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Status and Future Management of The Giant Garter Snake
(Thamnophis gigas) Within the Southern American Basin,
Sacramento and Sutter Counties, California

by

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Endangered Species Project

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ABSTRACT

The southern American Basin, located in Sacramento and Sutter counties, provides the most important habitat remaining in California for the giant garter snake (Thamnophis gigas). Nearly 30,000 acres of farmland (including about 140 miles of giant garter snake canal habitat) and open space within the Basin may be converted to urban use over the next 50 years. Development on such a scale would probably extirpate the giant garter snake within the Basin.

This paper describes the giant garter snake habitat and the proposed developments within the Basin, and recommends measures for the preservation and future management of the snake and its habitat.

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INTRODUCTION

The giant garter snake (Thamnophis gigas) is listed by the State of California as a Threatened species (Figure 1). It is endemic to the Sacramento and San Joaquin valleys, California, where it presently occurs in a clumped distribution pattern from Butte to Fresno counties (Figure 2). It has been extirpated from the San Joaquin Valley south of Fresno County and has recently suffered serious declines in southern Sacramento County (Hansen and Brode 1980; Hansen 1982, 1986, 1988).

Fitch (1940) described the giant garter snake (GGS) as a new subspecies, Thamnophis ordinoides gigas. Since that time, the western garter snakes have undergone a number of taxonomic changes which placed the GGS as a subspecies of T. elegans (Johnson 1947, Fox 1951) and then T. couchii (Fox and Dessauer 1965, Lawson and Dessauer 1979). More recently, Rossman and Stewart (1987) proposed that the GGS be accorded full species status as Thamnophis gigas. This classification was subsequently followed by Collins (1990).

The original range of the GGS, as reported by Fitch (1940), was the floor of the Great Valley of California from Sacramento and Antioch southward to Buena Vista Lake. Fox (1951) indicated that intergrades between the GGS and a closely related subspecies, T. e. hydrophila, occurred in the Valley from Sacramento north to near Gridley, Butte County.

Hansen and Brode (1980) suggested that the intergrades reported by Fox (1951) were actually GGS, and described the range of the GGS as extending from the vicinity of Burrell, Fresno County, north through the Central Valley to the vicinity of Gridley, Butte County. Lawson and Dessauer (1979) independently included specimens from Butte County as GGS. After examination of additional specimens, Rossman and Stewart (1987) extended the range of the GGS to about 20 miles north of Gridley.

The distribution of the GGS in the Sacramento Valley coincides for the most part with the major flood basins, including the American Basin, that historically formed along the Sacramento River (Figure 3).

Before reclamation was undertaken along the river, about 60 percent of the Sacramento Valley was subject to overflow which seasonally filled the broad, shallow flood basins. These basins supported heavy growths of tules or rushes and were locally known as "tules" (Bryan 1923, Hinds 1952). Today, only remnants of these once vast "tules" remain (Figure 4).

The southern American Basin (Basin) provides the most important habitat remaining in California for the GGS. The many interconnecting irrigation canals, feeder canals and drains, especially those associated with rice farming, provide habitat and travel corridors for the snake (Hansen, unpubl. notes).

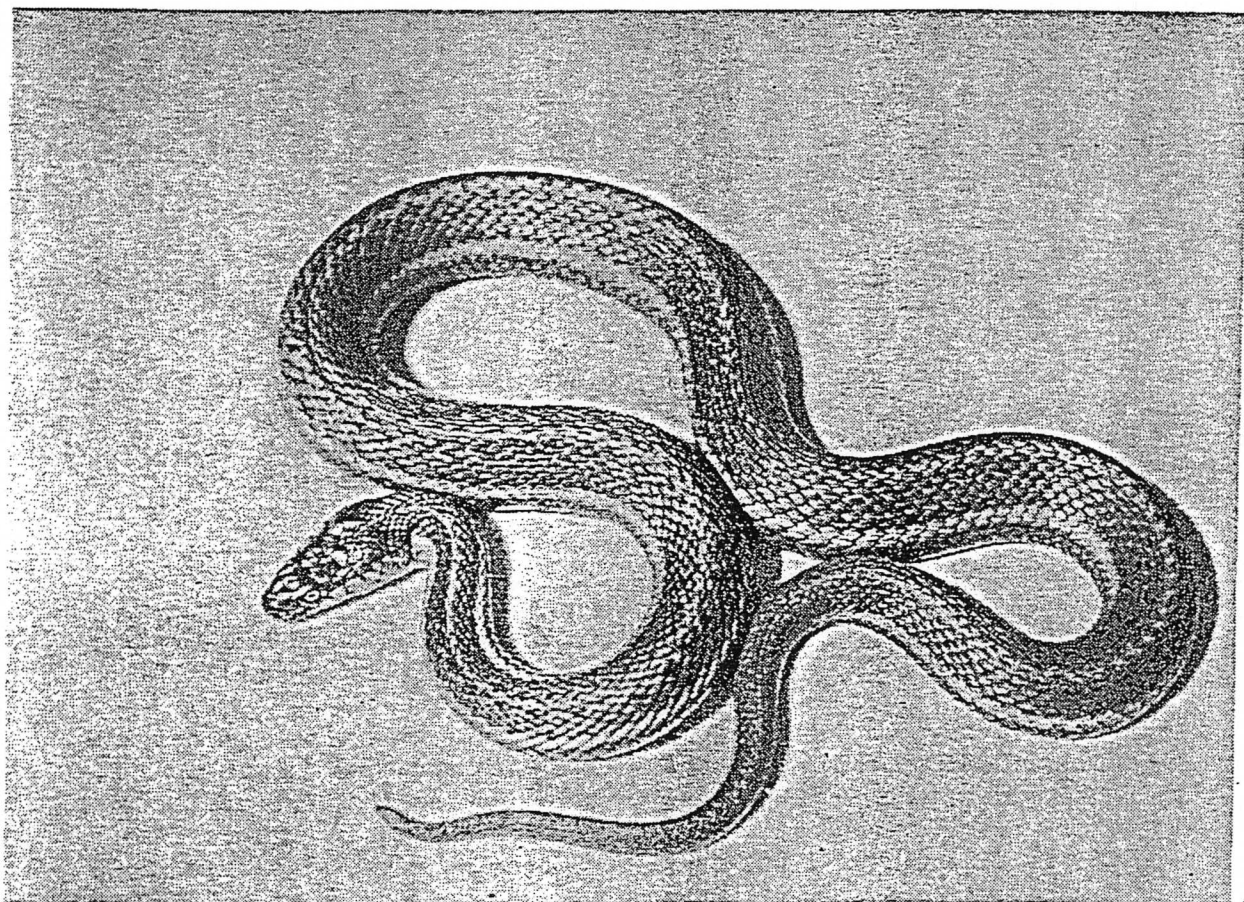


FIGURE 1. Adult female giant garter snake. Photo by George E. Hansen.

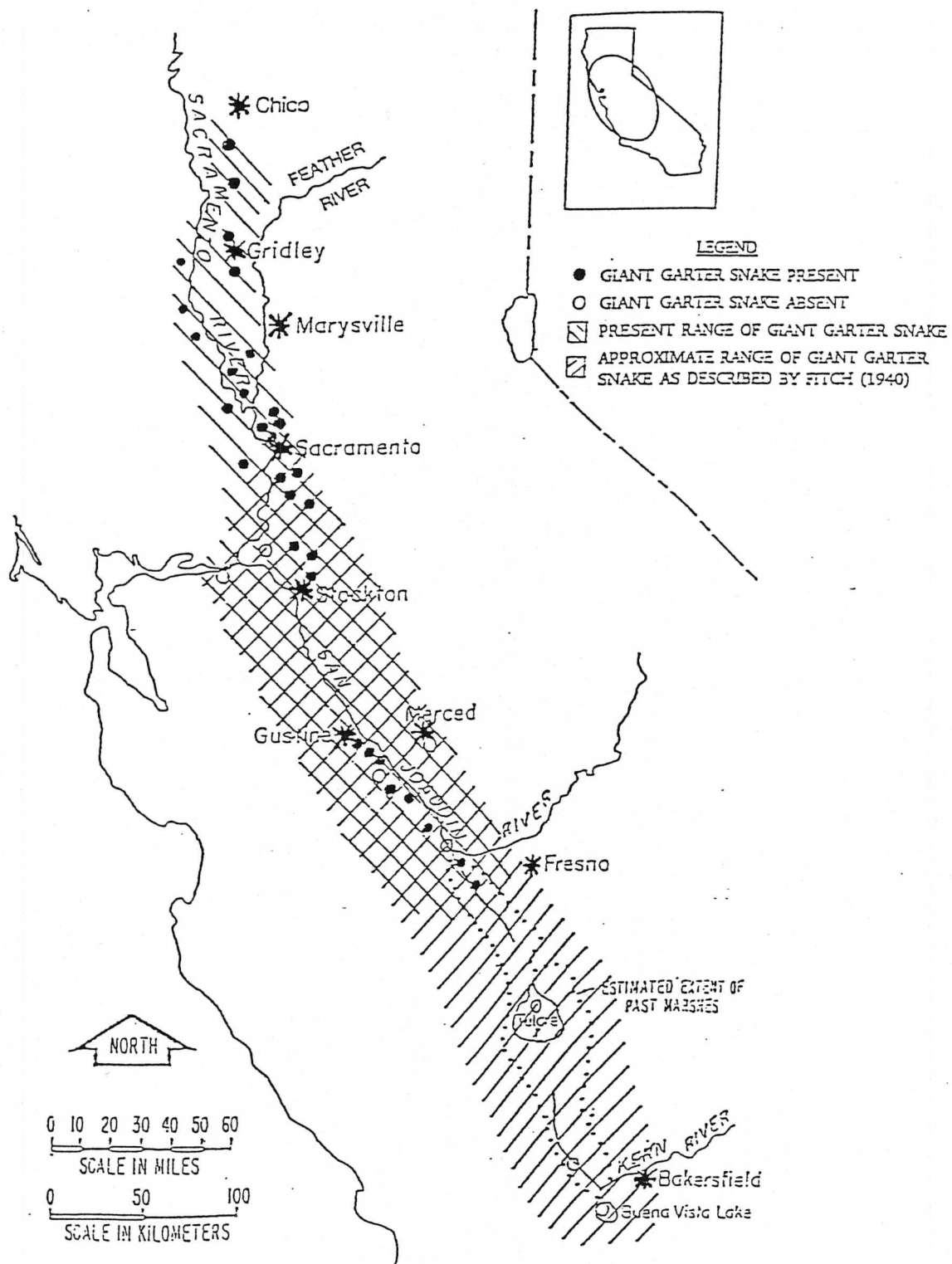


FIGURE 2. Distribution of the giant garter snake. Modified from Hansen and Brode (1980).

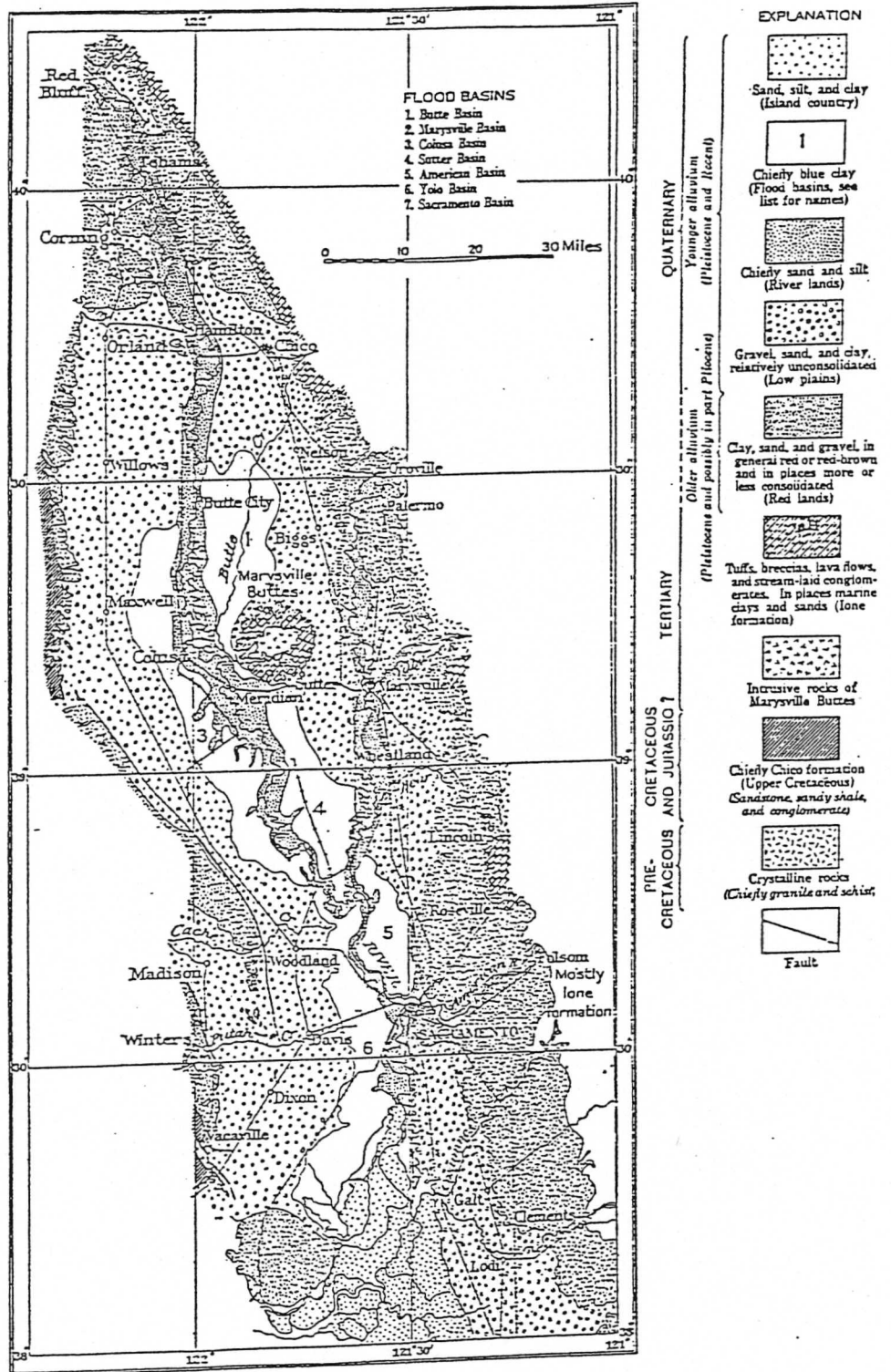


FIGURE 3. Map of the Sacramento Valley, showing geology, physiography, and locations of flood basins. From Bryan (1923).

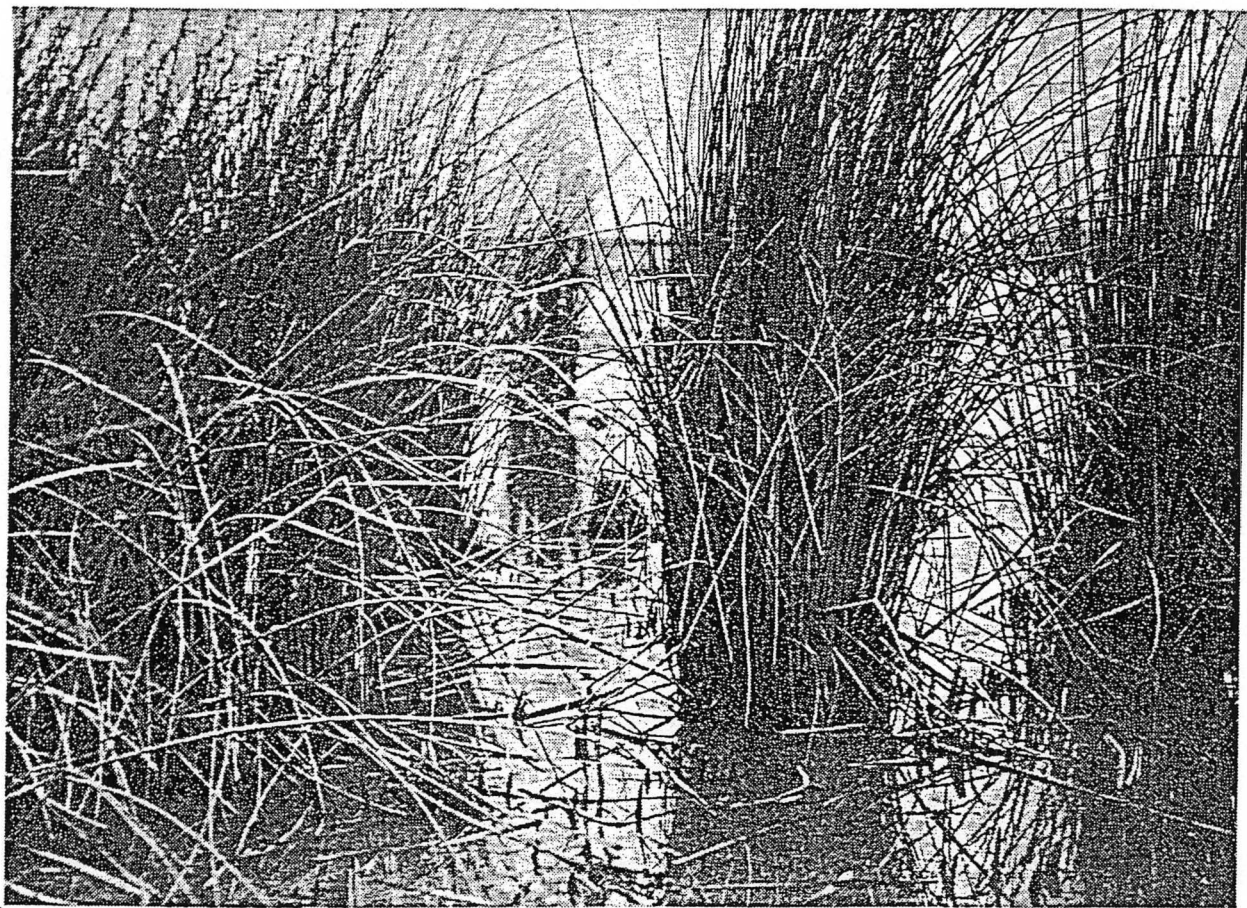


FIGURE 4. Tule marsh habitat of the giant garter snake in southern Sacramento County, California. Photo by George E. Hansen, 1977.

These irrigation canals and drains provide approximately 140 miles of GGS canal habitat. In addition, habitat is provided by small irrigation ditches and rice fields in an unknown amount.

Developments already proposed by the City of Sacramento and Sacramento and Sutter counties could adversely impact approximately 86 miles (61%) of the GGS canal habitat within the Basin. Proposed flood protection could result in the loss of nearly 30,000 acres of native habitat and farmland to urban development (U.S. Fish and Wildlife Service 1990). Approximately 25 miles of GGS canal habitat was relocated or otherwise disrupted during the widening of State Route 99/70 during 1984-1990.

The purpose of this paper is to (1) describe GGS habitat, (2) evaluate the potential impacts of the various projects on the GGS, and (3) recommend measures that will insure the continued survival of the GGS within the Basin.

STUDY AREA

The Basin lies along the eastern side of the Sacramento River north of the American River and south of the Natomas Cross Canal. The eastern and southern boundaries of the Basin are represented by the Natomas East Main Drainage Canal (Figure 5).

The Basin is characterized by agriculture, although the portion south of Interstate 80 (South Natomas) is mostly urbanized. Also the area that lies north of Interstate 80, east of Interstate 5, and south of Del Paso Road consists mostly of commercial/industrial development. The remaining major nonagricultural feature of the Basin is the Sacramento Metropolitan Airport (SMF).

Agriculture in the Basin is mostly rice farming. Irrigation water is pumped into the Basin in the spring, largely from the Sacramento River, and is routed through a series of inter-connecting canals and drains. In the fall, the irrigation water is pumped out of the Basin and most of the canals and ditches remain dry, except for rain water, throughout the winter.

MATERIALS AND METHODS

Habitat within the Basin was identified in the field and delineated on U.S. Geological Survey 7.5 minute topographic maps. The linear habitat was then measured by tracing the topographic maps with a Digitizing Area-line Meter (Tamaya Planix 5000). The relative importance of various habitats to the GGS was determined by field evaluation of characteristics of the habitat and frequency of GGS sightings. Information on proposed development was gained through standard environmental review procedures.

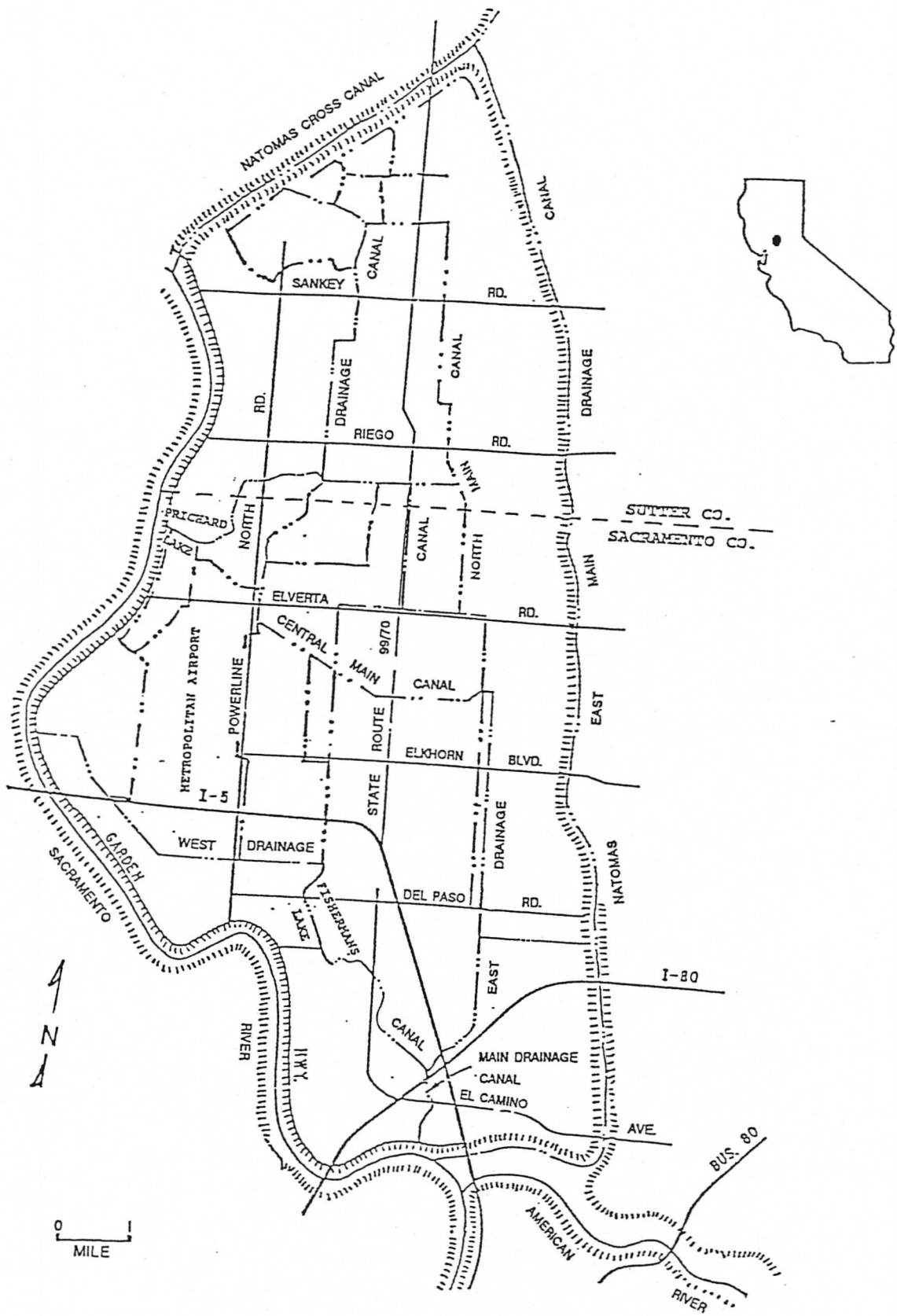


FIGURE 5. Map of the southern American Basin showing the major agricultural canals, roads, and other pertinent landmarks. Modified from U.S. Army Corps of Engineers (1987).

RESULTS

Habitat Requirements

The GGS inhabits sloughs, low gradient streams, and other waterways where it feeds on small fish and frogs. It finds shelter along banks and in adjacent uplands. It adapts well to man-made waterways as long as they have the primary requirements of (1) enough water during the active (summer) season to supply food and cover, (2) grassy banks for basking, (3) emergent vegetation for cover during the active season, and (4) high ground or uplands that provide cover and refuge from flood waters during the dormant (winter) season (Hansen 1988).

It appears that the GGS does not occur in larger bodies of water such as the Sacramento/San Joaquin Delta and the large rivers of the Sacramento Valley such as the American, Cosumnes, and Sacramento.

Habitat Within the Study Area

Although the original GGS habitat within the Basin has largely been lost, man-made irrigation canals and ditches associated with rice farming and other agriculture now provide important habitat. GGS use the canals for year-round habitat and movement between major population centers. The GGS occurs in a wide variety of canals and ditches in the area. Some are densely vegetated with little disturbance and some have a dirt road along one or both sides. Most of these waterways are ideal for the GGS because they are too small to support large predatory fish, but large enough to provide adequate food and cover.

The rice fields provide important habitat during late summer, when the fields are flooded and contain large numbers of mosquitofish (Gambusia affinis), Pacific treefrogs (Hyla regilla), and other food items. This food source may be especially important to newborn GGS (Hansen unpubl. notes).

Typical canals within the Basin are 10-20 ft wide with small levees on either side. A dirt maintenance road may be on one or both sides of the levees. The GGS appears to favor those areas where there are two or more canals or ditches in parallel combination (Figure 6). Along the canals there are periodic check dams and intersections with other canals. These structures provide habitat for the GGS in the form of deeper, food-holding water, and cover in the form of broken concrete, woody debris, and undercut banks (Figure 7).

GGS habitat within the Basin occurs in three large areas that are separated from each other by major highways (Figure 8). Within each of these three areas, movement of the GGS is generally unrestricted, except for a few short crossings over or under two-lane roads. To move between these three areas, however, GGS must

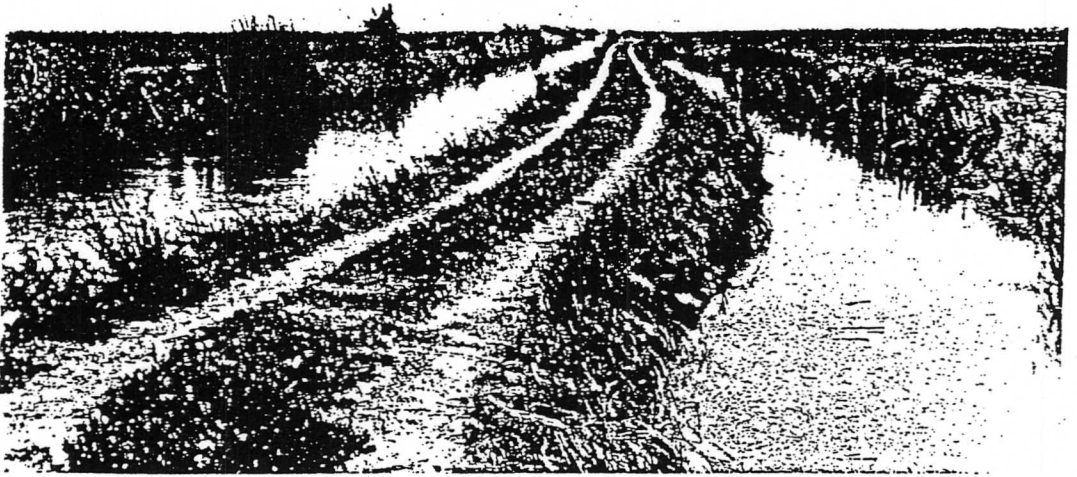


FIGURE 6. Two-ditch giant garter snake habitat along the North Main Canal adjacent to rice fields. Photo by John M. Brode, 1990.

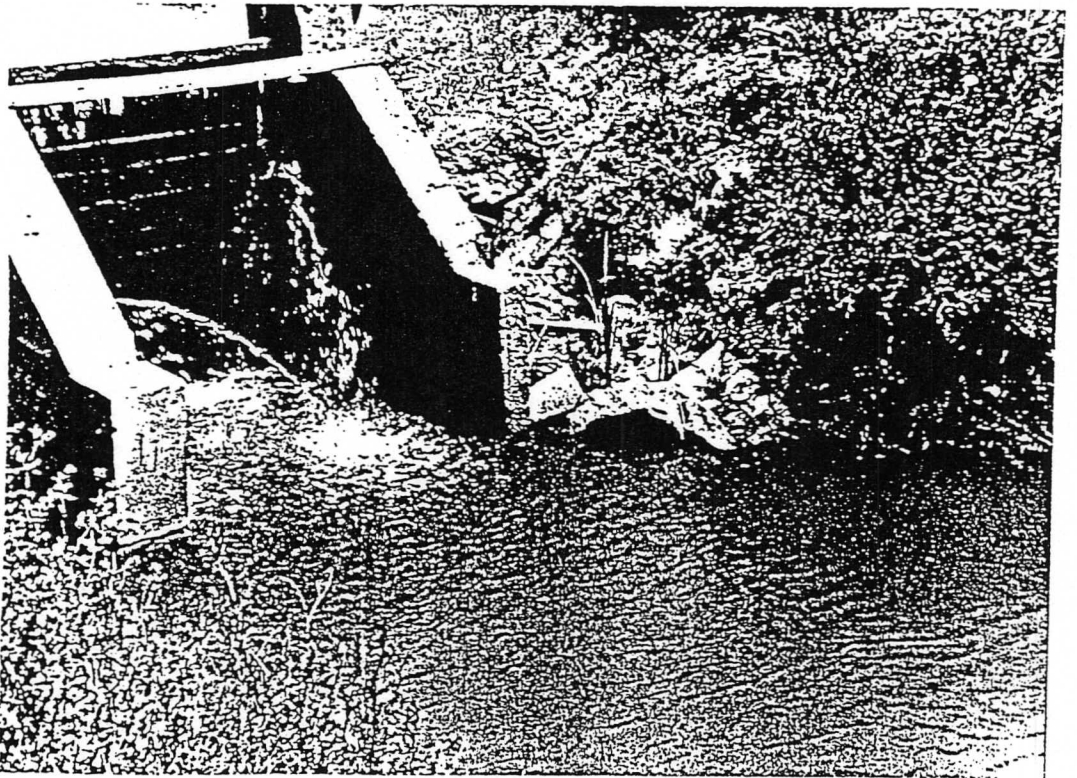


FIGURE 7. Check dam on North Main Canal. A giant garter snake was observed basking among the broken concrete on the opposite bank shortly before this photo was taken. Photo by John M. Brode, 1990.

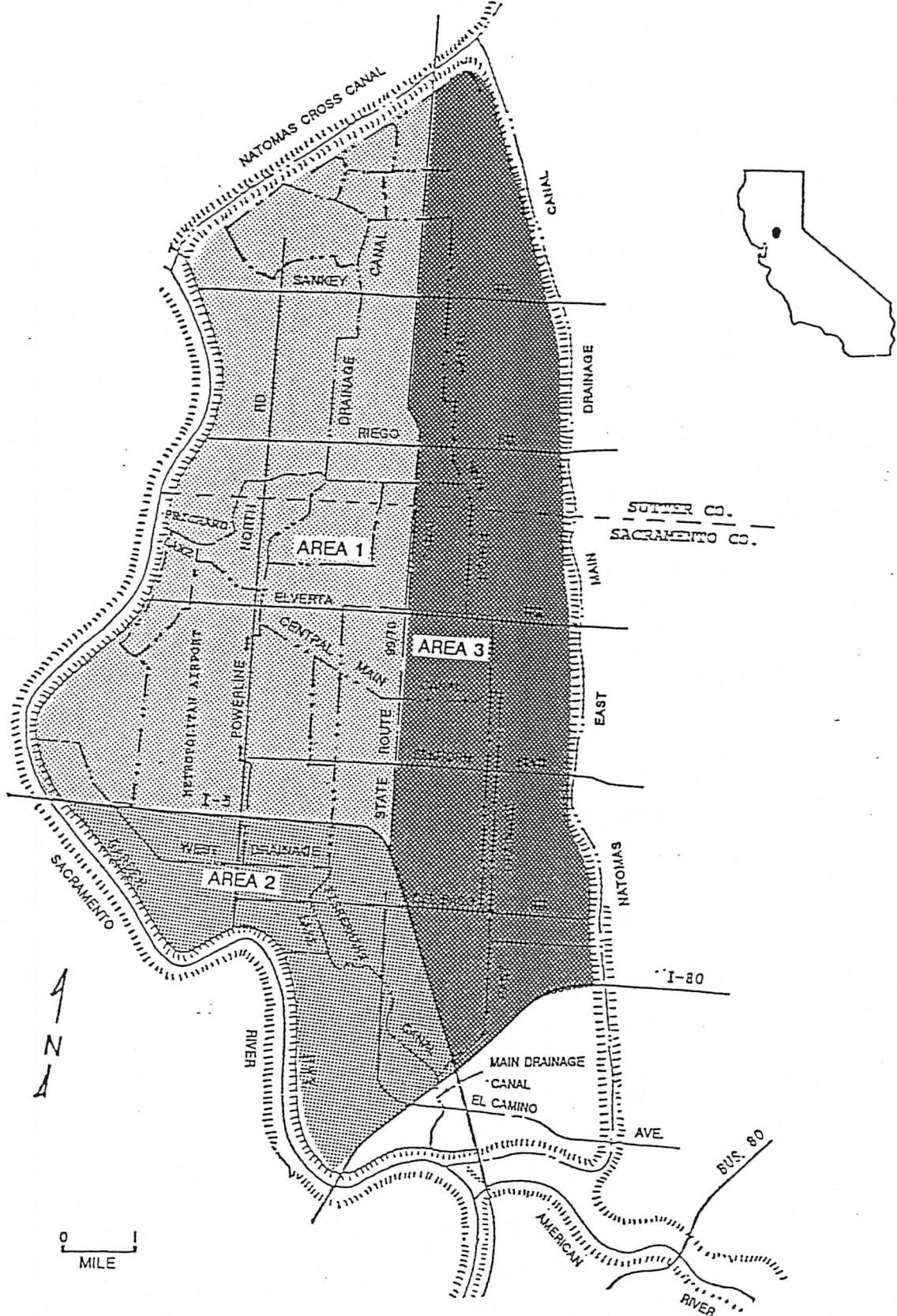


FIGURE 8. Map of the southern American Basin showing the three giant garter snake habitat areas.

travel over or under multi-lane highways that are 200-300 ft wide. It appears that GGS will negotiate large box culverts of considerable length, provided that vegetative cover along the canals extends to the entrance of the culverts and there is adequate clearance (2-3 ft) above the water within the culvert (Hansen unpubl. notes) (Figure 9).

Area 1. This area lies west of State Route (SR) 99/70 and north of Interstate 5 (I-5). Important habitat areas include Prichard Lake and the North Drainage Canal and its associated rice fields. Prichard Lake is a dead-end slough with steep banks and much emergent vegetation and willows (Figure 10). GGS have been observed basking in the small willows overhanging Prichard Lake (Hansen unpubl. notes). The North Drainage Canal provides good habitat and a movement corridor from Prichard Lake to the north end of Area 3. Other movement corridors for the GGS include the ditches that run south along Powerline Road and Lone Tree Road and under I-5 to the West Drainage Canal, and the East Drainage Canal that runs east and under SR99/70.

Area 2. South of Area 1 lies Area 2, which is bounded on the north and east by I-5 and on the south by I-80. Fisherman's Lake is the main habitat here (Figure 11). The West Drainage Canal flows through Fisherman's Lake and provides the main corridor for movement of GGS between areas 1 and 2. This is the smallest of the three areas and is the most isolated, having no direct connection to Area 3 except at the extreme south end where the West Drainage Canal and East Drainage Canal converge.

Area 3. The third area encompasses roughly the eastern half of the Basin. It lies east of SR99/70 and I-5 and north of I-80. The main habitat in Area 3 is located along the North Main Canal and East Drainage Canal. The North Main Canal, with its associated rice fields, is very important to the GGS (Figure 6). So important in fact, that we now refer to this canal as "Snake Alley". Snake Alley is within a prime rice-growing area, which enhances the GGS habitat. There are many connecting ditches and parallel ditches in various arrays. The combination of Snake Alley, the East Drainage Canal, and the canal that parallels the east side of SR99/70 between Elverta Road and the north end of Snake Alley provides a continuous habitat of approximately 12 miles, which surrounds about 2,400 acres of rice. There are five or six major structures associated with connecting ditches which enhance the habitat qualities of Snake Alley (Figure 7).

DEVELOPMENTS AND IMPACTS

Existing Developments

Virtually all of the Basin has been converted to agriculture. The principal crop is rice, although there are some orchards and row crops. South Natomas consists mostly of urban housing and commercial buildings. A limited amount of GGS habitat still

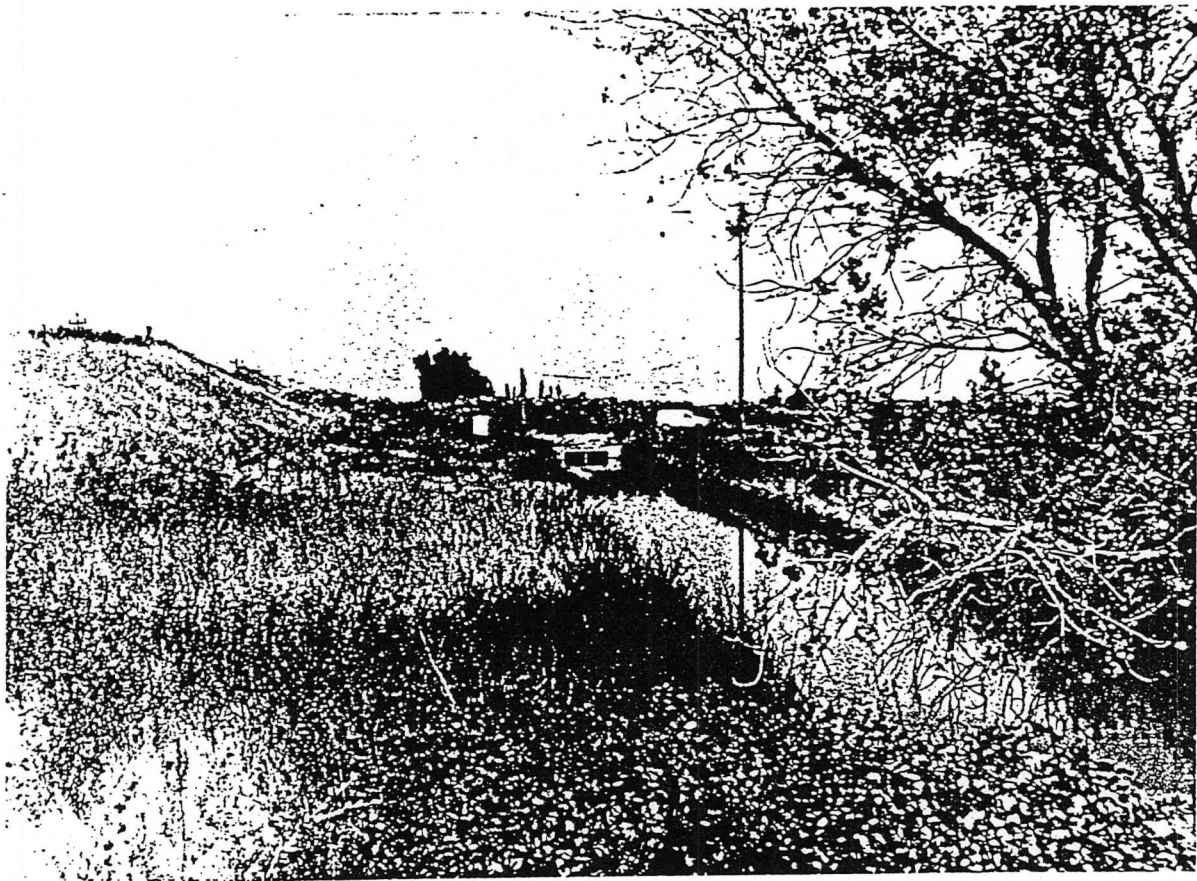


FIGURE 9. Box culvert under I-5 at Powerline Road, looking north from Bayou Road. Photo by John M. Brode, 1989.



FIGURE 10. Prichard Lake, habitat of the giant garter snake, at the southwestern terminus of the North Drainage Canal. Photo by George E. Hansen, 1987.

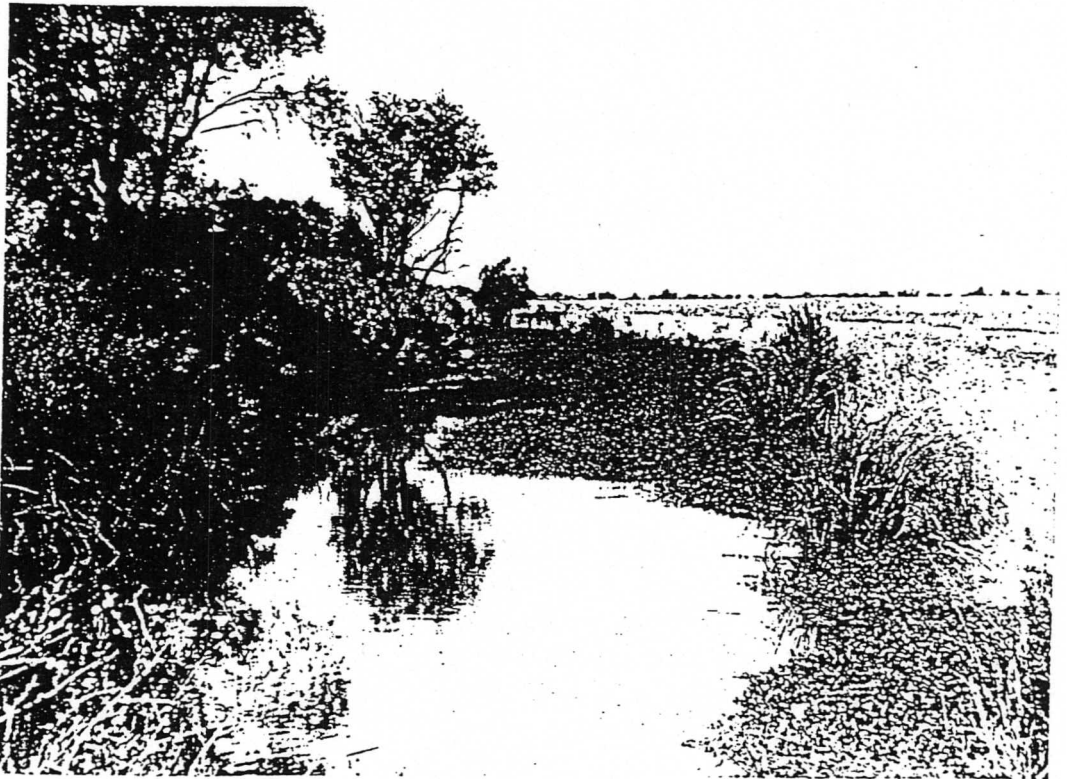


FIGURE 11. Fisherman's Lake, habitat of the giant garter snake along the West Drainage Canal. Photo by John M. Brode, 1989.

occurs here, along the Main Drainage Canal and associated ditches. North Natomas, south of Del Paso Road, contains light industry and two sport complexes, leaving little, if any, GGS habitat. The amount of GGS habitat lost in these two areas is unknown.

The SMF lands contain about 7 miles of actual and potential GGS canal habitat. The amount of GGS habitat lost during airport construction is unknown.

Anticipated Developments

An analysis by the U.S. Army Corps of Engineers concluded that, given a minimum of 200-year flood protection, nearly 30,000 acres of farmland and open space within the Basin could be converted to urban uses over the next 50 years (U.S. Fish and Wildlife Service 1990). If this were to take place, it could extirpate the GGS within the Basin. A number of development projects have already been proposed for the Basin. Some of them, of course, will depend upon the type and degree of flood protection that is provided in the future.

North Natomas Community Drainage System

This project is a proposal by the City of Sacramento to construct a storm drainage system to serve proposed urban development in the North Natomas area (Figure 12). The system will consist of two major open drainage channels, tributary open channels and storm drainage pipes, two pumping stations to lift storm runoff over the levee into the Sacramento River, and other related facilities. In reviewing the project, the Department determined that approximately 26 miles of GGS canal and ditch habitat would be destroyed by this project. At that time, the importance of the rice fields as GGS habitat was not fully understood, and therefore, the rice fields were not included in the estimate of habitat loss. Loss of this habitat will seriously jeopardize the continued existence of the GGS in the Basin. The project, as proposed, would not only eliminate prime habitat but may disrupt movement of the snake within the Basin. A mitigation plan to replace lost GGS habitat has been proposed by the City of Sacramento (City of Sacramento 1989). This plan, developed in cooperation with the Department, has the following objectives: 1) to replace habitat lost due to construction of the drainage system; 2) to provide, through proper design and vegetation planting, sufficient cover and refuge areas for breeding, basking, feeding and migration; 3) to provide suitable vegetation and aquatic environment for the production of GGS food items; 4) to provide a permanent water supply to sustain the mitigation habitat; and 5) to provide a viable long-term plan that will sustain the GGS population in the Basin.

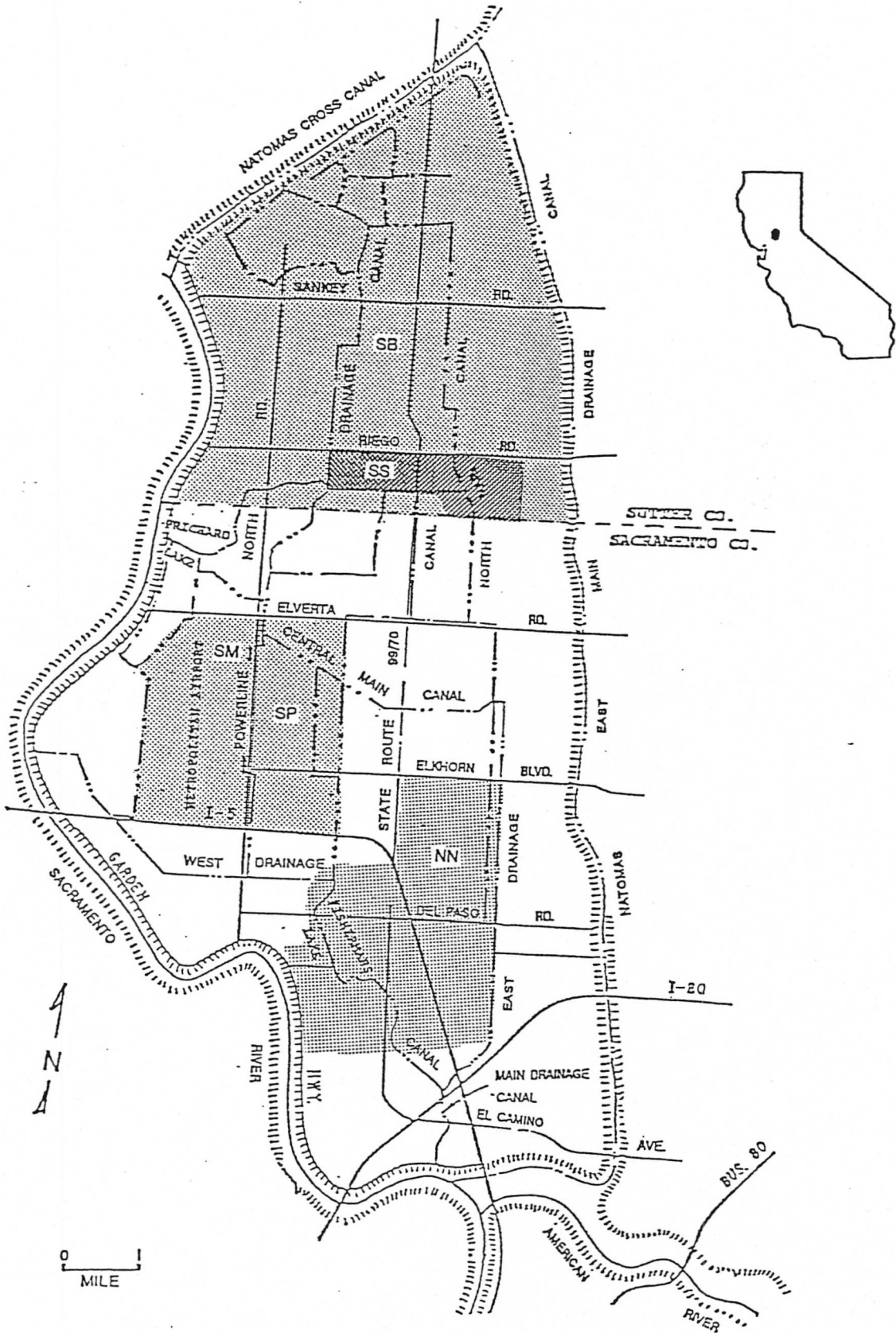


FIGURE 12. Map of the southern American Basin showing the locations and approximate boundaries of proposed developments. NN = North Natomas Community Drainage System, SB = Sutter Bay, SS = South Sutter Industrial Center, SM = Sacramento Metropolitan Airport, and SP = Metropolitan Airport Special Planning Area.

The basic concept of this plan was to integrate the GGS mitigation habitat with the proposed drainage canals to facilitate maintenance and operation. The proposed mitigation habitat would consist of combinations of 1-4 parallel ditches.

If this project goes forward, the success or failure of the proposed GGS mitigation habitat will be determined through a monitoring program (City of Sacramento 1990).

Sutter Bay Proposed Development

This proposed project encompasses virtually all the land in the Basin within Sutter County (Figure 12). However, this project is only conceptual at this time and its future may well depend upon the final flood control plan that is adopted for the Basin. If it were to proceed, several thousand acres of rice and approximately 42 miles of GGS canal habitat could be eliminated or seriously depleted. Increased traffic on local roads and highways could increase GGS road kills.

South Sutter Industrial Center

This proposed project lies on both sides of SR99/70 in Sutter County between the Sacramento/Sutter County line and Riego Road (Figure 12). This project could eliminate or seriously disrupt approximately 9 miles of essential GGS canal habitat. Increased traffic on local roads and highways could increase GGS road kills.

Sacramento Metropolitan Airport and Special Planning Area

Proposed expansion of facilities within the SMF boundaries would increase road traffic, thereby potentially increasing GGS road kills. Development of the Special Planning Area (SPA), east of Powerline Road and north of I-5, would also increase traffic and, subsequently, GGS road kills. The SPA proposal is to develop about 1,920 acres of agricultural land for light industry. This project could adversely affect about 9 miles of GGS canal habitat and over 1,500 acres of rice fields. In addition to the potential habitat loss, the major north-south GGS movement corridor along Powerline Road could be disrupted (Figure 12).

Sacramento Regional Transit

The extension of light rail service to Arco Arena (North Natomas) and SMF would adversely affect GGS habitat at some of the canals. Of special concern here would be the canals along Powerline Road and adjacent to I-5 near Lone Tree Road. An alternate route could affect GGS habitat near Fisherman's Lake and the West Drainage Canal.

Highway Improvements and Construction

Any improvements to local highways and other roads will result in increased traffic and increased GGS road kills. Highway construction, especially widening of highways and roads, would destroy or seriously damage existing GGS habitat, especially where canals and ditches parallel the roadways.

DISCUSSION AND RECOMMENDATIONS

It is important to preserve the essential GGS habitat and to assure genetic heterogeneity by maintaining free movement of the GGS within and between the three major habitat areas within the Basin. GGS populations in the three areas could become isolated from one another, thereby creating subpopulations with little or no opportunity for genetic exchange.

Habitat Management

We believe that rice farming in the Basin is a key element in maintaining high populations of GGS. While the irrigation canals and drains, associated with rice farming, provide the main habitat and movement corridors, the rice fields provide additional foraging areas that may be especially important to newborn snakes (Hansen unpubl. notes). Canals and ditches in nonrice areas appear to support lower GGS numbers.

The present rice farming practices appear to be compatible with GGS. Since the fields need to dry out or, at least, be dewatered, GGS have ample opportunity to return to the canals before harvesting begins.

The present procedures for maintaining the canals and ditches are, for the most part, compatible with GGS. Certain practices, are, however, detrimental to the GGS and its habitat. The detrimental practices are: 1) spraying or otherwise removing the vegetation from the banks of the canals, 2) lining the canals with cement or gunite, and 3) excavating canals during the GGS dormant season (October 1-May 1).

Adverse impacts to the GGS during maintenance operations can be lessened by adhering to the following guidelines:

- a) Excavate from only one side of the canal during a given year. Avoid excavating the banks above the high water level. Preferably, one side of the canal should be left undisturbed indefinitely (the preferred side would be the west or north side).
- b) Excavate the canals during the GGS active season. This is approximately May 1 to October 1.
- c) Leave the vegetation on the tops and sides of the canals undisturbed.

- d) Restrict auto traffic along the canals to maintenance or other official vehicles.

Conceptual Preservation Plan

The ideal GGS habitat within the Basin, as we recognize it, consists of two or more parallel irrigation ditches, preferably adjacent to rice fields, with adequate buffering from urban areas.

Buffers between GGS habitat and urban development should extend at least 100 ft from the outside edge of the GGS habitat (levee toe or maintenance road) to a boundary fence. The buffer should consist of at least 75 ft of native or ruderal vegetation with 15-25 ft of bare ground along the boundary fence. The bare ground area could be used for a bikeway, provided that there is a fence between the bikeway and the remaining buffer zone (Figure 13). Narrower buffers would be acceptable between GGS habitat and agriculture, and the buffer width would depend upon the particular crop and farming practices. GGS habitat should be separated from roads with a minimum 30-ft buffer between the GGS habitat and the outside edge of the road right-of-way (Figure 13).

Conceptually, a preservation plan for the GGS, within the Basin, would consist of a minimum of one core habitat within each of the three main habitat areas with connecting canals to provide for movement of GGS between and within the three areas (Figure 14).

Area 1

Habitat for the GGS could be enhanced here by providing rice fields or shallow tule marshes to provide additional summer foraging habitat adjacent to Prichard Lake. The northern end of the SMF property could be enhanced to provide such habitat. The main movement corridors and canal habitat include the North Drainage Canal, East Drainage Canal, and the Powerline Road and Lone Tree Road ditches. The Powerline Road ditch could be improved to provide a more direct connection south to the West Drainage Canal. The ditches on the west side of SMF could also be enhanced to increase their suitability as GGS habitat. An agricultural preserve for rice farming, in the area bordered by Elverta Road, Powerline Road, Riego Road, and SR99/70, including the canal and ditch system, would help insure the survival of the GGS in Area 1.

Area 2

If the North Natomas Community Drainage System (NNCDS) is approved and the Del Paso Canal is built, additional GGS ditch habitat will be constructed paralleling and hydraulically connected to Fisherman's Lake on the west. If the Del Paso Canal is not built, the west side of Fisherman's Lake would still be an acceptable area for GGS mitigation habitat. Another area for potential enhancement/mitigation habitat would be south of I-5

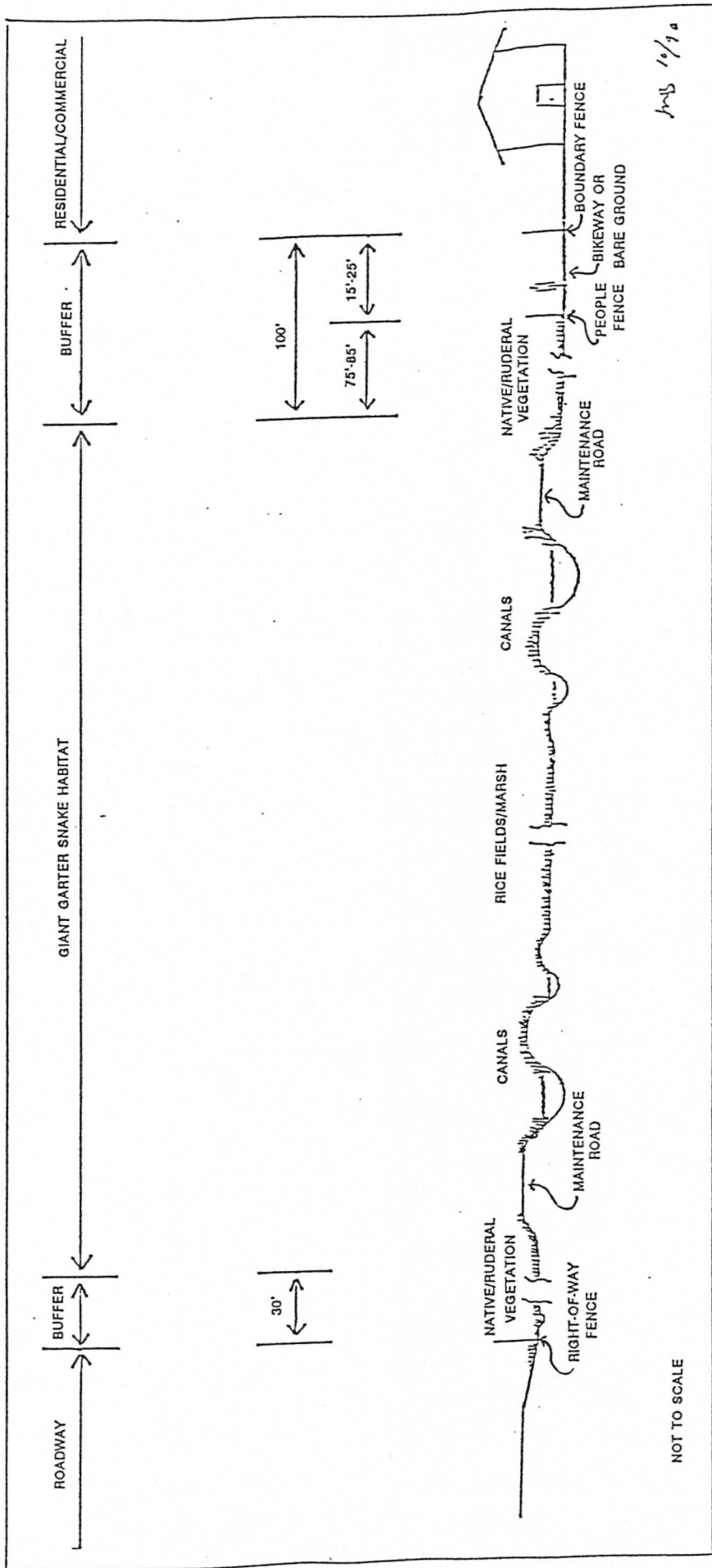


FIGURE 13. Conceptual drawing of giant garter snake habitat and buffers in relationship to various land uses in the southern American Basin.

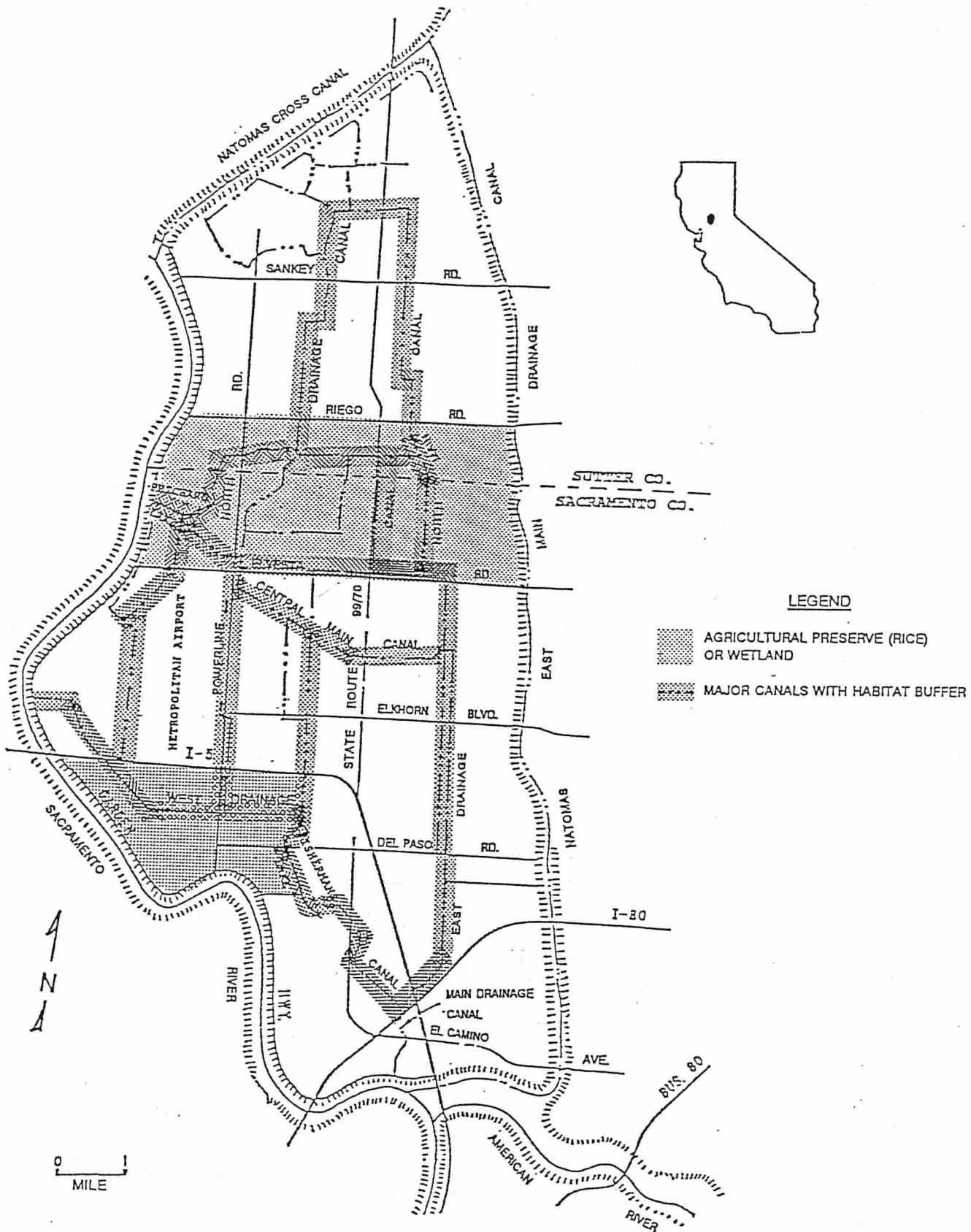


FIGURE 14. Conceptual Preservation Plan for the giant garter snake within the southern American Basin.

and adjacent to the West Drainage Canal, west of Lone Tree Road. The main canal habitat/movement corridors occur along the West Drainage Canal, Powerline Road ditch, and Lone Tree Road ditch.

Area 3

This is one of the most important GGS habitat areas and is probably the most vulnerable to loss or degradation. The North Main Canal (Snake Alley) and associated rice fields support the largest known concentration of GGS within the Basin. We propose that the North Main Canal, and some of its associated rice fields, be preserved for GGS habitat.

This area would be suitable for providing a bikeway along the North Main Canal between Elverta Road and Sankey Road. Such a bikeway could be extended south to Elkhorn Boulevard along the East Drainage Canal to connect with the bikeway proposed for the NNCDS. Commercial businesses could be developed at or near the intersections of Elverta, Riego, and Sankey Roads with SR99/70, provided that rice fields remain around those areas, and the canal systems are not disrupted. The southern portion of the area encompasses the proposed NNCDS. Conceptual mitigation for the GGS has already been proposed for this area (City of Sacramento 1989). If the NNCDS is not built, mitigation for the loss or degradation of GGS habitat within North Natomas will have to be re-evaluated.

Mitigation Guidelines

The following guidelines should be followed for GGS habitat not included in preservation areas. Mitigation should be designed so that there is no net loss of GGS habitat in quantity or quality.

Relocation or replacement of GGS canal habitat does not meet the habitat quality goal for the short term. Canals supporting GGS that were relocated in 1988, during the widening of SR99/70, have not been recolonized by GGS even though vegetation and prey species (mosquitofish and Pacific treefrogs) have become established. Although GGS have been sighted regularly in undisturbed canals that connect to the relocated canals, there have been only three sightings of GGS in the relocated canals (California Department of Fish and Game 1991). It may take 3-5 years, or longer, for newly constructed canals to provide the habitat needed to support resident populations of GGS. Recruitment to the general population of GGS will be reduced because of lost habitat and the loss or displacement of adult GGS during this time.

Because newly created GGS habitat takes several years to reach maturation, replacement of existing GGS habitat requires compensation at a 2:1 or greater ratio to achieve viable GGS population levels. Compensation greater than parity is required to overcome interim population declines that occur during the time between destruction of the original habitat and maturation of the new habitat. Replacement or supplemental GGS habitat

should be constructed as soon as possible after a conservation plan is approved. The timing of these activities should follow the Department of Fish and Game guidelines (Appendix).

We are continuing studies of GGS canal recolonization in an effort to determine the time necessary for newly constructed canals to become viable GGS habitat. The success of recolonization and the time required to achieve it will be key factors in determining appropriate mitigation for the GGS.

Officials of the City of Sacramento, and Sacramento and Sutter counties should develop a coordinated long-range development plan for the Basin. The plan must provide protection and management of wildlife, especially threatened and endangered species such as the GGS.

ACKNOWLEDGEMENTS

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Appendix

Guidelines for Procedures and Timing of Activities Related to the Modification or Relocation of Giant Garter Snake Habitat¹

Background

These procedures were developed to minimize adverse impacts to the giant garter snake (Thamnophis gigas) during construction activities in and around giant garter snake (GGS) habitat. The timing is based on present knowledge of the GGS seasonal activity cycle which may vary somewhat from year to year depending upon the weather.

GGS Activity Cycle

- o GGS begin emerging from winter retreats around April 1.
- o By April 15, most GGS are active and beginning to search for food.
- o By May 1, all GGS have usually emerged and are actively foraging.
- o Around October 1, GGS begin seeking winter retreats. Foraging and other activities are sporadic at this time and dependant upon weather conditions.
- o By November 1, Most GGS are in winter retreats and will remain there until spring.

Habitat Relocation Procedures and Timing

- o No grading, excavating, or filling may take place in or within 30 feet of existing GGS habitat between October 1 and May 1 unless authorized by the Department of Fish and Game (DFG).
- o Construction of replacement habitat may take place at any time of the year, but summer is preferred.
- o Water may be diverted as soon as the new habitat is completed, but placement of dams or other diversion structures in the existing habitat will require on-site approval by the DFG.
- o The new habitat will be revegetated as directed by DFG or as stipulated in the environmental documents.
- o Dewatering of the existing habitat may begin any time after November 1, but must begin by April 1.

¹ Prepared by John M. Brode, Department of Fish and Game, Inland Fisheries Division, October 1990.

- o Any GGS surveys required by the DFG will be completed to the satisfaction of the DFG prior to dewatering.
- o All water must be removed from the existing habitat by April 15, or as soon after as weather permits, and the habitat must remain dry (no standing water) for 15 consecutive days after April 15 and prior to excavating or filling the dewatered habitat.
- o DFG will be notified when dewatering begins and when it is completed. DFG will inspect the area to determine when the 15-day dry period may start.
- o The DFG contact for inspection will be Mr. John M. Brode (916) 355-7112, unless DFG makes other arrangements.

The above procedures are subject to revision and may be modified by DFG to accommodate special situations.

Guidelines for Procedures and Timing of Activities Related to the Modification or Relocation of Giant Garter Snake Habitat¹

Background

These procedures were developed to minimize adverse impacts to the giant garter snake (Thamnophis gigas) during construction activities in and around giant garter snake (GGS) habitat. The timing is based on present knowledge of the GGS seasonal activity cycle which may vary somewhat from year to year depending upon the weather.

GGS Activity Cycle

- o GGS begin emerging from winter retreats around April 1.
- o By April 15, most GGS are active and beginning to search for food.
- o By May 1, all GGS have usually emerged and are actively foraging.
- o Around October 1, GGS begin seeking winter retreats. Foraging and other activities are sporadic at this time and dependant upon weather conditions.
- o By November 1, Most GGS are in winter retreats and will remain there until spring.

Habitat Relocation Procedures and Timing

- o No grading, excavating, or filling may take place in or within 30 feet of existing GGS habitat between October 1 and May 1 unless authorized by the Department of Fish and Game (DFG).
- o Construction of replacement habitat may take place at any time of the year, but summer is preferred.
- o Water may be diverted as soon as the new habitat is completed, but placement of dams or other diversion structures in the existing habitat will require on-site approval by the DFG.
- o The new habitat will be revegetated as directed by DFG or as stipulated in the environmental documents.
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