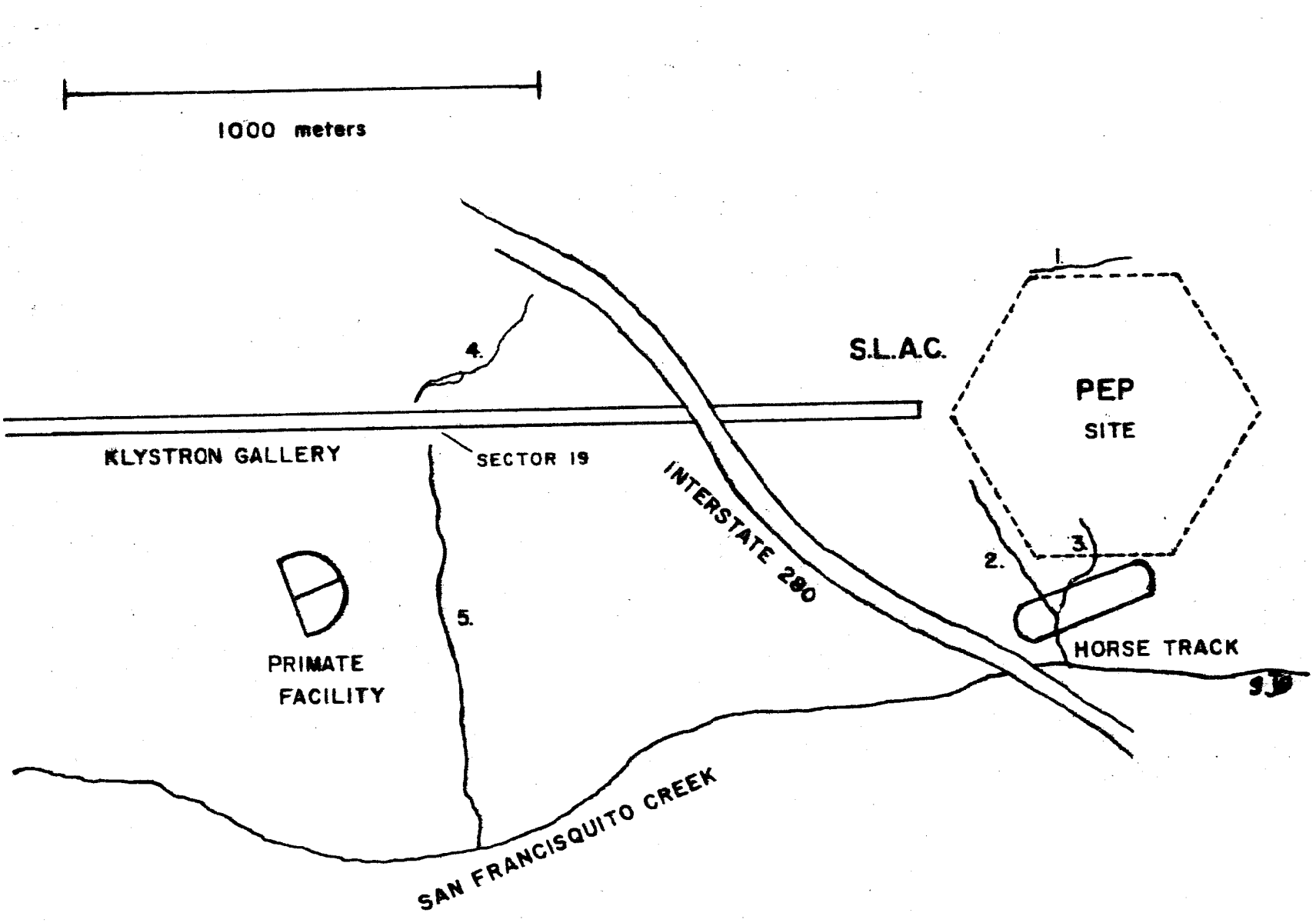

Figure 2. Area of SLAC considered in this study. Numbers denote the drainages discussed in this report.

A. *T. s. tetrataenia*

B. INTERGRADE

C. *T. s. infernalis*

Figure 3. Lateral red markings (light areas) of San Francisco Peninsula Thamnophis sirtalis. In life, dark areas are black.