DRAFT RECOVERY PLAN

FOR THE GIANT GARTER SNAKE

(Thamnopsis gigas)

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In memory of George E. Hansen, an extraordinarily talented herpetologist who was dedicated to the conservation of giant garter snakes

DISCLAIMER PAGE

Recovery plans delineate reasonable actions that are believed to be required to recover and/or protect listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views, official positions, or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service ***only*** after they have been signed by the Director, Regional Director, or Manager ***as approved***. Approved recovery plans are subject to modification as dictated by new findings, changes in species statuses, and the completion of recovery tasks.

<u>LITERATURE CITATION SHOULD READ AS FOLLOWS</u>:

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EXECUTIVE SUMMARY

Current Status: This recovery plan features the federally threatened giant garter snake (*Thamnopsis gigas*). This species inhabits wetland habitats within the Central Valley of California. Loss and fragmentation of wetland habitats have extirpated the giant garter snake from the majority of its historic range. This recovery plan also considers several species of concern that occur in Central Valley wetlands that benefit from actions taken to recover the giant garter snake. These species include the tricolored blackbird (*Agelaius tricolor*), white-faced ibis (*Plegadis chihi*), western pond turtle (*Clemmys marmorata*), and associated waterfowl.

Habitat Requirements and Limiting Factors: The giant garter snake inhabits agricultural wetlands and other waterways such as irrigation and drainage canals, sloughs, ponds, small lakes, low gradient streams, and adjacent uplands in the Central Valley. Because of the direct loss of natural habitat, the giant garter snake relies heavily on rice fields in the Sacramento Valley, but also uses managed marsh areas in Federal National Wildlife Refuges and State Wildlife Areas. There have been only a few recent sightings of giant garter snakes in the San Joaquin Valley. Habitat loss and fragmentation, flood control activities, changes in agricultural and land management practices, predation from introduced species, parasites, water pollution, and continuing threats are the main causes for the decline of this species.

Recovery Priority: 2C (full species, high degree of threat, high recovery potential). See Appendix A for how recovery priorities are established for listed species.

Recovery Objective: The ultimate goal of this recovery plan is to delist the giant garter snake.

Recovery Criteria: Recovery criteria for the giant garter snake are defined for four recovery units in the Central Valley: the Sacramento Valley, Mid-Valley, San Joaquin Valley, and South Valley units. Recovery criteria include:

a. Monitoring shows that in 17 out of 20 years, 90 percent of the subpopulations in four recovery units contain both adults and young.

b. All extant populations within the recovery unit are protected from threats that limit populations.

c. Supporting habitat within the recovery unit is adaptively managed and monitored.

d. Subpopulations are well connected by corridors of suitable habitat.

e. Repatriation (reintroduction) has been successful at a specified number of suitable sites.

Actions Needed:

1. Protect existing populations and habitat.
2. Restore populations to former habitat.
3. Survey to determine species distributions.
4. Monitor populations.
5. Conduct necessary research, including studies on demographics, population genetics, and habitat use.
6. Develop and implement incentive programs, and an outreach and education plan.

Total Estimated Cost of Recovery: The total estimated cost of recovery for the giant garter snake is broken down by priority of tasks. Certain costs, such as securing and protecting specific habitat areas, have yet to be determined.

Priority 1 tasks: $61,048,000
Those actions that must be taken to prevent extinction or prevent the species from declining irreversibly in the foreseeable future.

Priority 2 tasks: $950,000
Those actions that must be taken to prevent a significant decline in the species population or habitat quality, or some other significant negative impact short of extinction.

Priority 3 tasks: $360,000
All other actions necessary to meet the recovery and conservation

objectives outlined in this recovery plan.

Cost of Recovery: $62,358,000 plus additional costs yet to be determined.

Date of Recovery: Delisting could be initiated by 2028, if recovery criteria have been met.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

Brief Overview

This recovery plan features the giant garter snake. The giant garter snake is an endemic species of wetlands in the Central Valley of California. The Central Valley extends 644 kilometers (400 miles) from the vicinity of Red Bluff in the north to Bakersfield in the south and encompasses an area of about 5,260,840 hectares (13,000,000 acres) (Figure 1). The Central Valley is made up of the Sacramento Valley in the north and the San Joaquin Valley in the south. Historically, giant garter snakes were found in the Sacramento and San Joaquin Valleys from the vicinity of Butte County southward to Buena Vista Lake, near Bakersfield in Kern County. Today, populations of the giant garter snake are found in the Sacramento Valley and isolated portions of the San Joaquin Valley, making up 13 recognized populations. They historically inhabited natural wetlands and now occupy a variety of agricultural, managed, and natural wetlands including their waterways and adjacent upland habitats. As a result of habitat loss and fragmentation, declining populations, and continuing threats to the remaining populations, the giant garter snake was listed as a federally threatened species on October 20, 1993 (U.S. Fish and Wildlife Service 1993). The State of California listed the giant garter snake as a threatened species in 1971. The Federal recovery priority number for the giant garter snake is 2C (full species, high degree of threat, high recovery potential). See Appendix A for how recovery priorities are established for listed species.

In addition to the giant garter snake, wetland habitats of the Central Valley are also important to a wide variety of other wildlife species. Many of the recovery tasks recommended in this recovery plan for the giant garter snake may also benefit a number of species of concern to the U. S. Fish and Wildlife Service. These are waterfowl, the western pond turtle, tricolored blackbird, and white-faced ibis. All of these species of concern utilize Central Valley wetlands but are more widely distributed geographically than the giant garter snake. The Central Valley of California is the most important wintering area for waterfowl in the Pacific Flyway, supporting over 20 species and 60 percent of the total flyway population. The western pond turtle shares the same wetland habitat types as the

Figure 1. The Central Valley of California

giant garter snake, but its distribution extends beyond the Central Valley into Oregon and Washington. Tricolored blackbirds and white-faced ibis both nest in wetland habitats of the Central Valley and forage in adjacent agricultural lands. The tricolored blackbird, which also nests in upland habitats, is more widely distributed in California and southern Oregon. The white-faced ibis nests and winters primarily in the western United States. More detailed accounts for these species of concern are included in Appendix B.

Description and Taxonomy

The giant garter snake was originally described and named by Fitch (1940) as *Thamnophis ordinoides gigas*.[1] Fitch presented an exhaustive study of what he called the *ordinoides* artenkreis (species complex or group of closely related species) which included the six species now recognized as the Pacific coast garter snake (*T. atratus*), Sierra garter snake (*T. couchii*), western terrestrial garter snake (*T. elegans*), giant garter snake (*T. gigas*), two-striped garter snake (*T. hammondii*), and northwestern garter snake (*T. ordinoides*.) Though Fitch continued to place all the taxa in the species *T. ordinoides*, he divided the *ordinoides* artenkreis into three intergrading groups on the basis of morphology and ecology: Elegans, Hydrophila, and Ordinoides. The Hydrophila group encompasses the more aquatic taxa, including the giant garter snake.

Although Fitch's monograph and division of the garter snakes into three subgroups helped to clarify the relationships within the garter snake complex, it did not resolve the contradictory situation in which two or three subspecies of the same species occurred sympatrically. Mayr (1942) suggested that Fitch's three subspecies groups be recognized as distinct species. Further taxonomic revisions of the western garter snakes attempted to resolve these apparent contradictions.

The first division of Fitch's *ordinoides* artenkreis was suggested by Johnson

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Prior to Fitch's (1940) study of western garter snakes, the common name, "giant garter snake," applied to the subspecies *Thamnophis ordinoides couchii* (Van Denburgh and Slevin 1918, Van Denburgh 1922), which included garter snakes from the San Joaquin Valley and the lower Sierra Nevada. Van Denburgh (1922) described the range as extending from Shasta County to Kern County and from Monterey County to as far east as the eastern side of the Sierra Nevada, including the Owens Valley.

(1947). He determined Fitch's Ordinoides group was made up of a distinct species (*T. ordinoides*) and applied the specific epithet *elegans* to the Elegans group. Fitch (1948) and Fox (1948) later reviewed the systematics of the western garter snakes and placed the giant garter snake (along with the remainder of Fitch's *ordinoides* artenkreis) as subspecies of the western terrestrial garter snake, *T. elegans*. Fox (1951) continued to recognize this arrangement because of apparent intergradation between the aquatic and terrestrial groups of snakes comprising the terrestrial garter snake group.

Fox and Dessauer (1965) examined plasma proteins of western garter snakes and found no phenotypic characteristics of intergradation. From this evidence of reproductive isolation, Fox and Dessauer (1965) concluded that the terrestrial form should be recognized as *T. elegans* and the aquatic form as *T. couchii*. The *T. couchii* group included six subspecies, one of which was the giant garter snake, known then as *T. couchii gigas*.

The first garter snake phylogeny based on biochemical data (Lawson and Dessauer 1979) portrayed the relationships among members of Fitch's *ordinoides* artenkreis. Their phenogram, based on allozyme data, revealed that the species *T. couchii* consisted of distinct subgroups and pointed toward the species level distinctness of *T. couchii*, *T. hammondii*, *T. gigas*, and *T. atratus*. Rossman and Stewart (1987) used morphological characters to further examine and reevaluate the relationships of the taxa within *T. couchii*. They demonstrated that *T. couchii* was a composite of four distinct species (*T. atratus*, *T. couchii*, *T. gigas*, and *T. hammondii*) and formally recognized the giant garter snake, *T. gigas*, as a full species. Specimens Fitch (1940) considered to be intergrades between *T. gigas* and *T. couchii* were also reexamined and determined to be typical *T. couchii*.

Based on molecular (Lawson and Dessauer 1979, de Queiroz and Lawson 1994) and morphological (Rossman and Stewart 1987) studies, the giant garter snake was hypothesized to have a sister-taxon relationship with the Pacific coast garter snake. Details of the relationships between the giant garter snake and Pacific coast garter snake, where their ranges meet, are lacking. However, the comparatively low levels of genetic differentiation between giant garter snakes and Pacific coast garter snakes (1.4 percent mtDNA sequence divergence, de Queiroz and Lawson

1994) suggests that separation of these two lineages is quite recent.

Subspecies have not been described for the giant garter snake, but there appears to be some morphological variation, principally with aspects of dorsal coloration and pattern, that conforms to geographic units (i.e., northern and southern groupings) (Boundy 1990). To date, there have been no range-wide studies of genetic variation in giant garter snakes. The only contemporary genetic studies on the giant garter snake have incorporated allozyme variation (Lawson and Dessauer 1979) or mtDNA sequencing (de Queiroz and Lawson 1994) in phylogenetic studies of the Sierra garter snake complex.

Figure 2 depicts an adult and newborn (neonate) giant garter snake from the Natomas Basin. The giant garter snake reaches a maximum total length of at least 162 centimeters (64 inches). The maximum number of dorsal scale rows is 23 or 21; supralabials (scales on upper lip) number 8, with the 6th shorter than the 7th; subcaudals (scales on the underside of the tail, counted beginning with the first scale behind the vent) number 73 to 81 in males, 65 to 73 in females; the lateral stripe, when present, is confined to dorsal scale rows 2 and 3 (Van Denburgh and Slevin 1918, Fitch 1940, Stebbins 1985, Rossman and Stewart 1987, Rossman *et al.* 1996).

Dorsal background color varies from brown to olive with a cream, yellow, or orange dorsal stripe and two light colored lateral stripes (Figure 2). Some individuals have a checkered pattern of black spots between the dorsal and lateral stripes. Background coloration, prominence of the checkered pattern, and the three yellow stripes are individually and geographically variable (R. Hansen 1980). Individuals in the northern Sacramento Valley tend to be darker with more pronounced mid-dorsal and lateral stripes (California Department of Fish and Game 1992). The ventral coloration is variable from cream to orange to olive-brown to pale blue with or without ventral markings (G. Hansen 1980, California Department of Fish and Game 1992). Supralabial scales are dull brown and usually lack distinct wedge markings (G. Hansen 1980, California Department of Fish and Game 1992). As giant garter snakes near ecdysis (skin shedding), all pattern characteristics and colors may be obscured (G. Hansen pers. comm. 1998).
Figure 2. Photograph of an adult and newborn giant garter snake

The giant garter snake can be distinguished from the common garter snake (*T. sirtalis*) and the western terrestrial garter snake by its color pattern, scale numbers, and head shape. The giant garter snake lacks the red lateral markings of the common garter snake. The western terrestrial garter snake has well defined stripes and a black to dark gray ground color. The giant garter snake has a maximum of 23 or 21 scale rows and 8 supralabials. The common garter snake has a maximum of 19 scale rows and 7 supralabials, and the western terrestrial garter snake has a maximum of 19 or 21 scale rows and 8 supralabials. In addition, the giant garter snake's seventh supralabial scale is wider than the sixth (R. Hansen 1980, Stebbins 1985, Rossman *et al.* 1996). The giant garter snake has an elongated head with a pointed muzzle (Stebbins 1985, Rossman *et al.* 1996). The relative width of the muzzle of the giant garter snake averages 75.6 percent in males and 65.1 percent in females (calculated as InR/NR, where InR is the width of contact between the internasal and rostral scales, and NR is the width of contact between the nasal and rostral scales) (Rossman *et al.* 1996). The common garter snake and the western terrestrial garter snake have broad muzzles; the relative muzzle width of the western terrestrial garter snake averages 99 to 112 percent, and the relative muzzle width of the common garter snake averages 127.6 percent (Rossman *et al.* 1996).

<u>Distribution</u>

Giant garter snakes are endemic to the valley floors of the Sacramento and San Joaquin Valleys of California (Fitch 1940, Hansen and Brode 1980, R. Hansen 1980, Rossman and Stewart 1987) (Figure 3). Although the boundaries of its original distribution are uncertain, records coincide with the historical distribution of the large flood basins, fresh water marshes, and tributary streams of the Central Valley of California (Hansen and Brode 1980). Fitch (1940) described the historical range of giant garter snakes as extending from the vicinity of Sacramento and Contra Costa Counties southward to Buena Vista Lake, near Bakersfield in Kern County. Fox (1951) indicated that intergrades between giant garter snakes and another closely related species (then called *T. elegans aquaticus*) occurred from Butte County near Gridley south to Sacramento. Hansen and Brode (1980) suggested that the intergrades described by Fox (1951) were actually giant garter snakes and described the range of the giant garter snake as extending from Burrel in Fresno County, north to Gridley. Rossman and

Figure 3. Distribution of the giant garter snake

Stewart (1987) examined additional specimens and concluded that the range of the giant garter snake extended to about 32 kilometers (20 miles) north of Gridley. The giant garter snake probably occurred historically from Butte County in the north, southward to Buena Vista Lake in Kern County. Giant garter snakes have probably always been absent from the northern portion of the San Joaquin Valley, where the floodplain of the San Joaquin River is restricted to a relatively narrow trough by alluvium from tributary rivers and streams. This 100-kilometer (62-mile) gap in its distribution separates populations in Merced County from those along the eastern fringes in the Sacramento/San Joaquin River Delta (the Delta) in San Joaquin County (Hansen and Brode 1980). Because extensive marshes are known to have once occurred in the Delta, it is possible that giant garter snakes historically occupied this area (G. Hansen 1986, 1988). The eastern and western boundaries of their range are probably defined by the foothills of the Coast Ranges and the Sierra Nevada Mountains. Rossman *et al.* (1996) described the elevational distribution ranging from 0 to 122 meters (0 to 400 feet). Locality records in the southern Sacramento Valley occurred between 3 and 12 meters (10 and 40 feet) elevation (G. Hansen 1986).

G. Hansen (1980) investigated the gap between the distribution of the giant garter snake and the Sierra garter snake on the eastern side of San Joaquin Valley and determined that the ranges of the two garter snake species were limited historically by extensive riparian forests along river corridors. The river corridors lacked rocks or exposed vegetation (e.g., bulrushes, cattails) and areas on shore that might serve as basking sites. Prey items may also have been less abundant in these riparian corridors than in sloughs and marshes of the Central Valley floor (R. Hansen 1980).

Agricultural and flood control activities have extirpated the giant garter snake from the southern one third of its range in the former wetlands associated with the historic Buena Vista, Tulare, and Kern lakebeds (Hansen and Brode 1980, R. Hansen 1980, California Department of Fish and Game 1992, G. Hansen 1986, G. Hansen 1988) (Figure 3). As recently as the 1970's, the range of the giant garter snake extended from near Burrel (Hansen and Brode 1980) northward to the vicinity of Chico (Rossman and Stewart 1987). California Department of Fish and Game studies (G. Hansen 1988) indicate that giant garter snake populations are distributed in portions of the rice production zones of Sacramento, Sutter, Butte, Colusa, and Glenn Counties; along the western border of the Yolo Bypass in Yolo and Solano Counties, west to the vicinity of Woodland in Yolo County and the vicinity of Liberty Farms in Solano County; and along the eastern fringes of the Sacramento/San Joaquin River Delta from the Laguna Creek/Elk Grove region of central Sacramento County southward to the Stockton area of San Joaquin County (Figure 3). Giant garter snakes also occur in the central San Joaquin Valley in rice production zones in the Grasslands area of Fresno and Merced Counties, and at Mendota Wildlife Area in Fresno County (G. Hansen 1996, G. Hansen pers. comm. 1998) (Figure 3). In September 1998, a giant garter snake was positively identified in the western Sacramento/San Joaquin Delta in the vicinity of Decker and Sherman Islands, in Sacramento County. The last record of a giant garter snake this far west in the Delta was from a specimen collected in the 1930's to 1940's (G. Hansen pers. comm. 1998). It is not know if this snake represents a resident population in the western Delta or was washed into the Delta during high water flows in the winter of 1997-1998.

The San Joaquin Valley subpopulations of giant garter snakes have apparently suffered severe declines and possible extirpations over the last two decades. Prior to 1980, several areas within the San Joaquin Valley supported populations of giant garter snakes. Until recently, there were no post-1980 sightings from Stockton and southward, despite several survey efforts (G. Hansen 1988). Surveys of historic localities conducted during 1986 did not detect any giant garter snakes (G. Hansen 1988). However, during the 1995 surveys of historic locality records and adjacent waterways, one road-killed giant garter snake was found, and three presumed giant garter snakes were observed but not captured. These two sightings occurred at the Mendota Wildlife Area, and two occurred several miles south of the city of Los Banos. These data indicated that giant garter snakes are still extant in two localities within the San Joaquin Valley, but are in extremely low to undetectable numbers. Giant garter snakes also were observed in the Caldoni Marsh/White Slough Wildlife Area in San Joaquin County during 1995 surveys (G. Hansen 1996).

The California Department of Fish and Game and the Grassland Water District have begun (spring of 1998) a cooperative effort to investigate the status of giant garter snakes in the San Joaquin Valley. Surveys in 1998 have detected seven giant garter snakes at a locality recorded in 1976 (California Natural Diversity Data Base 1996 data), along Los Banos Creek, west of Kesterson National Wildlife Refuge in Merced County. Four adult females and three adult males were captured, measured, and tagged. Snout-vent lengths ranged from 55.6 centimeters (21.9 inches) to 96.5 centimeters (38.0 inches). Another female giant garter snake (96.2 centimeters [37.8 inches] snout-vent length) was captured at a locality recorded in 1976 (California Natural Diversity Data Base 1996 data) just west of the town of Dos Palos in Merced County.

In 1994, the Biological Resources Division of the U.S. Geological Survey (formerly the National Biological Survey) began a study of the life history and habitat requirements of the giant garter snake in response to an interagency submittal for consideration as a National Biological Survey Ecosystem Initiative. Since April of 1995, the Biological Resources Division has further documented occurrences of giant garter snakes within some of the 13 populations identified in the final rule to list this species (U.S. Fish and Wildlife Service 1993). The Biological Resources Division has studied populations of giant garter snakes at the Sacramento and Colusa National Wildlife Refuges within the Colusa Basin; at Gilsizer Slough within the Sutter Basin; and at the Badger Creek area of the Cosumnes River Preserve, within the Badger Creek/Willow Creek area (Wylie *et al.* 1997). These populations, along with the American Basin population of giant garter snakes, represent the largest extant populations. During 1997, the Biological Resources Division also surveyed at Stone Lakes National Wildlife Refuge, where four locality records occur on or within close proximity to the Refuge, dating from 1992 and prior (California Natural Diversity Data Base 1996 data). Although suitable habitat is present at Stone Lakes National Wildlife Refuge, the Biological Resources Division did not find giant garter snakes during their trapping efforts (G. Wylie pers. comm. 1998). Surveys over the last two decades have located the giant garter snake as far north as the Butte Basin in the Sacramento Valley.

Currently, the U. S. Fish and Wildlife Service recognizes 13 separate populations of giant garter snakes, with each population representing a cluster of discrete locality records (U.S. Fish and Wildlife Service 1993). The 13 extant populations

largely coincide with historical riverine flood basins and tributary streams throughout the Central Valley (G. Hansen 1980, Brode and Hansen 1992): (1) Butte Basin, (2) Colusa Basin, (3) Sutter Basin, (4) American Basin, (5) Yolo Basin/Willow Slough, (6) Yolo Basin/Liberty Farms, (7) Sacramento Basin, (8) Badger Creek/Willow Creek, (9) Caldoni Marsh, (10) East Stockton -- Diverting Canal and Duck Creek, (11) North and South Grasslands, (12) Mendota, and (13) Burrel/Lanare. These populations are distributed discontinuously in small isolated patches and are vulnerable to extirpation by random, naturally occurring environmental events; population dynamics; and genetic processes. All 13 populations are isolated from each other without protected dispersal corridors. These populations span the Central Valley from just southwest of Fresno (i.e., Burrel/Lanare) north to Butte Creek. The 11 counties where the giant garter snake
is still presumed to occur are: Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, and Yolo.

<u>Life History and Ecology</u>
Giant garter snakes feed primarily on aquatic prey such as fish and amphibians. Brode (1988) and G. Hansen (1988) suggest that the giant garter snake specializes in ambushing small fish underwater, and Rossman *et al.* (1996) suggested the giant garter snake occupies a niche similar to some eastern water snakes (*Nerodia* spp.). They appear to take advantage of pools which trap and concentrate prey items. R. Hansen (1980) and Hansen and Brode (1993) observed giant garter snakes feeding on mosquitofish (*Gambusia affinis*) confined to small pools of water. The predominant food items of giant garter snakes are now introduced species such as carp (*Cyprinus carpio*), mosquito fish, other small fish, and bullfrogs (*Rana catesbeiana*) (Fitch 1941, Fox 1952, R. Hansen 1980, Brode 1988, Hansen and Brode 1993, Rossman *et al.* 1996, G. Wylie pers. comm 1998).

Native species preyed upon by giant garter snakes include the Sacramento blackfish (*Orthodox microlepidotus*) and the Pacific treefrog (*Hyla regilla*). Cunningham (1959) reported a record of a giant garter snake from Buena Vista Lake, Kern County, swallowing a live Sacramento blackfish which it had just dragged onto the bank. Historically, giant garter snake food also may have included the extinct thick-tailed chub (*Gila crassicauda*) and the federally threatened California red-legged frog (*Rana aurora draytonii*), which has been extirpated from the Central Valley floor (R. Hansen 1980, Rossman *et al.* 1996).

The breeding season for the giant garter snake begins soon after emergence from overwintering sites and extends from March into May, and resumes briefly during September (G. Hansen pers. comm. 1998). Males immediately begin searching for mates after emerging (G. Hansen pers. comm. 1991). Females brood young internally, and typically give birth to live young from late July through early September (Hansen and Hansen 1990). Brood size is variable, ranging from 10 to 46 young, with a mean of 23 (Hansen and Hansen 1990). At birth young average about 20.6 centimeters (8.1 inches) snout-vent length and weigh 3 to 5 grams (0.1 to 0.2 ounces). Young immediately scatter into dense cover and absorb their yolk sacs, after which they begin feeding on their own. Although growth rates are variable, young typically more than double in size by 1 year of age (G. Hansen pers. comm. 1991). Sexual maturity averages 3 years in males and 5 years for females (G. Hansen pers. comm. 1991).

During 1989 and 1990, sex ratio data were collected from giant garter snakes captured by hand in the Natomas Basin population (Hansen and Brode 1993). In a sample of 191 individuals, the ratio of females to males was approximately 1.5:1 (Hansen and Brode 1993). During 1996, sex ratio data were collected for three other populations (Wylie *et al.* 1997). The ratio of females to males was approximately 1:1 at both Badger Creek Marsh in Sacramento County and Gilsizer Slough in Sutter County. In contrast, the sex ratio was roughly 2:1 at Colusa National Wildlife Refuge in Colusa County. The differences in sex ratios may be due to the differences in trapping techniques. All snakes at Badger Creek were caught using floating minnow traps, while 68 percent of snakes at Gilsizer Slough were caught using traps and 32 percent were caught by hand. At Colusa National Wildlife Refuge, 78 percent were caught by hand and 22 percent by trap because of the difficulty in deploying floating minnow traps. All giant garter snakes captured by Hansen and Brode (1993) were captured by hand. Capture by hand depends on visual detections and thus probably detects mostly larger snakes, which tend to be females (Wylie *et al.* 1997), however, G. Hansen (pers. comm. 1998) suggested that floating traps may be less effective for trapping larger giant garter snakes.

There are few population size estimates for giant garter snakes. Hansen and Brode (1993) marked and released 84 giant garter snakes in a 2.6-square kilometer (1-square mile) area of rice lands in the Natomas Basin. Of the 107 giant garter snakes captured in the area the following year, only 9 marked snakes were recaptured, indicating a local population size of approximately 1,000 giant garter snakes within the square mile (G. Hansen pers. comm. 1998). Wylie *et al.* (1997) reported captures of giant garter snakes during the 1996 field season: 66 snakes captured at Gilsizer Slough (not previously caught in 1995), 46 at Colusa National Wildlife Refuge, and 36 at Badger Creek Marsh. Mark-recapture studies conducted by the Biological Resources Division also yielded population estimates for these three study sites (see Table 1) (G. Wylie pers. comm. 1998). The population at the 1,430-hectare (3,500-acre) Gilsizer Slough study site was estimated to be 206 individuals in 1995 and 170 individuals in 1996 (G. Wylie pers. comm. 1998). The much larger study area at Colusa National Wildlife Refuge (4,500 hectares [11,120 acres]) was estimated to have 132 individuals in 1996, and 119 individuals in 1997. In contrast, the smallest study site was estimated to have one of the highest population sizes; the 235-hectare (580-acre) Badger Creek Marsh was estimated to have 191 giant garter snakes in 1996 (G. Wylie pers. comm. 1998).

The Biological Resources Division also estimated the home range sizes of giant garter snakes at three study sites. Home range estimates were derived from telemetry data using the adaptive kernal method (G. Wylie pers. comm. 1998) (see Table 1). The median home range estimate for individual snakes at Gilsizer Slough is 19.0 hectares (47 acres) (range 0.8 hectare [2 acres] to 259.5 hectares [641 acres], N[2]=27) (G. Wylie pers. comm. 1998). The median home range estimate at Colusa National Wildlife Refuge is 53.2 hectares (131 acres) (range 1.3 to 1,130 hectares [3.2 to 2,792 acres], N=29)(G. Wylie pers. comm. 1998). At Badger Creek, median home range was 9.2 hectares (23 acres) (range 4.2 to 82.0 hectares [10.3 to 203 acres], N=8) (G. Wylie pers. comm. 1998).

[2] "N" represents the number of individual snakes studied.

Table 1. Population estimates and home range size estimates for three populations of giant garter snakes.

Site (surface area in hectares/acres)	Year	Population Estimate (95% C.I.)*	Median Home Range in hectares/ acres (range in hectares)**
Gilsizer Slough (1,430/3,500)	1995 1996	206 (136-349) 170 (128-248)	19.0/47 (0.8-259.5) N =27
Colusa NWR (4,500/11,120)	1996 1997	132 (80-254) 119 (72-239)	53.2/131 (1.3 - 1,130) N =29
Badger Creek (235/580)	1996	191 (69-674)	9.2/23 (4.2 - 82.0) N =8

* Population estimates for giant garter snakes from the mark-recapture model with time-specific changes in probability of capture, which results in a conservative estimate. Estimates are derived from 2 week time intervals. ** Home range estimates (hectares/acres) for individual giant garter snakes derived from telemetry using the adaptive kernal method. "N " is the number of snakes in the sample. "C.I." is the Confidence Interval.

Hansen and Brode (1993) found that among 191 Natomas Basin giant garter snakes, females on the average, were found to be longer and heavier than males (excluding neonates), with males ranging up to 820 millimeters (32.3 inches) snout-vent length (average 665 millimeters [26.2 inches] snout-vent length, N = 75) and females ranging up to 1,080 millimeters (42.5 inches) snout-vent length (average 887 millimeters [34.9 inches] snout-vent length, N=116); with males ranging to 289 grams (10.2 ounces) (average 140 grams [4.9 ounces], N=74) and females ranging up to 785 grams (1.73 pounds) (average 433 grams [1.0 pound], N=115) (G. Hansen, pers. comm. 1998) (See Figure 4 for male and female snout-vent lengths for a study area in the Natomas Basin, and Figures 5 and 6 for male and female snout-vent lengths and weight classes, for study areas at Badger Creek, Gilsizer Slough, and Colusa National Wildlife Refuge). Male giant garter snakes captured during 1998 on the Sacramento National Wildlife Refuge Complex averaged 698.12 millimeters (27.5 inches) and 159.21 grams (5.6 ounces, N=16), while females averaged 821.57 millimeters (32.3 inches) and 331.88 grams (11.7 ounces, N=53) (M. Wolder pers. comm. 1998). There is very little known about the behavior of giant garter snakes. Van Denburgh and Slevin (1918), Van Denburgh (1922), and Fitch (1940) described the extreme wariness of giant garter snakes and the difficulty of approaching and capturing them, as have many

Figure 4. Snout-vent lengths of female and male giant garter snakes from the

Natomas Basin. Source: Caltrans/California Department of Fish and Game data (1988-1989).

Figure 5. Snout-vent lengths of giant garter snakes from three study areas. Source: U.S. Geological Survey., Biological Resources Division, Dixion Field Station.

Figure 6. Weight classes of giant garter snakes from three study sites. Source: U.S. Geological Survey, Biological Resources Division, Dixon Field Station.

subsequent authors (R. Hansen 1980, Hansen and Brode 1980, Brode 1988). In response to disturbance, giant garter snakes retreat to or dive under water (Fitch 1941, R. Hansen 1980) may remain motionless, or retreat underground (G. Hansen pers. comm. 1998, G. Wylie pers. comm. 1998). During cool weather, giant garter snakes often retreat into burrows, riprap, or vegetation rather than dive into the water (G. Hansen pers. comm. 1998). Fitch (1940) attributed the snake's wariness to the open habitat and lack of trees, logs, rocks, and bushes for cover from predators.

One behavioral characteristic that is widespread in natricine snakes (a group of snakes characterized by aquatic tendencies; belonging to the subfamily Natricinae, e.g., *Thamnophis* spp., *Nerodia* spp.), is the voiding of cloacal secretions when alarmed. R. Hansen (1980) noted that both giant garter snakes and Sierra garter snakes thrashed about when picked up, and attempted to smear the "musk" on the captor and themselves. Musking behavior is assumed to discourage attacks by rendering the snake unpalatable (R. Hansen 1980).

A number of native mammals and birds are known or are likely predators of giant garter snakes, including raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*), opossums (*Didelphis virginiana*), foxes (*Vulpes vulpes*, *Urocyon cinereoargenteus*), hawks (*Buteo* spp.), northern harriers (*Circus cyaneus*), egrets (*Casmerodius albus*, *Egretta thula*), bitterns (*Botaurus lentiginosus*), and great blue herons (*Ardea herodias*). Many areas supporting garter snakes have been documented to have abundant predators (R. Hansen 1980, Hansen and Brode 1993, Wylie *et al.* 1997). G. Hansen (1986) observed that nearly all giant garter snakes captured and examined possessed scars or recent injuries, presumably acquired during attacks by predators. R. Hansen (1980) concluded that the abundance and diversity of predators suggested that predation pressure probably is severe. However, predation does not seem to be a limiting factor in areas that provide abundant cover, high concentrations of prey items, and connectivity to a permanent water source (Wylie *et al.* 1997).

The giant garter snake may coexist with two other species of garter snakes. The valley garter snake (*T. sirtalis fitchi*) was found to coexist with giant garter snakes in all areas that currently support them (R. Hansen 1980, G. Hansen 1986). The western terrestrial garter snake was observed at locations in the Elk Grove and Galt areas of Sacramento County, and Badger Creek Marsh supports all three species of garter snakes (G. Hansen 1986). Differences in foraging behavior may allow these species to co-occur. The valley garter snake forages among vegetation bordering the water, while the giant garter snake captures its food in the water (R. Hansen 1980). Giant garter snakes may also successfully compete with the valley garter snake by specializing on small fish as prey (Brode 1988).

Giant garter snakes are most active from early spring through mid-fall. Activity is probably dependent on weather conditions and may be variable from year to year but follows a general pattern (Brode 1990, Hansen and Brode 1993):

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

Seasonal activity may begin earlier than April 1 (as early as March 1) in some years. Hansen and Brode (1993) reported captures of giant garter snakes in the Natomas Basin in March, and observed that injured snakes emerged during any month. In 1996, captures of giant garter snakes began in March at Gilsizer Slough and at Colusa National Wildlife Refuge (Wylie *et al.* 1997). Late March was reported as the earliest time of regular seasonal activity at the Mendota Wildlife Area (R. Hansen 1980). Giant garter snake activity peaks during April and May, and therefore, may become less detectable in mid- to late summer (Hansen and Brode 1993). Hansen and Brode (1993) found that the sudden decrease in observations of giant garter snakes along canals in June and July corresponded with the sudden appearance of giant garter snakes within maturing rice fields. Captures at Gilsizer Slough and Colusa National Wildlife Refuge became infrequent after June of 1996 (Wylie *et al.* 1997). At Badger Creek Marsh, captures in 1996 became infrequent after mid-July, and in August of 1996, giant garter snakes at Badger Creek Marsh used burrows as much as 50 meters (164 feet) away from the marsh edge to escape extreme heat (Wylie *et al.* 1997).

Giant garter snakes are generally inactive in winter months although some individuals may bask or move short distances on warmer days. For example, juveniles were occasionally observed at the Mendota Wildlife Area during the winter months when the air temperature was only 15 degrees Celsius (59 degrees Fahrenheit) (R. Hansen 1980). In the Sacramento Valley, 50 percent of the radio-telemetered snakes were observed, at some time, basking or moving short distances in winter (Wylie *et al.* 1997).

Fitch (1940) termed the giant garter snake as a “strictly diurnal snake.” However, observations by R. Hansen (1980) suggest that giant garter snakes are flexible in terms of their activity. Giant garter snakes were observed feeding at night on mosquito fish which were confined to small pools of water, and giant garter snakes at the Mendota Wildlife Area exhibited diurnal activity during the spring (March to June), and nocturnal activity during the hot summer months (R. Hansen 1980). Cunningham (1959) observed giant garter snakes feeding at night in September, 2 ½ hours after dark at Buena Vista Lake. Hansen and Brode (1993) also observed giant garter snakes after sunset during hot weather. G. Hansen (pers. comm. 1991) reported observing giant garter snakes active at night at the Mendota Wildlife Area, Gray Lodge Wildlife Area, and within the Natomas Basin during cool spring nights as well as during hot weather. The daily activity of giant garter snakes was described by Hansen and Brode (1993) to follow a general pattern: 1) emergence from burrows after sunrise; 2) basking to warm bodies to activity temperatures, particularly during cool weather or on cold mornings; 3) foraging or courting activity for the remainder of the day. During radio-telemetry studies conducted by the Biological Resources Division, giant garter snakes typically moved little from day to day. However, total activity varied widely among individuals. At Colusa National Wildlife Refuge, snakes moved up to 8 kilometers (5 miles) in a few days in response to dewatering of habitat during refuge maintenance of water control structures (Wylie *et al.*. 1997). Giant garter snakes usually remain in close proximity to wetland habitats but can be found as far away as 250 meters (820 feet) from the edge of marsh habitat (G. Hansen 1988, Wylie *et al.* 1997). Hansen and Brode (1993) also documented giant garter snake movements within the Natomas Basin. Giant garter snakes moved at least 0.4

kilometer (0.25 mile) between small lateral ditches and larger canals and some marked and recaptured giant garter snakes moved distances greater than 0.8 kilometer (0.5 mile) in as little as a day.

Habitat and Ecosystem Description

The giant garter snake inhabits agricultural wetlands and other waterways, such as irrigation and drainage canals, ricelands, marshes, sloughs, ponds, small lakes, low gradient streams, and adjacent uplands in the Central Valley. Essential habitat components consist of: (1) adequate water during the snake's active season (early spring through mid-fall) to provide adequate permanent water to maintain dense populations of food organisms; (2) emergent, herbaceous wetland vegetation, such as cattails (*Typha* spp.) and bulrushes (*Scirpus* spp.), for escape cover and foraging habitat during the active season; (3) upland habitat with grassy banks and openings in waterside vegetation for basking; and (4) higher elevation upland habitats for cover and refuge from flood waters during the snake's inactive season in the winter (G. Hansen 1980, G. Hansen 1988, Brode and Hansen 1992, Hansen and Brode 1993). Giant garter snakes are absent from larger rivers, and from wetlands with sand, gravel, or rock substrates (G. Hansen 1980, Rossman and Stewart 1987, Brode 1988, G. Hansen 1988). Riparian woodlands do not typically provide suitable habitat because of excessive shade, lack of basking sites, and the absence of prey populations (G. Hansen 1980).

The ideal concept of a managed marsh as giant garter snake habitat should be in a configuration with shallow and deep water and variations in topography, including some higher ground resembling the ditch banks ... or "islands" similar to a rice check. Rice fields contain warm shallow water with sheltering emergent vegetation (i.e. rice plants) which is present within the fields during the giant garter snake active season in the spring, summer, and early fall. During the late summer when rice fields contain large numbers of mosquito fish and Pacific tree frogs, rice fields may provide important nursery areas for newborn giant garter snakes (Brode and Hansen 1992, Hansen and Brode 1993). The habitat and its associated water conveyance system, if managed properly, provides the giant garter snake ease of movement; protection from predators; warmth to aid metabolism, gestation, and digestion; and a source of food (G. Hansen pers. comm. 1997).

Giant garter snakes now appear to be most numerous in rice growing regions. The diverse habitat elements of ricelands; the rice fields, tail water marshes, the ditch and drain components of the water conveyance system, delivery canals, and associated levees, all contribute structure and complexity to this man-made ecosystem. Apparently, giant garter snakes can survive in this artificial ecosystem because the spring and summer flooding and fall dry-down of rice culture coincides fairly closely with the biological needs of the species (G. Hansen pers. comm. 1997). Giant garter snakes utilize ricelands extensively and depend on them for habitat. Giant garter snake seasonal activity associated with rice cultivation occurs as follows:

> **Spring**: Rice is planted and the fields are flooded with several inches of water. Rice fields that contain prey species such as small fish or frogs attract giant garter snakes.
>
> **Summer**: While the rice grows, garter snakes continue to use rice fields as long as their prey are present in sufficient densities.
>
> **Late Summer/Fall**: The water is drained from the rice fields and garter snakes move off the fields to other adjacent habitats. Rice is harvested at this time and female garter snakes have just borne young and need food to regain their body weight. In August and September the snakes can get a good supply of food from the ricelands because prey are concentrated in the rice drains. The dry-down of the rice fields in fall is thought to be important because prey, which have been proliferating, are concentrated in the remaining pockets of standing water where snakes can gorge prior to the period of winter inactivity.
>
> **Winter**: Giant garter snakes are dormant in the winter and rice fields are fallow.

In California, rice seed is planted into standing water by aircraft in mid-April and May. Most rice fields are leveled by laser-directed machinery to a slope of 0.02 to 0.05 meter per 100 meters (0.8 to 1.97 inches per 3,937 feet). Seed bed preparation begins as soon as the winter rains let up in March. Virtually, all plant nutrition and weed control practices occur just before or soon after planting. A top dressing of a nitrogen fertilizer is often required later in the summer.

Generally, water is maintained on the rice fields from the date of planting, until September, when fields are drained to speed the uniform ripening of the grain. At a minimum, growers must "hold" water on their fields for up to 28 days after the application of herbicides and insecticides, to protect the quality of released irrigation water. Drains are monitored throughout the pesticide application season to protect aquatic life. Harvest typically begins in September and lasts into mid-November.

Brode and Hansen (1992) and Hansen and Brode (1993), reported that giant garter snakes begin utilizing rice fields as habitat as early as June. In agricultural areas where rice fields and agricultural waterways are available, radio-telemetered giant garter snakes were located in rice fields 19 to 20 percent of the time, in marsh habitat 20 to 23 percent, and in canal and agricultural waterway habitats 50 to 56 percent. Between 48 and 55 percent of snakes used rice fields at some time. Where marsh habitat and adjacent uplands were the only habitat available, giant garter snakes used the marsh edge most of the time (Wylie *et al.* 1997).

Giant garter snakes bask in bulrush, cattails, shrubs overhanging the water, patches of waterweed (*Ludwigia peploides*) and other floating vegetation, and on grassy banks. In the San Joaquin Valley, giant garter snakes also bask in saltbush (*Atriplex* spp.) (Van Denburgh and Slevin 1918, Brode 1988). Riparian vegetation such as saltbush and willows (*Salix* spp.) provide cover from predation. Giant garter snakes also bask in openings in vegetation, created by riprap placed around water control structures. Giant garter snakes use small mammal burrows and other soil crevices above prevailing flood elevations during the winter (i.e., November to mid-March). Giant garter snakes typically select burrows with sunny exposures along south and west facing slopes (G. Hansen pers. comm. 1993). Small mammal burrows, crayfish burrows, and soil crevices provide retreats from extreme heat for giant garter snakes during the active season (Hansen and Brode 1993). Wintering sites varied from canal banks and marsh locations, to riprap along a railroad grade near the marsh (Wylie *et al*. 1997). Wintering locations of radio-telemetered snakes tended to be in the vicinity of spring capture sites. Giant garter snakes use burrows in the summer as much as

50 meters (164 feet) away from the marsh edge, whereas, overwintering snakes use burrows as far as 250 meters (820 feet) from the edge of marsh habitat (Wylie *et al*. 1997).

Reasons for Decline and Current Threats

The current distribution and abundance of the giant garter snake is much reduced from former times. Agricultural and flood control activities have extirpated the giant garter snake from the southern one third of its range in former wetlands which were associated with the historic Buena Vista, Tulare, and Kern lakebeds (Brode and Hansen 1992, California Department of Fish and Game 1992, G. Hansen 1986, Hansen and Brode 1980, R. Hansen 1980). These lakebeds once supported vast expanses of ideal giant garter snake habitat, consisting of cattail and bulrush dominated marshes. South of Fresno, virtually no suitable freshwater habitat remains (Hansen and Brode 1980). Vast expanses of bulrush and cattail floodplain habitat also typified much of the Sacramento Valley historically (Hinds 1952). Prior to reclamation activities beginning in the mid- to late 1800's, about 60 percent of the Sacramento Valley was subject to seasonal overflow flooding in broad, shallow flood basins that provided expansive areas of giant garter snake habitat (Hinds 1952). Valley floor wetlands are subject to the cumulative effects of upstream watershed modifications, water storage and diversion projects, as well as urban and agricultural development. Most natural habitats have been lost, however, a small percentage of seminatural wetlands remain, only a small percentage of which currently provides suitable habitat for the giant garter snake.

Although habitat has been lost or degraded throughout the Central Valley, there have been many recent sightings of giant garter snakes in the Sacramento Valley while there have been very few recent sightings within the San Joaquin Valley. The 1995 report on the status of giant garter snakes in the San Joaquin Valley (G. Hansen 1996) indicates that central San Joaquin Valley giant garter snake numbers appear to have declined even more dramatically than has suitable habitat. Other factors, in addition to habitat loss, may be contributing to the decline of the giant garter snake in the area. These are factors which affect giant garter snakes within suitable habitat and include interrupted water supply, poor water quality, and contaminants (G. Hansen 1996). Beam and Menges (1997) evaluated historic wetland management practices on State Wildlife Areas and private duck clubs in the Grasslands and concluded that several historic changes in the landscape may be linked to the observed decline of giant garter snakes in this region. These historic changes in the landscape that did not favor giant garter snakes were 1) wetland management techniques that did not provide summer water, 2) use of contaminated agricultural drainwater on wetland areas, and 3) lack of flood control.

Selenium contamination and impaired water quality have been identified as a threat to the species and a contributing factor in the decline of giant garter snake populations, particularly for the North and South Grasslands subpopulation (i.e., Kesterson National Wildlife Refuge area) (U.S. Fish and Wildlife Service 1993). High levels of selenium contamination have been documented in biota from at least six major canals and water courses in the Grasslands (Saiki *et al*. 1991, 1992) that have historic giant garter snake records. The bioaccumulative food chain threat of selenium contamination on fish, frogs, and fish-eating birds (Ohlendorf *et al*. 1986, 1988, Saiki and Lowe 1987, Saiki and May 1988, Hothem and Ohlendorf 1989, and Saiki *et al*. 1991, 1992, 1993) in this region has been well documented. Contaminant studies on aquatic organisms and their habitats in the Grasslands and neighboring areas documented elevated levels of waterborne selenium in many representative water bodies in this region (San Joaquin Valley Drainage Program 1990, Central Valley Regional Water Quality Control Board 1992, Nakamoto and Hassler 1992), at concentrations in excess of known toxicity thresholds of giant garter snake prey species (Hermanutz 1992, Hermanutz *et al*. 1992, Nakamoto and Hassler 1992). Though there are little data specifically addressing the toxicity of selenium, mercury, or metals to reptiles, it is expected that reptiles would have toxicity thresholds similar to those of fish and birds (U.S. Fish and Wildlife Service 1993). Several large giant garter snake populations inhabit ricelands. These agricultural wetlands, however, are also threatened with urban development in many locations. Cities within the current range of the giant garter snake that are rapidly expanding include (1) Chico, (2) Woodland, (3) Sacramento, (4) Galt, (5) Stockton, (6) Gustine, (7) Los Banos, and (8) Yuba City/Marysville. Giant garter snake populations found in agricultural wetlands are also threatened by incompatible agricultural management practices (e.g., conversion of ricelands to orchards or cotton) within these ricelands.

Loss of habitat remains the greatest threat to the survival of the giant garter snake. However, degradation of habitat and additional mortality factors may cumulatively threaten the survival of some giant garter snake subpopulations. Activities which may degrade habitat include maintenance of flood control and agricultural waterways, weed abatement, rodent control, discharge of contaminants into wetlands and waterways, and overgrazing in wetland or streamside habitats. These activities can also result in direct mortality of giant garter snakes. Although many maintenance practices are necessary to maintain habitat for the giant garter snake, incompatible maintenance regimes may degrade habitat and increase the risk of giant garter snake mortality (Brode and Hansen 1992, California Department of Fish and Game 1992, G. Hansen 1988, Hansen and Brode 1993). Ongoing maintenance of aquatic habitats for flood control and agricultural purposes may eliminate or prevent establishment of habitat characteristics required by giant garter snakes and can fragment and isolate available habitat, prevent dispersal of snakes among habitat units, and adversely affect the availability of the garter snake's food items (Brode and Hansen 1992, California Department of Fish and Game 1992, G. Hansen 1988, Hansen and Brode 1993). Weed abatement and rodent control may destroy surface cover and underground retreats (California Department of Fish and Game 1992, G. Hansen 1986, G. Hansen 1988, Hansen and Brode 1993). Flood control and canal maintenance activities which may result in death of giant garter snakes and the degradation of habitat includes the construction of levees, channelization of streams, lining streams and canals with concrete or rock riprap, clearing and dredging streams and canals, weed control, and destruction of rodent burrows (California Department of Fish and Game 1992, G. Hansen 1986, G. Hansen 1988, Hansen and Brode 1980, Hansen and Brode 1993). Agricultural practices such as tilling, grading, harvesting, and other equipment operated activities may also kill or injure snakes (California Department of Fish and Game 1992). Additional mortality factors include road mortalities, predation by introduced game fish, bullfrogs, and parasitism.

A 4-year study by Hansen and Brode (1993) monitored newly constructed or modified canals within the Natomas Basin to determine the rate of establishment of giant garter snake habitat. They observed that ongoing maintenance, including scraping canal banks, mowing, and applying herbicides, prevented establishment of vegetation in newly relocated canals within the Natomas Basin. Vegetation became reestablished along several smaller canals that were disturbed less frequently. Rodent and other burrows, and cracks suitable for giant garter snake cover became established sooner where weed abatement was not practiced. Giant garter snake recolonization, in relocated canals, was not detected during the 4-year study.

Land management changes also may affect giant garter snake populations. In the Grasslands, wetland management changes on State Wildlife Areas and private duck clubs affect the availability of summer water which is necessary to provide giant garter snake foraging habitat. Changes in the mid-1970's from watergrass production to moist-soil management for swamp timothy and smartweed resulted in earlier spring irrigation and decreases in summer water. Irrigation of private duck clubs for cattle provided summer water in canals, sloughs, and other water conveyance systems throughout the basin. However, in the mid-1970's, private duck clubs were encouraged to withhold grazing and to change their focus to moist-soil management (Beam and Menges 1997). These land management changes resulting in reduced summer water coincided with the apparent declines of giant garter snake populations in the Grasslands (Beam and Menges 1997, G. Hansen 1988, G. Hansen 1995).

Cattle grazing and irrigated pastures provide the summer water that giant garter snakes require. However, overgrazing may degrade giant garter snake habitat and eliminate cover. The giant garter snake requires dense vegetative cover in proximity to waterside foraging and basking habitats in which to seek refuge from predators and other forms of disturbance. Livestock overgrazing along the edges of water sources degrades habitat quality in a number of ways: (1) eating and trampling aquatic and riparian vegetation needed for cover from predators, (2) changes in plant species composition, (3) trampling snakes and burrows needed for shelter, (4) water pollution, and (5) reducing or eliminating fish and amphibian prey populations.

Habitat alterations that result in loss of cover and lower densities of prey items may increase the vulnerability of giant garter snakes to avian and mammalian predators, and may also increase the giant garter snakes vulnerability to predation by introduced game fish such as largemouth bass (*Micropterus salmoides*) and catfish (*Ictalurus* spp.). These introduced predatory fishes have been responsible for eliminating many species of native fishes and aquatic vertebrates in the western United States (Minkley 1973, Moyle 1976). Brood areas free of predatory fish may be important, in that these areas allow juvenile giant garter snakes to grow large enough to avoid predation by game fish (G. Hansen pers. comm. 1998). Introduced predatory fish may also compete with giant garter snakes for smaller forage fish (California Department of Fish and Game 1992, G. Hansen 1986). G. Hansen (1986) also suggested that habitat alterations may allow other garter snake species access to giant garter snake habitat, allowing them to compete more successfully with giant garter snakes (California Department of Fish and Game 1992, G. Hansen 1986).

The introduction of the bullfrog to virtually all areas that are inhabited by the giant garter snake may greatly increase the threat of predation facing the species. A large body of evidence implicates the spread of bullfrogs in the demise of numerous species of native amphibians and reptiles (Schwalbe and Rosen 1989, Holland 1992). Bury and Whelan (1984) cited 14 cases of bullfrogs eating snakes. These studies documented (1) bullfrog ingestion of garter snakes up to 80 centimeters (31.5 inches) in length, (2) depletion of garter snake age class structure less than 80 centimeters (31.5 inches) length (snout-vent), and (3) the disappearance and subsequent resurgence of garter snake populations coincident with the introduction and decline of bullfrog populations. Although these studies were conducted on other species of garter snakes, it is likely that the giant garter snake is similarly affected. Schwalbe and Rosen (1989) concluded that bullfrogs have a high potential of eliminating garter snake populations. Treanor (1983) found that unidentified garter snakes comprised 6.0 and 6.4 percent volume of bullfrog stomach contents in the months of July and August at Gray Lodge Wildlife Area, a known giant garter snake location. Mid-summer corresponds to the birthing period of giant garter snakes, suggesting that young snakes are particularly vulnerable to bullfrog predation.

Little information on the threats of disease and parasitism exist for garter snakes. However, George Hansen (*in litt*. 1992) documented parasite infestations in giant garter snakes from the American Basin. G. Hansen suggested that the parasites he observed may contribute to the observed low survival of neonate giant garter snakes in the American Basin (G. Hansen *in litt*. 1992). Unidentified nematode worms were observed in captive-held snakes. The nematode worms were 5 to 8 centimeters (2 to 3 inches) in length, approximately the thickness of a pencil lead, and colored with narrow alternating rings of red and beige. Giant garter snakes developed lumps under the skin from which worms frequently exited the lumps by burrowing out through the snake's skin. Young snakes with these lumps grew more slowly than the apparently uninfected siblings and several affected young died after lingering malaise. Older snakes exhibited signs of respiratory distress 1 to 2 days prior to death, indicating that the airways may have been blocked by presence of the parasitic worm. G. Hansen did not observe the parasite, the lumps it causes, or any of the symptoms associated with the presence of the worms, in any areas except the American Basin. During life history studies of San Francisco garter snakes (*Thamnophis sirtalis tetrataenia = T. s. infernalis*), eight captive garter snakes also exhibited similar symptoms and parasite infestations. The parasites were identified as juvenile nematode worms, *Eustrongylides* spp., where the primary hosts are aquatic piscivorous (fish eating) birds. San Francisco garter snakes likely acquired the larvae from the secondary hosts, freshwater fish, and bullfrogs (Larsen 1994). The significance of these or other parasites as a mortality factor is unknown. G. Hansen recommends that giant garter snakes from the American Basin not be relocated to other geographic areas until further documentation of the distribution and effects of this parasite have been obtained. Snakes held for captive breeding, or temporarily held for release to a new location, should not be held with snakes from other geographic locations or fed prey from areas outside their home ranges (G. Hansen *in litt*. 1992).

Road kills of giant garter snakes may also be a significant mortality factor in areas where roadways lie in close proximity to giant garter snake populations. Paved roads tend to have a higher rate of road mortalities than gravel roads because of increased traffic and traveling speeds (G. Hansen pers. comm. 1998). Hansen and Brode (1993) documented 31 road killed snakes during their 4-year study within the Natomas Basin.

Conservation Measures

The giant garter snake was listed as threatened by the State of California in 1971 and by the U.S. Fish and Wildlife Service in 1993 (U.S. Fish and Wildlife Service

1993). Conservation efforts have included establishment of guidelines and mechanisms to minimize and mitigate take, habitat and population surveys, development of management plans for public lands, and land acquisitions.

In 1990, the California Department of Fish and Game established guidelines for procedures and timing of activities related to the modification or relocation of giant garter snake habitat (Appendix C). These guidelines are designed to minimize adverse impacts to the giant garter snake during construction activities in and around garter snake habitat. The California Department of Fish and Game also developed a protocol for preproject surveys (Appendix D). In 1997, the U.S. Fish and Wildlife Service completed a programmatic biological consultation on the effects of small projects on giant garter snakes. The programmatic opinion provides terms and conditions to minimize and mitigate impacts to giant garter snakes and their habitat (U.S. Fish and Wildlife Service *in litt*. 1997a).

Several large scale survey efforts and status reviews have been made since the giant garter snake's listing by the State in 1971 (Hansen and Brode 1980, G. Hansen 1986, G. Hansen 1988, Brode and Hansen 1992, G. Hansen 1995). The majority of locality records have been gathered through these efforts. There have also been several small scale, preproject surveys as part of the section 7 and section 10(a) permit processes of the Endangered Species Act.

The Biological Resources Division has been studying the life history and habitat requirements of the giant garter snake since 1994 (Habitat Ecosystem Initiative). Study sites are located at the Sacramento and Colusa National Wildlife Refuges within the Colusa Basin, at Gilsizer Slough within the Sutter Basin, and at the Badger Creek area of the Cosumnes River Preserve within the Badger Creek/Willow Creek area (Wylie *et al.* 1997). Information has been collected on movements, population sizes, and habitat use. These data are currently being compiled.

With Endangered Species Act section 6 funding, the California Department of Fish and Game and the Grassland Water District began, in the spring of 1998, a cooperative effort to investigate the status of giant garter snakes in the San Joaquin Valley. The Biological Resources Division is providing training, expertise, equipment, and data analysis. Trapping efforts are being conducted in the North and South Grasslands Area, including the Grassland Water District, Los Banos State Wildlife Area, San Luis National Wildlife Refuge, Volta State Wildlife Area, and Mendota State Wildlife Area. Trapping began in early April of 1998, however, no giant garter snakes were detected until May 17, 1998. Unusually cool temperatures in April and early May of 1998, likely caused snakes to be inactive much later in the year than usual. Preliminary survey results have detected seven giant garter snakes along Los Banos Creek west of Kesterson National Wildlife Refuge, and another giant garter snake was captured just west of the town of Dos Palos, Merced County. These two sites were know to previously support giant garter snakes, based on 1976 California Natural Diversity Data Base records (California Natural Diversity Data Base 1996 data).

Several regional habitat conservation planning efforts are underway that allow for development, while setting aside, enhancing, and protecting habitat for the giant garter snake and other sensitive species found in the region. The Natomas Basin Habitat Conservation Plan prepared by the City of Sacramento, was approved by the U.S. Fish and Wildlife Service in December 1997. This Plan proposes to protect, manage, and monitor large tracts of riceland currently occupied by the giant garter snake, and to create managed marsh habitat where none now exists. The Natomas Basin Habitat Conservation Plan includes an adaptive management plan with provisions to adopt and incorporate strategies developed in the Giant Garter Snake Recovery Plan. Other regional multispecies Habitat Conservation Plans that are currently being developed to include the giant garter snake are the South Sacramento Habitat Conservation Plan, Yolo County Habitat Conservation Plan, San Joaquin County Habitat Conservation Plan, and California Department of Fish and Game striped bass (*Morone saxatilis*) management program Habitat Conservation Plan. With provisions for habitat protection, restoration, creation, and built-in responsiveness to Recovery Plan recommendations, these Habitat Conservation Plans should play a significant role in giant garter snake recovery efforts.

A 102-hectare (252-acre) Conservation Bank has been proposed by Wildlands, Inc. on private land near the Colusa National Wildlife Refuge (Dolan Ranch Conservation Bank). The Conservation Bank, if approved, would be available to mitigate impacts to giant garter snake habitat within the Colusa area through preservation and creation of habitat at the Conservation Bank site (D. Mead pers. comm. 1998).

Through its Endangered Species Conservation Program, the Bureau of Reclamation is addressing potential impacts to endangered species caused by operations and maintenance of Central Valley Project facilities. In October 1997, the Bureau of Reclamation completed a final draft of the Central Valley Project Operation and Maintenance Plan: Protection of Endangered Species, which specifies measures to reduce the impacts of routine maintenance procedures to giant garter snakes and their habitat and other listed species. Implementation of the Operations and Maintenance Plan is intended to begin when the final document is approved. Development of integrated pest management procedures, erosion control plans, and site-specific measures are scheduled to be completed by the year 2003.

The California Department of Fish and Game, through Federal section 6 funds, conducted a study, from July 1996 through June 1997, to evaluate management practices on State owned areas in the San Joaquin Valley. The primary study areas were Los Banos and Mendota Wildlife areas and the Grassland Water District. The objective of the study was to investigate whether past and current management practices on State owned and managed Wildlife Areas may have contributed to the apparent decline of giant garter snakes in the San Joaquin Valley and to develop better management practices if necessary. Results of this study are discussed in the section on Reasons for Decline.

The U. S. Environmental Protection Agency and the California Department of Pesticide Regulation (1998) have produced Interim Measures Rodenticide Bulletins for Butte, Colusa, Fresno, Glenn, Kern, Madera, Merced, Sacramento, San Joaquin, Solano, Sutter, Yolo, and Yuba Counties. These bulletins identify use limitations, which apply to areas where giant garter snakes have been reported. However, the areas identified in the bulletins are limited and do not cover all areas where giant garter snakes occur or are likely to occur. As a corollary to the Rodenticide Bulletins, the California Department of Pesticide Regulation in cooperation with the U.S. Fish and Wildlife Service, is developing pocket cards to aid the public in identifying giant garter snakes and their habitat (R. Marovich pers. comm. 1998).

In 1992, the California Department of Fish and Game acquired 108 hectares (267 acres) of Gilsizer Slough with funds from the Inland Wetlands Conservation Program. The California Department of Fish and Game prepared the Gilsizer Slough Management/Development Plan in December 1993 to protect, enhance, and develop habitat for wintering waterfowl and other wildlife, including the giant garter snake. Gilsizer Slough currently supports a significant population of giant garter snakes and has been a study site of the Biological Resources Division.

The Sacramento National Wildlife Refuge Complex is conducting a study of land acquisition possibilities in the refuge complex vicinity for giant garter snake habitat funded through the Central Valley Project Improvement Act b(1) “other” program. The study is intended to identify parcels of land within the refuge complex area that, if protected, could be restored or enhanced to provide habitat for the giant garter snake (U.S. Fish and Wildlife Service *in litt*. 1997b). The Refuge is currently preparing a restoration and management plan for the 182 hectare (450 acre) Tract 24 on Colusa National Wildlife Refuge. The parcel will be restored to permanent and seasonal wetland habitat for giant garter snakes, other resident wildlife, and migratory birds. Upland areas will be restored to native grasslands to provide upland habitat for a variety of species, including the giant garter snake. Once the parcel is restored, giant garter snake use of newly created habitat will be monitored by the Biological Resources Division (G. Wylie pers. comm. 1997). The Sacramento National Wildlife Refuge Complex is implementing routine management operations and maintenance procedures that are consistent with protecting and enhancing habitat for the giant garter snake and other listed species.

In 1996, the Bureau of Reclamation and the U.S. Fish and Wildlife Service provided $1,250,000 from the Central Valley Project Improvement Act Section 3406(b)(1) “other” to support the acquisition of Valensin Ranch by The Nature Conservancy. California Department of Fish and Game, North American Wetlands Conservation Council, Natural Resources Conservation Service, National Fish and Wildlife Foundation, California Department of Transportation, American Farmlands Trust, State and County Departments of Parks and Recreation, California Urban Water Agencies, CALFED Bay/Delta, and The Nature Conservancy also contributed funding. Valensin Ranch is located along the Cosumnes River in southern Sacramento County and includes the Badger Creek area. The Badger Creek marsh currently supports a giant garter snake population and is a Biological Resources Division study site.

The California Rice Industry Association has developed recommended stewardship practices for rice farming to protect giant garter snakes. The Association's recommendations are as follows:

> Typical rice farming practices are generally compatible with giant garter snakes. However, it is important to be able to identify and know how to protect the snake. Growers and their field help should read and understand Managing Ricelands for Giant Garter Snakes, a pamphlet available through the California Rice Industry Association. Free copies of the pamphlet are available from county agricultural commissioners, University of California Cooperative Extension offices, and the California Rice Industry Association at (916) 929-3996.
>
> Giant garter snakes tend to congregate and hunt for prey in puddles near rice boxes and other irrigation structures. Growers should take extra care when buttoning or opening field in these areas. If given a chance, giant garter snakes will quickly flee to safety. Rice fields with snakes should be drained gradually to avoid stranding snakes in the middle of a dry field.
>
> Driving carefully and minimizing trips atop ditch banks should be encouraged when snakes are present, especially during spring planting.
>
> One of the best ways to protect giant garter snakes is to follow the agricultural burn rules. After fields pass the "crackle test", they are too dry to be productive foraging habitat. Snakes generally move back to drains to hunt frogs, small fish, and other prey once fields have been drained (California Rice Industry Association 1995).

National Wildlife Refuges, State Wildlife Areas, and Other Wetland Conservation

Efforts

To date, the majority of wetland conservation efforts in both the public and private sectors has been waterfowl habitat driven. However, because giant garter snakes share wetland habitats with waterfowl, wetland conservation efforts where they are properly located and designed can make a significant contribution to recovery of the giant garter snake.

The loss of wetland habitat in California's Central Valley, and substantial crop depredation caused by early migrating ducks, led to the establishment of a number of National Wildlife Refuges and State Wildlife Areas in the mid-1900's to protect existing wetlands and create additional habitat for breeding and wintering waterfowl. In the 1990's, existing National Wildlife Refuges and State Wildlife Areas have been significantly expanded and new units have been created through fee title acquisitions. Purposes and goals of National Wildlife Refuges have been expanded to include threatened and endangered species, biodiversity, migratory birds of all species, and wildlife-dependent recreation.

Within the Central Valley, there are currently four National Wildlife Refuge complexes. These are (1) in the Sacramento Valley, the Sacramento National Wildlife Refuge Complex, which includes Sacramento, Colusa, Delevan, Sutter, Butte Sink, and Sacramento River National Wildlife Refuges; (2) in southern Sacramento County, Stone Lakes National Wildlife Refuge; (3) in the upper San Joaquin Valley, the San Luis National Wildlife Refuge Complex, which includes San Luis, Merced, and San Joaquin River National Wildlife Refuges; and (4) in the southern San Joaquin Valley, the Kern National Wildlife Refuge Complex, which includes Kern and Pixley National Wildlife Refuges on the Central Valley floor.

The Sacramento National Wildlife Refuge Complex manages approximately 12,950 hectares (32,000 acres) included in six refuges within the Sacramento Valley. Depending on the refuge, managed wetlands comprise 48 to 94 percent of the total habitat base. Among wetland habitats, 5 to 15 percent are managed as permanent wetlands (flooded year round) or summer wetlands (flooded from fall through mid-July), 5 to 25 percent as watergrass (flooded August or September through April or May then irrigated once in May or June), and 65 to 90 percent as seasonal wetlands (flooded September or October to April). Small acreages of natural wetlands (remnant sloughs, vernal pools, etc.) exist on some of the refuges. Uplands comprise varying combinations of grassland, alkali meadow, and riparian forest habitats. The percentages of the different wetland types vary slightly from year to year based on management treatments (i.e., burning) or maintenance requirements. Currently lands surrounding the refuge complex are agricultural fields, with rice being the dominant crop. Orchards are the dominant crop type surrounding the Sacramento River National Wildlife Refuge units other than the Llano Seco Unit. All refuges in the Sacramento National Wildlife Refuge Complex are subject to extensive flooding in some years.

The Stone Lakes National Wildlife Refuge comprises approximately 416 hectares (1,027 acres) of fee title properties. Of this acreage, approximately 31 percent is managed as permanent wetland, 25 percent is seasonal wetland, 17 percent is managed as riparian and oak woodland, and the remainder is managed as irrigated pasture or other agricultural land. All areas of the National Wildlife Refuge are subject to flooding during extreme water years, with some areas of the refuge flooding to depths as great as 1.5 to 2.4 meters (5 to 8 feet) (B. Treiterer pers. comm. 1998).

The San Luis National Wildlife Refuge Complex manages approximately 3,700 hectares (9,150 acres) of wetlands included in six refuges within the San Joaquin Valley. A substantial percentage of wetland habitat occurs on each refuge within the complex. Among wetland habitats, 5 to 15 percent is managed as permanent wetland, 5 to 15 percent is managed as summer wetlands, 3 to 12 percent is managed for watergrass, and 62 to 88 percent is managed as seasonal marsh habitat. The percentages of the different wetland types vary slightly from year to year based on management treatments (i.e., burning) or maintenance requirements.

The Kern and Pixley National Wildlife Refuges encompass about 4,300 hectares (10,618 acres) and 2,500 hectares (6,192 acres), respectively. Approximately 75 percent of the Kern National Wildlife Refuge is managed as seasonal wetlands, with the remainder in upland habitats. Pixley National Wildlife Refuge is made up of approximately 15 percent seasonal wetlands and the remainder is uplands.

In the Central Valley, the State of California manages, through the Department of

Fish and Game, approximately 4,300 hectares (10,586 acres) of wetlands in the Sacramento Valley (Gray Lodge and Upper Butte Basin Wildlife Areas); and 6,000 hectares (14,875 acres) in the San Joaquin Valley (Los Banos, Volta, Mendota, and Grasslands Wildlife Areas). Among these wetland habitats, roughly 20 percent are managed as permanent (flooded year-round) or semipermanent (flooded during summer months) wetlands. Permanent or semipermanent wetlands include a small acreage (0.8 to 4 hectares [2 to 10 acres]) as flooded areas of upland habitat, remnant natural sloughs, and managed impoundments. The percentage of wetlands changes from year to year depending upon species needs and restoration activities.

Over the years, private duck clubs also have been a dominant force in wetland conservation. The largest block of privately-owned wetlands in the Central Valley is the Grasslands Ecological Area of Merced County. The Grasslands area encompasses over 72,500 hectares (179,000 acres) of which about 90 percent is wetland habitat. The majority of private lands are within the Grassland Water District and in privately owned duck clubs. Other large privately owned wetland areas in the Valley include the Butte Sink and Willow Creek areas in the Sacramento Valley, and the Wasco area in the southern San Joaquin Valley.

Many duck clubs in the Central Valley are included in the U.S. Fish and Wildlife Service’s wetland easement program. In the Sacramento Valley, approximately 8,460 hectares (20,900 acres) of lands are enrolled in the easement program. These easement program lands, which are collectively known as Wildlife Management Areas, are located in the Butte Sink (4,150 hectares [10,254 acres]), Willow Creek/Lurline (2,220 hectares [5,488 acres]), and North Central Valley (2,090 hectares [5,159 acres]) areas. These areas are generally within rice growing regions of the Valley. Their habitat composition is approximately 5 to 10 percent upland habitat, 5 to 10 percent permanent wetland, 10 to 15 percent watergrass, and 65 to 75 percent seasonal wetland. In the San Joaquin Valley, over 26,700 hectares (66,000 acres) of lands in the East and West Grasslands Ecological Area are enrolled in the easement program. Easement lands are part of the National Wildlife Refuge system, but remain in private ownership.

In 1986, the United States and Canada developed and signed the North American

Waterfowl Management Plan as a result of the continuing declines in continental waterfowl populations (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1986). The Central Valley of California is identified, in the North American Waterfowl Management Plan, as 1 of 34 waterfowl habitat areas of major concern. The Central Valley Habitat Joint Venture, which comprises private groups and government agencies, has established goals to increase waterfowl populations in the Central Valley. These goals include (1) protecting an additional 32,375 hectares (80,000 acres) of existing wetlands, (2) securing a firm water supply for State and Federal refuges and the Grasslands Resource Conservation District, (3) creating an additional 48,560 hectares (120,000 acres) of wetlands, and (4) enhancing over 117,760 hectares (291,000 acres) of existing wetlands (Central Valley Habitat Joint Venture Implementation Board 1990).

Conservation efforts for the giant garter snake have been undertaken on several occasions using sources of funds targeted for implementing the Central Valley Habitat Joint Venture Implementation Plan. For example, the restoration of wetlands at Colusa National Wildlife Refuge is being funded, in part, by a North American Wetlands Conservation Act grant. Additional sources of Federal funding for wetland restoration and enhancement include the Land and Water Conservation Fund, Federal Duck Stamp Funds, Water Resources Development Act, and Central Valley Project Improvement Act. Federal programs, such as the Wetland Reserve Program, Wildlife Habitat Improvement Program, and Conservation Reserve program sponsored by the Natural Resources Conservation Service; the U.S. Fish and Wildlife Service’s Partners for Fish and Wildlife program; and the Bureau of Reclamation’s recently established Wetlands Development Program, have resulted in restoration and enhancement of over 8,500 hectares (21,000 acres) of wetlands in the Central Valley since 1992. State programs, such as the Inland Wetlands Conservation Program, Waterfowl Habitat Program, and Waterfowl Brood Pond Program, have contributed over 4,450 hectares (11,000 acres) of restored or enhanced wetland habitat in California. Privately-funded programs, such as the California Waterfowl Association California Mallard Program and the Ducks Unlimited Valley Care Program, have also provided funds separately and in cooperation with State and Federal agencies to increase wetland acreages in the Central Valley. All of these programs target waterfowl habitat acquisition, creation, and enhancement. When properly designed and located, these programs can also benefit the giant garter snake as well as other wetland dependent species.

Ricelands and Agricultural Waterways as Giant Garter Snake Habitat

Ricelands, associated waterways, and adjacent uplands (hereafter referred to collectively as ricelands) provide the most important agricultural habitat for the giant garter snake, particularly in the Sacramento Valley portion of their range. Ricelands potentially provide 162,000 to 242,800 hectares (400,000 to 600,000 acres) of habitat connected by water conveyance facilities. For species of concern such as waterfowl, white-faced ibis, tricolored blackbird, and the western pond turtle, these agricultural lands provide foraging and nesting habitat. Migratory waterfowl are heavily dependent on agricultural lands for foraging in winter.

California is the only major production area in the United States where japonica-type medium grain rice is grown. The temperate climate in rice country, with warm days and moderately cool evenings, is well suited for growing this type of rice. The industry provides thousands of jobs and contributes over $540 million to the State's economy each year. The total retail value of California rice and rice products exceeds $4 billion (California Rice Industry Association 1993). Production trends and the economic outlook for the rice industry are included in Appendix E.

Rice is grown in 14 counties throughout California's Central Valley. However, the primary rice-growing region lies north of Sacramento in Butte, Colusa, Glenn, Sacramento, Sutter, Tehama, Yolo, and Yuba Counties. The rice country is served by an extensive system of natural and artificial waterways that provide reliable supplies of water (California Rice Industry Association 1993).

The Sacramento Valley is the main watershed area for the entire northern State, receiving runoff from the Coast Ranges, the Sierra Nevada and the Siskiyou Mountains. With its many natural rivers (including the Sacramento, Bear, Yuba, and Feather Rivers) and artificial waterways (such as the Tehama/Colusa Canal, Glenn/Colusa Canal, Corning Canal, and Sutter Bypass canals and associated drains), rice growers have had a reliable source of water in all water year types, which has provided stable and dependable habitat for giant garter snakes and other wetland dependent species.

Recovery Strategy

Recovery tasks emphasized in this plan for the giant garter snake are (1) habitat protection, (2) public participation, outreach, and education, (3) habitat management and restoration, (4) surveying and monitoring, and (5) research. Specific recovery tasks are outlined in the Stepdown Narrative.

The giant garter snake is threatened by loss of wetland habitat and by fragmentation of the remaining habitat found in the Central Valley. Therefore, protection of existing habitat for the giant garter snake throughout its current range is a key component of the recovery strategy for this species. Existing habitat includes natural marshes and wetlands, but also includes ricelands, which provide significant benefits to the giant garter snake, particularly in the Sacramento Valley. Maintenance of rice cultivation in the Sacramento Valley is considered to be important to the continued existence of giant garter snakes in this region. The highest priority protection areas, which are primarily in the Sacramento Valley, are those that currently support the largest populations of giant garter snakes. Wherever possible, protection should first focus on publicly owned lands. Corridors between existing populations of giant garter snakes should be maintained or created to enhance population interchange.

Because ricelands provide important habitat for giant garter snakes, cooperation from private landowners and entities will be necessary to help ensure recovery of this species. To this end, the recovery plan recommends development of reasonable and prudent practices in agricultural lands that are consistent with conserving giant garter snakes and their habitats, development and implementation of incentive programs for private landowners that conserve giant garter snake habitat, development and distribution of informational material to interested landowners and public lands managers, and support for the development of Habitat Conservation Plans.

Management plans need to be developed or refined for protected lands. In some cases, effective habitat management and restoration techniques have not been developed for the giant garter snake. Therefore, management must be “adaptive”or flexible based on new data, research, or observed outcomes of ongoing management and habitat restoration activities.

Recovery of the giant garter snake may also require repatriation (reintroduction) of snakes into suitable habitat within their historic range, if surveys show that populations do not currently inhabit these areas. Repatriation is defined here as releases into an area previously occupied by a species, but where it is now absent. Repatriation efforts are recommended for several areas of the San Joaquin Valley, if surveys do not reveal existing populations. Appendix F discusses repatriation as a recovery tool for the giant garter snake. Monitoring of extant and repatriated populations is required to assess progress towards meeting recovery criteria.

A number of research tasks are recommended for the giant garter snake. Research tasks include conducting genetic analyses, reintroduction/repatriation, assessing the health of selected giant garter snake populations, and investigating the potential effect of contaminants on giant garter snake populations. Additional research tasks include mark-recapture and radio-tracking studies, which will provide data needed to perform a population viability analysis for the giant garter snake. Population viability analyses, which incorporate best available data on population size, distribution, and population characteristics, can be an important tool for refining recovery criteria.

The key component of the recovery strategy for the giant garter snake - maintaining viable populations of giant garter snakes within the species’ historic range - is based on principles of conservation biology. An important principle in biological conservation is that conserving a species also means conserving genetic diversity within that species (i.e., its full genomic complement). There are significant biological reasons for maintaining genetic diversity. The assumption is that as populations of rare or endangered species become smaller and more fragmented over time, genetic variability (= heterozygosity) declines. Such declines in genetic variability raises concerns about the deleterious effects of inbreeding as well as reducing the probability of a population's long-term survival. A detailed discussion of the potential effects of reduced heterozygosities can be found in Avise (1994: 336-370 and references therein). Therefore, maintaining giant garter snake populations throughout the species’ range increases the probability that the species' genetic diversity will be protected and that conservation of the species can be achieved.

II. RECOVERY

Objective

The overall objective of this recovery plan is to delist the giant garter snake. Interim goals are (1) stabilizing and protecting existing populations, and (2) conducting research necessary to further refine recovery criteria. Because data upon which to base decisions about giant garter snake recovery are mostly lacking, recovery criteria in this plan are necessarily preliminary. Tasks carried out for the giant garter snake are expected to provide secondary benefits to tricolored blackbirds, white-faced ibis, western pond turtles, and waterfowl in the Central Valley.

Recovery Criteria

To assist in establishing recovery criteria and guiding recovery tasks, the Central Valley is divided into four recovery units (Figure 7). These are (1) the Sacramento Valley Unit, extending from the vicinity of Red Bluff south to the confluence of the Sacramento and Feather Rivers; (2) the Mid-Valley Unit, extending from the American and Yolo Basins south to Duck Slough near the City of Stockton; (3) the San Joaquin Valley Unit, extending south of Duck Slough to the Kings River; and (4) the South Valley Unit, extending south of the Kings River to the Kern River Basin. Table 2 lists giant garter snake populations included in each recovery unit.

For purposes of this recovery plan, the following definitions are used:

> *Recovery unit* - a geographic region that has similar land uses, conservation issues, and water supply.
>
> *Population* - all giant garter snakes within a basin or area (e.g., Colusa Basin, American Basin, Mendota Area).
>
> *Subpopulation* - a cluster of locality records in a contiguous habitat area.

Figure 7. Recovery units for the giant garter snake recovery plan.

Table 2. Giant garter snake populations located in Central Valley recovery units.

Recovery Unit	Giant Garter Snake Populations
Sacramento Valley	Butte Basin Colusa Basin Sutter Basin
Mid-Valley	American Basin Yolo -- Willow Slough Yolo -- Liberty Farms Sacramento Area Badger Creek/Willow Creek Caldoni Marsh (White Slough) East Stockton -- Diverting Canal and Duck Creek
San Joaquin Valley	North and South Grasslands Mendota Area Burrel/Lanare Area
South Valley	No populations known at this time

Giant Garter Snake Delisting Criteria:
The sizes and densities at which giant garter snake populations occur is not well known. Turner (1977) gives some density estimates for snakes. Population structure, population dynamics, the strength, frequency and direction of environmental fluctuations, and edge effects are also largely unknown for giant garter snakes. Until uncertainties about these and other small population effects and their interactions are resolved, it is not possible to establish population numbers as a delisting criterium for the giant garter snake. As an alternative, the first delisting criterium below for each recovery unit requires that subpopulations contain both adults and young. The U.S. Fish and Wildlife Service believes that if monitoring detects both adults and young in a given subpopulation, this suggests that the subpopulation is viable.

1. Sacramento Valley Recovery Unit

a. Monitoring shows that in 17 out of 20 years, 90 percent of the subpopulations in the recovery unit contain both adults and young.

b. The three existing populations within the recovery unit are protected from threats that limit populations.

c. Supporting habitat within the recovery unit is adaptively managed and monitored.

2. Mid-Valley Recovery Unit

a. Monitoring shows that in 17 out of 20 years, 90 percent of the subpopulations in the Recovery Unit (with the exception of the East Stockton -- Diverting Canal and Duck Creek population) contain both adults and young.

b. The six existing populations within the recovery unit are protected from threats that limit these populations.

c. Supporting habitat within the recovery unit is adaptively managed and monitored.

d. Subpopulations are well connected by corridors of suitable habitat.

e. Repatriation has been successful at all suitable sites that had recently (within last 10 years) extirpated populations.

3. San Joaquin Valley Recovery Unit

a. Monitoring shows that in 17 out of 20 years, 90 percent of the subpopulations in the Recovery Unit contain both adults and young.

b. The three existing populations within the recovery unit are protected from threats that limit populations.

c. Supporting habitat within the recovery unit is adaptively managed and monitored.

d. Subpopulations are well connected by corridors of suitable habitat.

e. Recovery or repatriation has been successful at a total of five sites within the Recovery Unit.

f. Giant garter snakes are broadly distributed within the North and South Grasslands and Mendota area.

4. South Valley Unit

a. Monitoring shows that in 17 out of 20 years, 90 percent of the subpopulations in the Tulare and Kern Basins contain both adults and young.

b. Existing or reestablished populations within the recovery unit are protected from threats that limit populations.

c. Supporting habitat within the recovery unit is adaptively managed and monitored.

d. Subpopulations are well connected by corridors of suitable habitat.

e. If surveys for giant garter snakes are negative, repatriation has been successful at four sites, two sites within the Kern (including Goose Lake) Basin and two sites within the Tulare Basin.

Recovery Priorities

Actions necessary to recover (or delist) the giant garter snake are ranked in three categories:

Priority 1 - an action that must be taken to prevent extinction or to prevent a species from declining irreversibly in the foreseeable future.

Priority 2 - an action that must be taken to prevent a significant decline in the species population or habitat quality or some other significant negative impact short of extinction.

Priority 3 - all other actions necessary to meet recovery objectives.

Because situations change as time passes, recovery/conservation priorities must be considered in the context of what has already happened and what is likely to happen at all sites. Therefore, the priorities assigned are intended to guide, not to constrain, the allocation of limited conservation resources.

STEPDOWN NARRATIVE

1. Protect known populations of the giant garter snake.

   1.1 Protect populations of the giant garter snake on private lands.

   For populations not already protected by a public or conservation agency, protect these populations through acquisition of habitat, conservation easements, agricultural easements (e.g., maintaining historic cropping patterns), memoranda of agreement, incentive programs, or other mechanisms. Appendix G lists potential public funding sources. Where additional species of concern occur on the same lands, protect these populations, where possible. Specific protection measures are recommended in Table 3 where tricolored blackbirds and white-faced ibis co-occur with the giant garter snake. Protection measures taken for the giant garter snake should benefit waterfowl and the western pond turtle on all private land areas listed in Table 3. The locations of currently protected areas are shown in Figure 8.

Table 3. Private land areas requiring protection for the giant garter snake. Basins listed below correspond wherever possible with basins defined in the Central Valley Habitat Joint Venture Implementation Plan (Central Valley Habitat Joint Venture Implementation Board 1990). See Appendix H for maps of the Joint Venture basins.

Task #	Location	County	Species Protected[1]	Landowner / Recommendations	Priority
Sacramento Valley Recovery Unit					
1.1.1	Colusa Basin (includes Lurline area)	Glenn, Colusa, Yolo	GGS, TCBB, WFI, WTF, WPT	Private / protect habitat through watershed management plan, tie into existing easement programs, restore wetland habitat where possible, protect and maintain wintering habitat for WFI, protect key TCBB nesting colonies in Lurline area	1
1.1.2	Butte Basin	Sutter, Colusa, Glenn, Butte	GGS, TCBB, WFI, WTF, WPT	Private / protect rice farming and natural wetland habitat though incentive programs, restore wetland habitat where possible, easements or acquisition, protect and maintain wintering habitat for WFI, restore wetland habitat where possible	1
1.1.3	Gilsizer Slough area (part of Sutter Basin)	Sutter	GGS, TCBB, WTF, WPT	Private / protect existing habitat for GGS and breeding colony sites for TCBB, restore wetland habitat where possible	1

Task #	Location	County	Species Protected[1]	Landowner / Recommendations	Priority
1.1.4	Robbins area (part of Sutter Basin)	Sutter	GGS, WTF, WPT	Private / protect rice farming though incentive programs, safe harbor agreements, easements or acquisition, restore wetland habitat where possible	1
Mid-Valley Recovery Unit					
1.1.5	District 10 (part of the American Basin)	Yuba	GGS, WFI, TCBB, WTF, WPT	Private / conduct surveys for GGS, protect and maintain wintering habitat for WFI and breeding colony sites for TCBB, maintain rice culture, restore wetland habitat where possible	3
1.1.6	Northern Yolo Basin	Yolo, Solano, Sacramento, Sutter	GGS, TCBB, WFI, WTF, WPT	Private -- Yolo County Habitat Conservation Planning effort underway / protect suitable habitat through acquisition and easements, protect and maintain wintering habitat for WFI in Yolo Bypass, restore wetland habitat where possible	3

Task #	Location	County	Species Protected[1]	Landowner / Recommendations	Priority
1.1.7	Southern American Basin, including Natomas area (part of American Basin)	Sacramento, Placer, Sutter	GGS, WTF, WPT	Private -- approved Habitat Conservation Plan / in-basin wetland habitat mitigation and protection is recommended over out-of-basin habitat mitigation and protection, refine Habitat Conservation Plan based on ongoing research, continue primarily rice production until managed marsh areas (a minimum of 25 percent) show equal or greater populations of GGS	1
1.1.8	Putah Creek/Liberty Farms/Northern Delta area (part of Yolo Basin)	Yolo, Solano, Sacramento, Contra Costa	GGS, TCBB, WTF, WPT	Private -- Yolo County Habitat Conservation Planning effort underway / protect suitable habitat adjacent to Jepson Prairie Preserve through acquisition and easements, enhance and create wetland habitat, maintain compatible agricultural practices	3
1.1.9	Stone/Beach Lakes area, including Cosumnes River area (part of the Sacramento/San Joaquin River Delta Basin)	Sacramento, San Joaquin	GGS, WTF, WPT	Private -- South Sacramento Habitat Conservation Planning effort underway / focus mitigation west and east of Interstate 5, acquire lands and restore wetlands south of Lambert Road to connect GGS population to Badger Creek/Willow Creek population, maintain compatible agricultural practices	1

Task #	Location	County	Species Protected[1]	Landowner / Recommendations	Priority
1.1.10	White Slough/ Duck Slough/Southern Delta area (part of the Sacramento/San Joaquin River Delta Basin)	San Joaquin, Contra Costa, Alameda	GGS, WTF, WPT	Private – San Joaquin County Habitat Conservation Planning effort underway / use mitigation ratio 1.1:1 for agriculture and 3:1 for sloughs and riparian habitat, mitigate for wetland habitat losses by protecting land and creating new wetland habitat in Caldoni Marsh area, connect habitat in White Slough area to Stone/Beach Lakes area to the north	3

Task #	Location	County	Species Protected[1]	Landowner / Recommendations	Priority
San Joaquin Valley Recovery Unit					
1.1.11	North and South Grasslands (part of San Joaquin Basin)	Merced, Madera, Fresno	GGS, TCBB, WFI, WTF, WPT	Private / develop and implement management plan benefitting GGS, restore wetland habitat for GGS, create additional nesting habitat for TCBB, protect existing TCBB breeding colonies, maintain compatible agricultural practices, protect and maintain wintering habitat for WFI	1
1.1.12	Mendota area (part of San Joaquin and Northern Tulare Basin)	Fresno, Madera	GGS, WTF, WPT	Private / develop and implement management plan benefitting GGS, restore wetland habitat for GGS	1
1.1.13	Burrell/Lanare area (part of San Joaquin and Northern Tulare Basin)	Fresno, Kings	GGS, WTF, WPT	Private / survey for GGS, repatriate if required, assure firm water supply, restore wetland habitat where possible	3

[1] GGS - giant garter snake; TCBB - tricolored blackbird; WFI - white-faced ibis; WTF - waterfowl; WPT - western pond turtle

Figure 8. Locations of private land areas requiring protections for the giant garter snake or providing potential repatriations sites.

1.2 Develop or update management recommendations for giant garter snake habitats.

Management recommendations should be developed or refined for ricelands, ditch and canal maintenance, wetlands, and for nonaquatic habitats. Recommendations should be updated periodically based on new information. Where habitat restoration is recommended as part of a management plan, habitat restoration guidelines should be developed and implemented (See Table 4 below). Guidelines will vary by location, based on the types of existing habitat and availability of water. Information gained in the giant garter snake monitoring studies by the Biological Resources Division at Colusa National Wildlife Refuge should provide insight into developing guidelines for restoring retired ricelands to natural marsh.

1.3 Develop, update, and implement management plans for populations on public and conservation lands.

For populations on existing public and conservation lands, management plans should be developed or updated to include benefits for giant garter snakes. Management recommendations developed in Task 1.2 should be incorporated into management plans, where appropriate. Management plans should be revised periodically to reflect the latest knowledge on species management, and plans should be implemented on an ongoing basis. Table 4 lists existing public and conservation lands that should be managed appropriately. Specific protection measures are recommended in Table 4 where tricolored blackbirds and white-faced ibis co-occur with the giant garter snake. Protection measures taken for the giant garter snake should benefit waterfowl and the western pond turtle on all public/conservation land areas listed in Table 4. Locations of public or conservation lands are shown in Figure 9.

Table 4. Public or conservation lands requiring appropriate management for the giant garter snake.

Task #	**Location**	**County**	**Species Protected**[1]	**Landowner / Recommendations**[2]	**Priority**
Sacramento Valley Recovery Unit					
1.3.1	Sacramento National Wildlife Refuge complex	Glenn, Colusa	GGS, WFI, TCBB, WTF, WPT	FWS / appropriately manage existing habitat, enhance existing wetlands, create new habitat for GGS, TCBB, WFI, incorporate GGS considerations into management guidelines	1
1.3.2	Upper Butte Basin Wildlife Area (Little Dry Creek, Howard Slough, Llano Seco)	Glenn, Butte	GGS, WTF, WPT	CDFG / appropriately manage existing habitat, enhance existing wetlands, create new habitat, incorporate GGS considerations into management guidelines	1
1.3.3	Gray Lodge Wildlife Area	Butte	GGS, WTF, WPT	CDFG / appropriately manage existing habitat, enhance existing wetlands, create new habitat, incorporate GGS considerations into management guidelines	1
1.3.4	Gilsizer Slough	Sutter	GGS, TCBB, WTF, WPT	CDFG / appropriately manage existing habitat, enhance existing wetlands, create new habitat for GGS and TCBB, incorporate GGS considerations into management guidelines	1

Task #	Location	County	Species Protected[1]	Landowner / Recommendations [2]	Priority
Mid-Valley Recovery Unit					
1.3.5	Stone Lakes National Wildlife Refuge	Sacramento	GGS, WTF, WPT	FWS and Sacramento County / incorporate GGS considerations into management guidelines, build refugia from flooding, expand habitat	1
1.3.6	White Slough Ecological Area (Caldoni Marsh)	San Joaquin	GGS, WTF, WPT	CDFG / incorporate GGS considerations into management guidelines, enhance and create habitat, avoid use of borrow pits as GGS habitat, vegetate canals	1
1.3.7	Valensin Ranch	Sacramento	GGS, WTF, WPT	TNC/DU/BLM / incorporate GGS considerations into management guidelines, enhance and create habitat	1
1.3.8	Sherman/Decker Island area	Sacramento	GGS, WTF, WPT	DWR / incorporate GGS considerations into management guidelines, enhance and create habitat	3

Task #	Location	County	Species Protected[1]	Landowner / Recommendations [2]	Priority
San Joaquin Valley Recovery Unit					
1.3.9	Mendota Wildlife Area	Fresno	GGS, WFI, TCBB, WTF, WPT	CDFG / develop and implement management plan benefitting GGS, protect existing habitat, expand and create new habitat for GGS and breeding colony sites for TCBB and WFI, summer water an important feature, protect and maintain wintering habitat for WFI, maintain compatible agricultural practices	1
1.3.10	China Island/Los Banos/Volta Wildlife Areas	Merced	GGS, TCBB, WTF, WPT	CDFG / incorporate GGS considerations into management guidelines, protect existing habitat, expand and create new habitat	1
1.3.11	San Luis National Wildlife Refuge	Merced	GGS, TCBB, WTF, WPT	FWS / incorporate GGS considerations into management guidelines, protect existing habitat, expand and create additional habitat for nesting TCBB	2

[1] GGS - giant garter snake; TCBB - tricolored blackbird; WFI - white-faced ibis; WTF - waterfowl; WPT - western pond turtle

[2] FWS - U.S. Fish and Wildlife Service; CDFG - California Department of Fish and Game; DWR - California Department of Water Resources; TNC - The Nature Conservancy; DU - Ducks Unlimited; BLM - U.S. Bureau of Land Management

Figure 9. Locations of public or conservation lands requiring appropriate management for giant garter snakes or providing potential repatriations sites.

1.4 Expedite permit approvals, where practical, for levee repairs that protect adjacent habitat of the giant garter snake.

Levee repair work in areas adjacent to giant garter snake habitat should be expedited when failure to complete levee repairs could result in flooding of habitat used by giant garter snakes during their winter dormant period.

1.5 Review water efficiency measures that may conflict with management recommendations for giant garter snakes and their habitat.

Water efficiency programs are designed to increase in-stream flows to benefit fisheries resources, including such federally listed species as the Delta smelt (*Hypomesus transpacificus*). However, water efficiency measures that reduce agricultural runoff, such as canal lining, crop shifting, and land fallowing, can in specific cases, conflict with habitat needs of the giant garter snake. Water efficiency measures in giant garter snake habitat should be reviewed on a case by case basis to determine their potential for adverse impacts to giant garter snakes. Where conflicts are apparent, water conservation policies should be revised to promote giant garter snake habitat provided that revisions do not preclude recovery of other listed species.

1.6 Explore, develop and implement methods to assure water deliveries for giant garter snakes.

To assure water deliveries for the giant garter snake, the allocation of those deliveries must adhere strictly to California's water rights priority system, and to the commitments and policies articulated in State and Federal law regarding the areas of origin. Water transfers should not result in the dewatering of drains and canals that provide giant garter snake habitat.

1.7 Develop and implement a monitoring program for giant garter snake populations.

For each population, develop a monitoring program that defines what sites should be monitored and the appropriate monitoring technique to be used based on the status and location of subpopulations as defined in developed protocols. Habitat changes should also be tracked at each monitoring site. Monitoring efforts should include the newly discovered, potential population of giant garter snakes at Sherman/Decker Island in the Delta.

2. Survey for new populations of giant garter snakes.

Survey appropriate habitat within historic and current range for additional populations. Populations discovered should be protected through Task 1.

2.1 Survey for new populations in Recovery Unit 4 - South Valley.

Surveys for giant garter snakes in the Kern and Tulare Basins of Recovery Unit 4 are needed to determine if any populations persist and to identify potential sites for repatriation.

2.2 Survey for new populations in Recovery Unit 3 - San Joaquin.

Surveys for giant garter snakes in Recovery Unit 3 are needed to determine if any additional populations persist and to identify potential sites for repatriation.

2.3 Survey for new populations in Recovery Unit 2 - Mid-Valley.

Because major portions of Recovery Unit 2 are rapidly urbanizing, surveys for giant garter snakes are needed to determine if any additional populations persist. This information will assist in establishing appropriate mitigation guidelines.

2.4 Survey Recovery Unit 1 - Sacramento Valley, to determine the distributional limits of the giant garter snake.

Surveys for giant garter snakes in Recovery Unit 1 are needed to determine the northern limit of this species' distribution in the Sacramento Valley.

2.5 Develop guidelines for collection of giant garter snake voucher specimens at new locations.

Collection of a voucher specimen may be necessary to unequivocally demonstrate that snakes observed in a new location are giant garter snakes. Guidelines should be developed for this effort and should include an adult/juvenile age structure study, prior to collecting any specimens. Specimens should be turned over for research as outlined in Task 4.5.

3. Reestablish populations of giant garter snakes to suitable habitat within former range.

3.1 Identify suitable sites and conduct surveys for repatriation of giant garter snakes.

The historic range of the giant garter snake in the San Joaquin and South Valley Recovery Units should be surveyed for suitable repatriation sites or areas following Tasks 2.1 and 2.2. All of these sites or areas provide habitat for one or more of the species of concern. Prior to preparing and implementing a repatriation plan for a selected site, the site should be intensively surveyed following the survey guidelines in Appendix I, to verify that no giant garter snakes are already inhabiting the repatriation site. Potential repatriation sites or areas for giant garter snake are listed in Table 5, and the location of potential repatriation sites/areas are shown in Figures 8 and 9. See Appendix H for maps of these basins.

Table 5. Potential repatriation sites or areas for the giant garter snake. Basins correspond wherever possible with basins defined in the Central Valley Habitat Joint Venture Implementation Plan (Central Valley Habitat Joint Venture Implementation Board 1990).

Location	**County**	**Landowner / Recommendations** [1]
San Joaquin Valley Unit		
Merced National Wildlife Refuge area	Merced	FWS and private / incorporate GGS considerations into management guidelines, protect existing habitat, expand and create new habitat to the north of the main refuge on FWS easement program lands and Arena Plains unit of the refuge
San Joaquin River National Wildlife Refuge	Stanislaus	FWS / incorporate GGS considerations into management guidelines
Madera Ranch	Madera	Private -- proposed water banking site / groundwater recharge areas should be developed on existing cultivated lands, GGS considerations should be included in any management plan for wetland areas

Location	County	Landowner / Recommendations [1]
South Valley Unit		
Kern National Wildlife Refuge	Kern	FWS / GGS considerations should be included in any management plan for wetland areas, assure firm water supply
Kern/Wasco area (part of Northern Tulare Basin)	Kern	Private / GGS considerations should be included in any management plan for wetland areas, assure firm water supply
Tulare Lake Basin (part of Northern Tulare Basin)	Tulare, Kings	Private / focus on South Wilbur area, GGS considerations should be included in any management plan for wetland areas, assure firm water supply

[1] FWS - U.S. Fish and Wildlife Service; GGS - giant garter snake

3.2 Prepare repatriation plans.

Once surveys conducted under Task 3.1 have been completed and verify that no giant garter snakes exists at the repatriation site, a repatriation plan should be developed. The repatriation guidelines in Appendix J should be followed.

3.3 Implement repatriation plans and monitor repatriated populations.

A repatriation plan should be implemented for each potential repatriation site. The repatriation guidelines in Appendix J should be followed. The monitoring protocol in the repatriation guidelines (Appendix J) should be followed to determine the success of the repatriation effort.

4. Conduct necessary research on the giant garter snake.

4.1 Conduct mark recapture studies in selected areas.

Mark recapture studies should be performed in selected areas of the giant garter snake's range to gather information on mortality rates, fecundity, and population size estimates. This information is needed to conduct a population viability analysis (see Task 4.4).

4.2 Conduct genetic analyses of archived and recently collected tissue.

Studies are needed to determine relatedness (dispersal) among the geographically separated populations of giant garter snakes. Pertinent questions or considerations are:

1) Is the genetic variability within giant garter snakes distributed across the range of the species, or is it interpopulational (i.e., a function of isolation of populational units)? An assessment of genetic variation and its distribution among remnant populations of giant garter snakes should allow for refinement of conservation priorities.

2) Genetic studies should serve as a guide for reintroductions to portions of the range where there are no extant populations.

3) Genetic studies may resolve questions concerning relationships between Sacramento Valley populations of the giant garter snake and those of the Santa Cruz garter snake occurring on the eastern slopes of the inner-coast ranges bordering the Sacramento Valley. For example, do the giant garter snake and the Santa Cruz garter snake maintain their genetic distinctiveness where their ranges meet, or is there evidence of historical or contemporary gene exchange (i.e., hybridization)?

4) Genetic studies should replace reliance on morphological markers (e.g., pattern variation) to determine interpopulational relationships. Use of morphological markers is unreliable in that patterns of genetic variation often are discordant with respect to external features such as color pattern.

4.3 Conduct radio-telemetry studies in selected areas.

Radio-telemetry studies are needed in selected areas to estimate mortality rates and home ranges, and to further elucidate habitat use by giant garter snakes. This information is needed to conduct a population viability analysis (see Task 4.4).

4.4 Conduct a population viability analysis.

Based on information collected in Tasks 4.1 and 4.3, conduct a population viability analysis to further refine recovery criteria. If new surveys (Task 2) find giant garter snakes inhabiting more areas in greater numbers than previously thought, viability analysis becomes less important than understanding basic life history, population dynamics, and habitat requirements.

4.5 Develop guidelines for collecting giant garter snake specimens for research.

Guidelines should be developed for preserving giant garter snake specimens salvaged (dead or injured snakes) in the field, so that these specimens can be used to the maximum extent possible in research studies.

4.6 Conduct a study to determine effective buffer distances between giant garter snake habitat and urban development.

A study should be conducted to determine the most effective configuration and composition of buffers between giant garter snake habitat and urban development to reduce snake mortalities on roadways and other urban-related impacts.

4.7 Study the effects of contaminants on giant garter snakes.

The heavy metal, selenium, is believed to be a possible reason for the decline of giant garter snake populations in the San Joaquin Valley. The potential effects of selenium on giant garter snake populations in this region of the Central Valley should be investigated. Results of this investigation should provide guidance to managers of giant garter snake habitat in this region.

4.8 Study the health of selected populations of the giant garter snake.

Where monitoring of selected populations of giant garter snakes reveals a potential health problem, studies should be conducted to investigate the potential significance of the mortality factor identified (e.g., nematode infestations, abscesses, and pesticide effects). The causal effects of these sources of mortality should be investigated if studies show these mortality factors to be significant.

4.9 Study the effects of introduced predators on giant garter snake populations, and develop and implement a management program to monitor affected populations.

A study should be conducted to determine how giant garter snake populations are affected by introduced predators, such as the bullfrog. A management plan should be developed to monitor populations and outline potential eradication methods, where appropriate, to stabilize the affected population.

4.10 Study the rate at which giant garter snakes populate newly created managed marsh.

A study should be conducted to determine how rapidly giant garter snakes populate newly-created managed marsh. The study should be conducted in several locations where marsh habitat is being created adjacent to occupied giant garter snake habitat. The study should be continued until monitoring shows snake populations have reached carrying capacity.

5. <u>Develop and implement an outreach and education program</u>.

5.1 <u>Develop and distribute guidelines for appropriate land use practices to landowners and agencies.</u>

5.1.1 <u>Finalize ditch and canal maintenance guidelines for water users.</u>

Draft guidelines have been developed by the Northern California Water Association for water users. These guidelines recommend reasonable practices consistent with conserving giant garter snakes. Use of these guidelines should prevent destruction or adverse modification of snake habitat, while allowing farming practices to continue. Appendix K includes the Northern California Water Association draft guidelines.

5.1.2 <u>Develop guidelines that minimize impacts to giant garter snakes when conducting canal vegetation management to control mosquito populations.</u>

Mosquito and vector control is achieved through a combination of components of integrated pest management: physical, biological, and chemical control (Appendix L). Biological and chemical control measures are less effective in heavily vegetated canals. Guidelines should be developed that would allow for vegetation management along canals to reduce mosquito populations while avoiding or minimizing adverse effects on giant garter snakes and other species of concern.

5.1.3 Develop and update guidelines for rodenticide, herbicide, and pesticide use in areas inhabited by the giant garter snake.

Bulletins have already been prepared for the use of rodenticides and burrow fumigants in giant garter snake habitat (U. S. Environmental Protection Agency and the California Department of Pesticide Regulation 1998). However, the areas identified in the bulletins are limited and do not cover all areas where giant garter snakes occur or are likely to occur. These bulletins need to be updated to reflect the current distribution of the giant garter snake. Additional bulletins should be prepared, where appropriate, to cover proper application of pesticides and herbicides in areas inhabited by the giant garter snake.

5.2 Develop and distribute informational material to interested parties.

Informational material about the giant garter snake should be developed and distributed to private landowners, public land managers, and other interested parties.

5.2.1 Develop and distribute informational material to interested and affected private landowners.

Information should be developed and distributed to interested and affected landowners. Potential forms of information transfer include pocket cards, photographs, brochures, video programs, and progress reports for dissemination in agricultural bulletins and newsletters.

5.2.2 Develop and distribute informational material to public land managers and schools.

Informational material on the biology, habitat requirements, and management guidelines should be provided to managers of public lands with extant populations of the giant garter snake. This information should be used to train employees and develop interpretive information for visitors and for use in schools.

6. Develop and implement economic and other incentives for conservation and recovery on private lands.

Development and widespread implementation of incentive programs for private agricultural lands are an integral part of recovery and conservation of the giant garter snake. The ultimate goal of incentive programs is to assist landowners in maintaining agricultural practices (e.g., rice cultivation) that benefit this species.

6.1 Develop agricultural incentives for landowners.

Agricultural incentives should be developed and made available to landowners who conserve giant garter snakes on their property. Existing tax incentive programs, such as those in the Federal and State tax codes (e.g., donation of conservation easement), should be promoted wherever possible. Agricultural incentives that promote the maintenance of historic cropping patterns in giant garter snake habitat should be developed and implemented.

6.2 Provide construction incentives for water districts and users.

Financial incentives should be developed and made available to water districts and users for the following types of activities:

a) Funding for limited amounts of rock riprap along banks of levees, ditches, and canals that benefit giant garter snakes.

b) Funding for purchase and installation of gates and warning signs on country roads to control unauthorized vehicular traffic.

c) Funding for security. Water districts have reported a problem with trespassers using their property to dump urban waste, which can harm giant garter snakes.

d) Funding for water district employee training in methods of identifying and appropriately managing habitat for the giant garter snake.

6.3 Promote development of Habitat Conservation Plans.

Habitat Conservation Plans should be promoted on a multijurisdictional level to minimize and mitigate impacts to the giant garter snake. All Habitat Conservation Plans developed should be consistent with recommendations in this recovery plan.

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III. IMPLEMENTATION SCHEDULE

The implementation schedule that follows outlines actions and estimated costs for the giant garter snake recovery program. It is a guide for meeting the objectives discussed in the Stepdown Narrative section of this recovery plan. This schedule describes and prioritizes tasks, provides an estimated time table for performance of tasks, indicates the responsible agencies, and estimates costs of performing tasks. These actions, when accomplished, should further the recovery and conservation of the covered species and protect its habitat.

Key to terms and acronyms used in the Implementation Schedule

Definition of task priorities:

Priority 1 - An action that must be taken to prevent extinction or prevent the species from declining irreversibly in the foreseeable future.

Priority 2 - An action that must be taken to prevent a significant decline in species population or habitat quality, or some other significant negative impact short of extinction.

Priority 3 - All other actions necessary to meet recovery or conservation objectives.

Definition of task durations:

Continual - A task that will be implemented on a routine basis once begun.

Ongoing - A task that is currently being implemented and will continue until action is no longer necessary.

Unknown - Either task duration or associated costs are not known at this time.

Total costs:

TBD - To be determined

Responsible parties:

BLM - U.S. Bureau of Land Management

BOR - U.S. Bureau of Reclamation

BRD - Biological Resources Division (U.S. Geological Survey)

CALFED - a consortium of State and Federal agencies
CIT - City
CDFG - California Department of Fish and Game
CDOT - California Department of Transportation
COE - U.S. Army Corps of Engineers
COUN - County
CPP - Conservation program participant (easements, incentives)
CRIA - California Rice Industry Association
DPR - California Department of Pesticide Regulations
DWR - California Department of Water Resources
EPA - Environmental Protection Agency
FB - Farm Bureau
FCD - Flood Control District
FHWA - Federal Highways Administration
FWS - U.S. Fish and Wildlife Service
GWD - Grasslands Water District
HCP - Habitat Conservation Plan permittee
MVCD - Mosquito and Vector Control District
NCWA - Northern California Water Association
NGO - Non-government Organization
NRCS - Natural Resources Conservation Service
NMFS - National Marine Fisheries Service
OWN - Private landowner or party
RB/DWR - Reclamation Board/California Department of Water Resources
(includes levee and reclamation districts)
RCD - Resource Conservation District
SWRCB - State Water Resources Control Board
WD - Water District

Implementation Schedule for the Giant Garter Snake Recovery Plan											
Task Priority	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $100,000 units)						Comments/Notes
					Total Costs	FY 1	FY 2	FY 3	FY 4		
1	1.1.1	Protect habitat on private lands in the Colusa Basin for GGS	Continual	FWS, CDFG, CPP, NRCS, NGO, RCD	TBD						
1	1.1.2	Protect habitat on private lands in the Butte Basin for GGS	5 years	FWS, CDFG, NGO, CPP, RCD, NRCS	50	10	10	10	10		
1	1.1.3	Protect habitat on private lands in the Gilsizer Slough area for GGS	Continual	FWS, CDFG, CPP, NRCS, NGO, RCD, RB/DWR	TBD						
1	1.1.4	Protect habitat on private lands in the Robbins area for GGS	5 years	FWS, CDFG, NGO, CPP, RCD, NRCS	50	10	10	10	10		
1	1.1.7	Protect habitat on private lands in the Southern American Basin (includes Natomas area) for GGS	Continual	HCP, COUN, CIT, RB/DWR	450	20	20	20	20		
1	1.1.9	Protect habitat on private lands in the Stone/Beach Lakes area for GGS	5 years	FWS, CDFG, CDOT, COUN, NGO, CPP, RCD, NRCS	50	10	10	10	10		
1	1.1.11	Protect habitat on private lands in the North and South Grasslands for GGS	Continual	FWS, CDFG, NRCS, GWD, FCD, NGO	TBD						

Implementation Schedule for the Giant Garter Snake Recovery Plan										
Task Priority	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
					Total Costs	FY 1	FY 2	FY 3	FY 4	
1	1.1.12	Protect habitat on private lands in the Mendota area for GGS	Continual	FWS, CDFG, NGO, CPP, RCD, NRCS	TBD					
1	1.3.1	Develop/update and implement management plan for Sacramento NWR Complex for GGS	Ongoing	FWS	TBD	0.3	0.3	0.3	0.3	GGS management to be part of Comprehensive Conservation Plan
1	1.3.2	Develop/update and implement management plan for the Upper Butte Basin WA for GGS	Continual	CDFG	TBD	0.17	0.17	0.17	0.17	
1	1.3.3	Develop/update and implement management plan for Gray Lodge WA for GGS	Continual	CDFG	TBD	0.15	0.15	0.15	0.15	
1	1.3.4	Develop/update and implement management plan for Gilsizer Slough for GGS	Continual	CDFG	TBD	0.1	0.1	0.1	0.1	
1	1.3.6	Develop/update and implement management plan for White Slough EA for GGS	Continual	CDFG	TBD	0.1	0.1	0.1	0.1	
1	1.3.7	Develop/update and implement management plan for Valensin Ranch for GGS	Continual	NGO, BLM, CDFG, CDOT	TBD	0.2	0.2	0.2	0.2	Any habitat restoration costs not included
1	1.3.9	Develop/update and implement management plan for Mendota WA for GGS	Continual	CDFG	TBD	0.42	0.42	0.42	0.42	
1	1.3.10	Develop/update and implement management plan for China Island/Los Banos/Volta WAs for GGS	Continual	CDFG	TBD	0.53	0.53	0.53	0.53	
1	1.4	Expedite permit approval, where practical, for levee repairs to protect habitat of GGS	Ongoing	FWS, CDFG, COE, NMFS, RB/DWR,	TBD	1	1	0.3	0.3	

Implementation Schedule for the Giant Garter Snake Recovery Plan										
Task Priority	**Task Number**	**Task Description**	**Task Duration**	**Responsible Parties**	**Cost Estimate (in $100,000 units)**					**Comments/Notes**
					Total Costs	**FY 1**	**FY 2**	**FY 3**	**FY 4**	
2	1.3.5	Develop/update and implement management plan for Stone Lakes NWR for GGS	Continual	FWS	TBD					
2	1.3.11	Develop/update and implement management plan for San Luis NWR for GGS	Continual	FWS	TBD					
2	1.5	Review water efficiency measures that may conflict with GGS management	Ongoing	FWS, BOR, RB/DWR, SWRCB, CALFED	TBD					
2	1.6	Explore, develop, and implement methods to assure water deliveries for GGS	Ongoing	NCWA, FWS, CDFG, RB/DWR, BOR, SWRCB	TBD					
2	1.7	Develop and implement a monitoring program for GGS populations	continual	FWS, CDFG, BRD	TBD	0.3				$30,000 required to develop monitoring program
2	4.1	Conduct mark recapture studies on GGS	5 years	FWS, CDFG, BRD	TBD					Cost per site = $50,000 per year
2	4.2	Conduct genetic analyses on GGS	3 years	FWS, CDFG, BRD	0.6		0.2	0.2	0.2	
2	4.3	Conduct radio telemetry studies on GGS	5 years	FWS, CDFG, BRD	TBD					Cost per site = $100,000 per year
2	4.7	Study the effects of contaminants on GGS	3 years	FWS, CDFG, BRD, BOR	3	1	1	1		
2	4.10	Study the rate at which giant garter snakes populate newly created managed marsh	5 years	FWS, CDFG, BRD, COUN	3	0.6	0.6	0.6	0.6	
2	5.1.1	Finalize ditch and canal maintenance guidelines for water users	1 year	FWS, CDFG, NCWA, CRIA	0.3	0.3				

Implementation Schedule for the Giant Garter Snake Recovery Plan										
Task Priority	**Task Number**	**Task Description**	**Task Duration**	**Responsible Parties**	**Cost Estimate (in $100,000 units)**					**Comments/Notes**
					Total Costs	**FY 1**	**FY 2**	**FY 3**	**FY 4**	
2	5.1.2	Develop guidelines that minimize impacts to giant garter snakes when conduction canal vegetation management to control mosquitos	1 year	MVCD, FWS, CDFG	0.6	0.6				
2	6.1	Develop agricultural incentives for landowners	Ongoing	NGO, NCWA, CRIA	TBD					
2	6.2	Provide construction incentives for water districts and users	Continual	FWS, CDFG, NCWA, CRIA, BOR, RB/DWR, NRCS	TBD	0.5	0.5	0.5	0.5	
3	1.1.5	Protect habitat on private lands in District 10 for GGS	Continual	FWS, CDFG, NGO, CPP, RCD	TBD					
3	1.1.6	Protect habitat on private lands in the Northern Yolo Basin area for GGS	Continual	FWS, CDFG, NRCS, CPP, NGO, COUN,	TBD					
3	1.1.8	Protect habitat on private lands in the Putah Creek/Liberty Farms/Northern Delta area for GGS	Continual	FWS, CDFG, NGO, CPP, RCD, NRCS	TBD					
3	1.1.10	Protect habitat on private lands in the White Slough/Duck Slough/ Southern Delta area for GGS	Continual	FWS, CDFG, COUN, CPP, NGO, RCD, NRCS	TBD					
3	1.1.13	Protect habitat on private lands in the Burrell/Lanare area for GGS	Continual	FWS, CDFG, CPP, NGO, RCD, NRCS	TBD					

Implementation Schedule for the Giant Garter Snake Recovery Plan

Task Priority	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
					Total Costs	FY 1	FY 2	FY 3	FY 4	
3	1.2	Develop or update management recommendations for GGS habitats	Ongoing	FWS, CDFG, NGO, BRD, BLM	TBD					
3	1.3.8	Develop/update and implement management plan for Sherman/Decker Island area for GGS	Continual	DWR	TBD					
3	2.4	Survey Recovery Unit 1 to determine GGS distributional limits	5 years	FWS, CDFG, BRD	1	0.2	0.2	0.2	0.2	
3	2.5	Develop guidelines for collection of GGS voucher specimens	6 months	FWS, CDFG	0.3	0.3				Collection would take place during other field work
3	3.1	Identify suitable sites and conduct surveys for repatriation of GGS	5 years	FWS, CDFG, BRD	TBD	0	0	0	0	Cost = $50,000 per site
3	3.2	Prepare repatriation plans	6 months	FWS, CDFG, BRD	TBD					Cost = $5,000 per site
3	3.3	Develop and Implement repatriation plans and monitor repatriated populations	continual	FWS, CDFG, BRD	TBD					Costs could include radio telemetry studies and standard monitoring
3	4.4	Conduct a population viability analysis for the GGS	1 year	FWS, CDFG, BRD	0.15					Analysis to be conducted after Tasks 4.1 and 4.3 are completed
3	4.5	Develop guidelines for collecting GGS specimens for research	6 months	FWS, CDFG, BRD	0.05	0.05				
3	4.6	Conduct a study of effective buffers between GGS and urban development	3 years	FWS, CDFG, BRD, CDOT, FHWA	0.9	0.3	0.3	0.3		
3	4.8	Study the health of selected GGS populations	Continual	FWS, CDFG, BRD	TBD					

Implementation Schedule for the Giant Garter Snake Recovery Plan										
Task Priority	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
					Total Costs	FY 1	FY 2	FY 3	FY 4	
3	4.9	Study the effects of introduced predators (i.e., bullfrogs), on GGS populations	continual	FWS, CDFG, BRD	TBD					
3	5.1.3	Develop and update guidelines for pesticides used in areas inhabited by GGS	3 years	DPR, EPA, FWS, CDFG, CRIA, NCWA	0	0	0	0	0	
3	5.2.1	Develop and distribute factual information to interested and effected private landowners	Ongoing	FWS, CDFG, CRIA, NCWA, BOR, CDOT, RB/DWR, NGO, OWN, FB	TBD	0.3	0.3	0.3	0.3	
3	5.2.2	Develop and distribute factual information to public land managers and schools	Ongoing	FWS, CDFG	0	0	0	0	0	
3	6.3	Promote development of HCPs	Continual	FWS, CDFG, CRIA, NCWA, NGO	TBD					

* Additional costs are yet to be determined (TBD).

APPENDICES

Appendix A. Priorities for Recovery of Threatened and Endangered Species.

Degree of Threat	Recovery Potential	Taxonomy	Priority	Conflict
	High	Monotypic Genus	1	1C 1
	High	Species	2	2C 2
High	High	Subspecies	3	3C 3
	Low	Monotypic Genus	4	4C 4
	Low	Species	5	5C 5
	Low	Subspecies	6	6C 6
	High	Monotypic Genus	7	7C 7
	High	Species	8	8C 8
Moderate	High	Subspecies	9	9C 9
	Low	Monotypic Genus	10	10C 10
	Low	Species	11	11C 11
	Low	Subspecies	12	12C 12
	High	Monotypic Genus	13	13C 13
	High	Species	14	14C 14
Low	High	Subspecies	15	15C 15
	Low	Monotypic Genus	16	16C 16
	Low	Species	17	17C 17
	Low	Subspecies	18	18C 18

C = conflict with human activities

Appendix B. Species Accounts for Wetland Wildlife Species of Concern that Co-occur with the Giant Garter Snake in the Central Valley.

TRICOLORED BLACKBIRD
(*Agelaius tricolor*)

Taxonomy

The tricolored blackbird was first described in 1836 as the tricolored red-wing (*Agelaius tricolor*), and continued to be known by that name through the middle of the 20th century, when it became known as the tricolored blackbird (Neff 1937, 1942; DeHaven *et al*. 1975a, 1975b). No sub-species have been described (American Ornithologists' Union 1957).

Description

Male tricolored blackbirds are glossy black with red shoulder patches edged in white. Females are sooty brown, streaked overall, and usually have substantial red-brown tipping on lesser coverts, forming a small, distinct shoulder patch (Pyle 1997). Males are larger than females. Tricolored blackbirds are highly gregarious and can occur in flocks and colonies of over 10,000 birds, with colonies getting as large as 50,000 birds (Orians 1961, Payne 1967).

Identification

Female tricolored blackbirds are slightly darker, have a longer bill, and may have less distinct streaking on the breast than the female of the closely related red-winged blackbird (*Agelaius phoeniceus*). Distinguishing females of the two species in the field is difficult. Male red-winged blackbirds have red shoulders with no border (in the Central Valley of California), or bordered in buffy yellow (remainder of range). Red-winged blackbirds are larger overall than tricolored blackbirds (Orians 1961, Payne 1969, DeHaven 1975).

Historical Distribution

Historically, the tricolored blackbird bred from Shasta County, California, through the Central Valley and along the coast of California from Humboldt County to Baja California. A few records of breeding occur in southern and northern Oregon. They also were found in the plateau region of northeastern California and the northwestern portion (Riverside and San Bernardino Counties) of the Mojave

Desert (DeHaven *et al*. 1975a). Colonies have been reported in 46 California counties (Beedy and Hamilton in press). Tricolored blackbirds have been found from sea level to approximately 1,370 meters (4,500 feet), with the majority of colonies found in the Central Valley from 6 to 122 meters (20 to 400 feet) in elevation (DeHaven *et al*. 1975a).

The studies by Neff (1937, 1942) were the first systematic effort to estimate the breeding population of tricolored blackbirds in California. An estimated total of 1,500,000 nests were observed between 1931 and 1936 (an admitted underestimate), with the largest annual estimate of 491,000 nests found in 1934. The 491,000 nests would equal approximately 736,500 adults (Beedy and Hamilton 1997). One colony in 1932, two in 1933, and one in 1994 were estimated to have over 100,000 nests, all in Glenn and Sacramento Counties. Because of the high densities of tricolored blackbird nests and the fluid nature of the populations, population estimates were very difficult and "notoriously inaccurate" (Neff 1937, page 65).

Although not a complete count, between 1968 and 1972, 168 nesting colonies were found in California and southern Oregon (DeHaven *et al*. 1975a). About 78 percent (131) were in the Central Valley. Most of the rest were found in coastal counties, northern California, and a few in southern Oregon. A greater concentration of colonies was found in Sacramento (11), Merced (10) Stanislaus (7), Glenn (7), and Colusa (4) Counties. The highest counts (181,000) were made in 1969.

Wintering populations were apparently concentrated around the counties of the Delta confluence of the Sacramento and San Joaquin Rivers, and the San Francisco Bay area south to San Luis Obispo County and north into Napa and Sonoma Counties (Neff 1942). However, tricolored blackbirds will winter within most of their range within the Central Valley (DeHaven *et al*. 1975b). Band returns from tricolored blackbirds marked as nestlings in the San Joaquin Valley indicated that generally the birds moved northwestward in winter toward the San Francisco Bay area, while those banded in Glenn and Butte Counties migrated south to the same area for the winter (Neff 1942).

Current Distribution

Between 1992 and 1994, Hamilton *et al*. (1994) observed 111 colonies, but estimated that there was over 200 nesting colonies in California. Few of these colonies were over 20,000 birds. The estimated population from a late April 1994 survey was a minimum of 324,621 birds (this number was later updated to 370,000 by Beedy and Hamilton 1997). The researchers felt, however, that birds were probably missed in agricultural fields. The largest colonies and greatest numbers of birds were found in the San Joaquin Valley. Colonies were found throughout most of the historical range, but colonies were smaller than historic colony sizes and colony location varied (Hamilton *et al*. 1994). A survey in late April of 1997 found 232,960 tricolored blackbirds in California, a 37 percent decline from the 1994 survey. Over 50 percent of the birds were again counted in the San Joaquin Valley in 1997 (Beedy and Hamilton 1997, E. Beedy pers. comm.). Although the population numbers and colony sizes have declined, the current distribution has remained approximately the same as Neff found in the 1930's (E. Beedy pers. comm.)

Life History

Tricolored blackbirds forage in areas that provide abundant insects, including pastures, dry seasonal pools, agricultural fields such as alfalfa and rice, feedlots, and dairies. They may also be found foraging in riparian scrub, saltbush (*Atriplex* spp.), marsh borders, and grassland habitats. Intensively managed agriculture such as orchards and vineyards do not offer suitable areas for foraging (Beedy and Hamilton 1997). Insects from flooded fields in the Central Valley probably provided a good food source for tricolored blackbird colonies (DeHaven *et al*. 1975a). Both adults feed the nestlings, usually foraging within 5 kilometers (3.1 miles) of the colony, but can range up to 13 kilometers (8 miles) from the colony (Beedy and Hamilton 1997).

Tricolored blackbirds feed on both animal and plant material. In Merced County, nestlings and fledglings are fed primarily animal material (91 percent), with males consuming approximately 27 percent and females consuming 56 percent animal material during the breeding season (Skorupa *et al*. 1980). Adults will also forage on crops that are available. The type of insect consumed varies from place to place, and indicates that tricolored blackbirds will take advantage of a good foraging opportunity (such as a newly mowed field). The majority of insects in one study (16:1 by volume) were injurious to agricultural crops, thus benefitting the land owner (Skorupa *et al*. 1980).

Female tricolored blackbirds may breed when they are 1 year old, but males usually don't breed until they are 2 years old. Breeding colonies have a female to male ratio of 2.4:1. Nest building and incubation are performed solely by the female (Orians 1961, E. Beedy pers. comm.). Banding studies by Neff (1942) and DeHaven and Neff (1973), found that tricolored blackbirds may live up to 13 years.

Tricolored blackbird breeding colony size is highly variable, but tends to be large. Between 1931 and 1936, colonies varied between 6 pairs to well over 200,000 pairs (Neff 1937). Nests can be highly concentrated in a colony, with an average of 1 per 0.37 square meters (1 per 4 square feet) (Neff 1937). Tricolored blackbirds lay three or four eggs from late March through late July (average mid-April to mid-May). Eggs are incubated by the female for only 11 to 13 days and hatch asynchronously. Because of this, the last chick to hatch (smallest) often dies of starvation and during food shortages, the smallest chick may be ejected from the nest before it dies. Entire colonies may also be deserted because of lack of adequate food supply. Both adults feed the young while in the nest and when fledged, but the female does the majority of the feeding (Orians 1961, Hamilton *et al*. 1994). Once young birds fledge, they gather into creches. Creches consist of groups of 10 to 100 fledglings that are up to 5 kilometers (3.1 miles) from the natal colony that are still being fed by the adults. A large colony can produce as many as 30 creches. Creches can be mistaken for small, late-season colonies (Hamilton *et al*. 1994). The total time from incubation to fledging is 45 days.

Breeding colony size and location can fluctuate widely from year to year. If the habitat remains stable, a site will be used for several years. In a study between 1969 to 1972, 25 percent of the colonies had fewer than 1,000 birds, 62 percent had 1,000 to 10,000 birds, and 13 percent had greater than 10,000 birds. All large colonies (above 10,000 birds) were found in the Central Valley. The largest colony, 30,000 birds, was observed in 1972 near Knights Landing (Yolo County, California). Other colonies over 20,000 were found in Sutter, Colusa, Sacramento, and Kings County (DeHaven *et al*. 1975a). In 1994 and 1997, the largest breeding colonies (over 30,000 birds) were again found in the Central Valley, although exact location of the largest colonies varied year to year. One colony of 38,000 birds was found in Riverside County in 1997 (Beedy and Hamilton 1997). For a site to be suitable for breeding, tricolored blackbirds require water, foraging habitat, and nesting substrate. A lack of one of these factors will prevent colony initiation, and a loss of one during the breeding season may cause colony abandonment (Beedy and Hamilton 1997, E. Beedy pers. comm.).

Colonies in the San Joaquin Valley and the Sacramento County area are initiated prior to those in the Sacramento Valley, with no large colonies appearing in the northern part of the Central Valley until May. It appears that colonies that fail early or that are successful move to more northern colony locations for another breeding effort. Birds that fail in their nesting effort can reinitiate quickly, often within a couple of weeks (Hamilton 1998). This type of behavior is known as itinerant breeding. Because of the short breeding period (45 days), individual birds can breed up to 3 times in 1 year (E. Beedy pers. comm.), therefore, surveys that include all colonies in California throughout the breeding season, may give an inflated number due to counting birds more than once during successive breeding efforts.

Breeding activities in the colony are highly synchronized, with nest building, copulation, and egg-laying occurring at about the same time throughout a colony. Single flocks that establish colonies with several thousands of nests may have all eggs laid within a week. Larger colonies made up of more than one flock may have different nesting stages within the colony. Males vigorously defend their territories, singing and displaying while perched on the vegetation, for about 1 day before nest building starts. After copulation, the males leave and may not return until the eggs hatch. Females do not display any aggression towards other females (Orians 1961).

Tricolored blackbirds are highly gregarious, moving in flocks to choose nesting sites and foraging areas. Large colonies may exhibit all stages of nesting due to flocks coming together in one place at different times, while small colonies made up of one flock tend to be all in one stage of nesting (Neff 1937). Because of their gregarious nature, a tricolored blackbird colony or flock can cause damage to agricultural fields such as rice, milo, corn, and sunflower (Neff 1942). Large numbers of non-breeding birds may congregate in mobile flocks (Neff 1937). During dry years, the colonies tend to be concentrated into smaller areas, while wetter years allow colonies to spread out more (Hamilton *et al*. 1994). Tricolored blackbirds do not show an affinity for natal colonies; returning breeders are not likely to breed where they were hatched (DeHaven *et al*. 1975a).

The tricolored blackbird is highly erratic in choosing its breeding colonies from year to year (Neff 1937, DeHaven *et al*. 1975a, Hamilton *et al*. 1994, Beedy and Hamilton 1997). Colonies that were active one year may not be active the next year if the conditions at the colony site have changed, making it an undesirable breeding location. Factors affecting colony location include winter rainfall, predators, agricultural practices, and prey abundance (Hamilton *et al*. 1994). One explanation of the colony variation can be seen in the source and sink hypothesis (Pulliam 1988, Lewin 1989). Colonies may be population sources or population sinks. The population sources produce more than is necessary to maintain the colony, while the sinks produce less. For the tricolored blackbird, a source colony may become a sink colony the next year because of a lack of water, predation, or crop harvesting, for example. As long as the source colonies produce enough young, the species may be able to maintain itself.

Tricolored blackbirds may roost together with red-winged blackbirds outside of the breeding season (Orians 1961). However, tricolored blackbirds and red-winged blackbirds tend to have separate breeding locations (Beedy and Hayworth 1992). Predators of eggs and young include fox (*Vulpes* spp.), skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), mink (*Mustela* spp.), hawks (*Buteo* spp. and *Accipiter* spp.), crows (*Corvus brachyrhynchos*), owls (families *Strigidae* and *Tytonidae*), and snakes (*Thamnophis* spp. and others) (Neff 1937). Black-crowned night herons (*Nycticorax nycticorax*) frequently destroy colonies in marshes where heron colonies are near tricolored blackbird colonies (Beedy and Hamilton 1997, E. Beedy pers. comm.). Tricolored blackbirds seem to be highly susceptible to disturbance by humans or predators, and may abandon a colony site when it is disturbed (Beedy and Hayworth 1992).

When breeding, tricolored blackbirds make daily foraging flights to areas surrounding the colony. Incubating females will make foraging flights in the morning and the evening, and often during the day. Foraging flights are usually made in large flocks, which can move from place to place to take advantage of a local food source (for example a newly mowed field) (Orians 1961). In the winter, tricolored blackbirds depart from roosts in the morning, returning in the late afternoon to roost (Beedy and Hayworth 1992).

Habitat and Community Associations

The majority of colonies (over 90 percent) observed by Neff (1937) were in cattails (*Typha* spp.), tules (*Scirpus* spp.), or willows (*Salix* spp.), with nests also being observed in a variety of other habitat types. He concluded that marsh habitat is not necessary for continued nesting success of tricolored blackbirds. In later studies, dependence on wetland vegetation was diminished. DeHaven *et al*. (1975a) found 69 percent (108) of 156 colonies in marsh vegetation, including cattails, bulrush, and willows. Another 25 percent were found in blackberries (*Rubus* sp.). For surveys conducted at 74 colonies in 1992 to 1994, only 43.2 percent were in cattail marsh, 35.8 percent in blackberries, and 6.8 percent in grain and silage fields (Hamilton *et al*. 1994).

Tricolored blackbirds have become heavily dependent on agricultural areas. Nesting concentrations have shifted from native vegetation to exotic vegetation including the Himalayan berry (*Rubus discolor*) and cultivated agricultural crops. In 1994, an unusually dry year, over 65 percent of the total birds counted were on five silage fields and one grain field (Hamilton *et al*. 1994). The majority of tricolored blackbird colonies currently depend on privately owned agricultural land. Tricolored blackbirds will rarely breed in rice fields, but the reproductive success is one third the rate found in Himalayan berry. Himalayan berry appears to be the most successful nesting substrate (Cook 1996). They are also heavily dependent on dairies, feedlots, and the areas surrounding them. Surveys in 1997 confirmed the heavy use of dairies and their associated silage fields (Beedy and Hamilton 1997).

Reasons for Decline

Neff (1937) found colonies had been destroyed by draining water and burning vegetation, as well as by heavy windstorms. He also had concerns about collection of birds for meat and feathers as well, estimating that 300,000 birds were taken within a 5-year period. Neff (1937) felt that the loss of colonies due to reclamation or drainage was not having a significant impact on the species. He hypothesized that the increase in rice fields was having a positive impact on the species by providing food and marsh habitat associated with irrigation. The tricolored blackbird had declined when marshes were being drained in the early part of the century, but had rebounded, and was possibly more abundant in 1936 than ever before because irrigated rice fields provided an increase in food supply (Neff 1937). This hypothesis is contradicted by the fact that rice production has doubled several times since 1937, yet the tricolored blackbird population has not increased along with it, but has instead declined (DeHaven *et al*. 1975a, Beedy and Hamilton 1997).

The main causes of decline of the tricolored blackbird are loss of native wetland habitat for nest building, loss of associated foraging habitat, disturbance and mortality by predators and humans, destruction of colonies by agricultural practices, direct poisoning, and poisoning by selenium (Beedy *et al*. 1991). Young tricolored blackbirds died as a result of selenium poisoning at Kesterson National Wildlife Refuge, Merced County. Deformities such as club feet were found on dead young. An analysis of a composite sample of the livers of dead young collected from the refuge in 1987, indicated elevated selenium levels (Beedy and Hayworth 1992). Prey items from the refuge also showed elevated selenium levels (Beedy and Hayworth 1992). Active hazing at the refuge prevented tricolored blackbirds from establishing large colonies in 1987, and the subsequent covering of the contaminated evaporation ponds has prevented tricolored blackbird breeding in these heavily contaminated areas (Beedy and Hayworth 1992, Hamilton *et al*. 1994).

<u>Threats to Survival</u>

In recent surveys, more than half the population of tricolored blackbirds occurred in a few, large colonies on private land. Colonies in active agricultural fields are susceptible to destruction when crops are harvested (Beedy and Hamilton 1997). Tricolored blackbirds are particularly susceptible to mowing and heavy grazing during the breeding season (Hamilton *et al*. 1994). Of particular concern is the harvesting of silage fields that have active tricolored blackbird colonies in them. Large colonies have been completely destroyed when the silage is harvested (Beedy and Hamilton 1997).

The loss of native vegetation causes tricolored blackbirds to concentrate in large colonies. Large concentrated colonies are more vulnerable to catastrophic events that may destroy the entire colony (Hamilton *et al*. 1994). The main threats to the survival of the tricolored blackbird are land development that leads to habitat loss, large-scale failures of colonies due to disturbance or agricultural operations, flooding of colonies, and direct mortality due to predation by black-crowned night heron (E. Beedy pers. comm.).

<u>Conservation Efforts</u>

The Service included the tricolored blackbird as a candidate for federal listing in 1991 (U.S. Fish and Wildlife Service 1991). Subsequent surveys indicated that the species was more widespread than previously thought. The California Department of Fish and Game also considers the tricolored blackbird a species of concern. The Migratory Bird Treaty Act of 1918 gives some protection to the tricolored blackbird (Beedy and Hamilton 1997).

Efforts are underway to conduct range wide surveys to determine if the tricolored blackbird population has stabilized or is continuing to decline. An intensive breeding season survey was conducted from 1991 to 1994, cooperatively funded by the Service and California Department of Fish and Game (Hamilton *et al*. 1994). California Department of Fish and Game again coordinated a range wide survey in 1997 (Beedy and Hamilton, 1997).

Habitat at several National Wildlife Refuges has been managed for the benefit of the tricolored blackbird, although management for tricolored blackbirds at refuges is not always possible. Management of water levels to maintain suitable conditions for a breeding colony has been implemented at Kern National Wildlife Refuge, San Luis National Wildlife Refuge, and Sacramento National Wildlife Refuge (Beedy and Hamilton 1997). Predation by black-crowned continues to be a problem at the refuges (E. Beedy pers. comm.).

In 1993 and 1994, some large colonies found in silage fields were saved from destruction by purchasing the crop (State and Federal Funds) or voluntarily delaying harvesting. These actions saved the reproductive output of thousands of birds both years. However, the U.S. Fish and Wildlife Service and the California Department of Fish and Game do not consider continued crop purchase a viable method of maintaining the population over the long-term (Beedy and Hamilton 1997).

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WHITE-FACED IBIS
(*Plegadis chihi*)

Taxonomy

The white-faced ibis (*Plegadis chihi*) is in the family Threskiornithidae (ibises and spoonbills) in the order Ciconiiformes (Sibley and Ahlquist 1990). It is closely related to the glossy ibis (*Plegadis falcinellus*) and the puna ibis (*Plegadis ridgwayi*) (Hancock *et al*. 1992). The white-faced ibis is considered a full species by recent ornithologists (American Ornithologist's Union 1983, Sibley and Ahlquist 1990, Hancock *et al.* 1992). There are no recognized subspecies of the white-faced ibis (American Ornithologist's Union 1957).

Description

Adult white-faced ibis are medium-sized wading birds [total length 46 to 56 centimeters (18.1 to 20.0 inches), weight 450 to 525 grams (15.8 to 18.5 ounces)], dark maroon-brown in color, with a long decurved bill that is thicker at the base than in curlews. The neck and legs are long; the bill and legs are blackish in color (Belknap 1957, Cogswell 1977, Ryder and Manry 1994). During the breeding season the plumage reflects iridescent purple, violet, and green; a white band of feathers separates the face from the forehead and extends completely behind the back of the eye; the legs and the irises are red; and bare facial skin turns reddish or purple (Belknap 1957, Cogswell 1977, Hancock *et al*. 1992, Ryder and Manry 1994).

Identification

Breeding white-faced ibis can be distinguished from breeding glossy ibis by the latter's brown iris, blackish facial skin, grayish legs, and lack of white encircling the back of the eye (Belknap 1957, Ryder and Manry 1994). Non-breeding adult plumage is similar in these two species except for the red iris (versus brown) in the white-faced ibis (Belknap 1957, Ryder and Manry 1994). In the wild, juveniles of the two species are difficult or impossible to distinguish (Hancock *et al.* 1992).

Historical Distribution

The distribution of white-faced ibis before settlement by Europeans was likely greater than during more recent time because rapid human population growth during the last century has destroyed wetland habitat throughout its distribution in California (Frayer *et al.* 1989). Ibis breeding colonies have been destroyed at various historical locations throughout California. These included Tulare and Buena Vista Lakes (Kern County) and San Jacinto Lake (Riverside County); both areas also provided habitat for ibis during migration (Booser and Sprunt 1980).

<u>Current Distribution</u>

White-faced ibis occur in two disjunct populations, one largely in western North America and the other in the pampas of central and southern South America (Hancock *et al.* 1992). In North America, white-faced ibis winter primarily in Mexico and also in the Central and Imperial Valleys of California, coastal Louisiana, and Texas (Ryder 1967, Capen 1976, Ryder and Manry 1994, Shuford and Hickey 1996). Key areas of wintering white-faced ibis in California's Central Valley (1990-1996) include the Delevan-Colusa Butte Sink Area, northwestern Yuba County (District 10), the Yolo Bypass, Grasslands Wetlands Complex, and Mendota Wildlife Area (Shuford and Hickey 1996). In southern California, wintering areas include the Imperial and Coachella Valleys, and the Prado Basin/Upper Santa Ana River Valley (Shuford and Hickey 1996).

The largest North American breeding colonies of white-faced ibis occur in Utah (Great Salt Lake), Nevada (Carson River Basin), Oregon (Harney Basin), and coastal Texas and Louisiana (Ivey *et al.* 1988, Taylor *et al.* 1989, Ryder and Manry 1994, Kelchlin 1997). Substantial colonies of nesting white-faced ibis have recently been reported in southeastern Idaho (Taylor *et al.* 1989) and in California. The largest recent breeding colonies in the Central Valley of California have been reported from Mendota Wildlife Area and Colusa National Wildlife Refuge (Table 1B). Reports of smaller breeding colonies of white-faced ibis in California's Central Valley since 1985, include the Woodland Sugar Ponds (in 1985 - about 800 adults observed, but only 30 successful nests [E. Beedy pers. comm. 1998] and in 1988 - 25 successful nests [Earnst *et al*. 1998]), San Luis National Wildlife Refuge (1995), and Tulare Lake Basin (at least 1997) (see Table 1B). White-faced ibis have also bred in California's Central Valley at South Wilbur Flood Area (Kings County; 100 to 110 pairs, Ivey and Severson 1984); Kern National Wildlife Refuge (Kern County, 1979, 15 to 35 pairs, Voeks and English 1981) and continue to nest at the Refuge in years with late spring water (J. Allen pers. comm.

1998); and Buena Vista Lake (Kern County, 1979, 8 nests, Voeks and English 1981; nesting also occurred during the early 1900s until Buena Vista Lake was drained in 1954, Booser and Sprunt 1980).

Life History

White-faced ibis forage largely on invertebrates and to a lesser degree on small vertebrates. Major food items reported include earth worms (Bray and Klebenow 1988), crayfish (Belknap 1957) and larval and adult insects (Belknap 1957, Capen 1976). Other foods include spiders, snails, leeches (Kaneko 1972, Capen 1976), small fish, and frogs (Belknap 1957).

White-faced ibis are highly gregarious and feed in loose flocks that can exceed 1,000 birds (Ryder and Manry 1994). They feed while walking by probing in soft substrates or at the base of vegetation (Belknap 1957, Kotter 1970, Bray and Klebenow 1988). Foraging white-faced ibis also secure food by snatching animals exposed on the soil surface (Capen 1976). In deeper water, they feed by sweeping their bills sideways while vibrating their mandibles rapidly in the water column (Belknap 1957). White-faced ibis nest in colonies of varying size. Nesting in North America begins about mid-April and ends with fledged young in August or September (Kotter 1970, Kaneko 1972, Capen 1977, Ryder and Manry 1994). Reproduction is often asynchronous with courting, nest-building, incubating birds, and fledglings present concomitantly within larger colonies (Belknap 1957, Ivey and Severson 1984).

Usually 3 to 4 eggs are laid, approximately 1 every 2 days per nest (Kotter 1970, Kaneko 1972, Capen 1976, Kelchlin 1997). Both parents share with incubation which lasts about 17 to 26 days (Belknap 1957, Kotter 1970). The parents also share with feeding their altricial (not capable of moving about on its own soon after hatching) young until fledging approximately 8 weeks later (Kotter 1970). Mortality of young occurs from exposure to excessive heat, cold and rain, and predation by birds and mammals (Belknap 1957, Kotter 1970, Capen 1976). Usually one brood is attempted each nesting season except when an earlier nesting attempt fails (Capen 1976). Annual reproductive success has been reported to range from 1.42 to 2.99 chicks per clutch (Ryder and Manry 1994, Taft *et al.* 1995).

Nesting and wintering white-faced ibis concentrate locally in large numbers and also occur in lesser numbers over a wide area of its range (Ryder 1967, Booser and Sprunt 1980, Hancock *et al.* 1992). The white-faced ibis is well adapted to changes in environmental conditions such as drought and flooding (Ryder 1967). Therefore, use of specific areas can vary greatly from year to year depending on habitat conditions (Ryder 1967).

Most populations of white-faced ibis are migratory (Ryder 1967). White-faced ibis breeding in Utah, Nevada, Oregon, and Idaho migrate southerly to wintering grounds in Mexico, and the Central Valley and southern coastal regions of California (Ryder 1967, Ryder and Manry 1994, Kelchlin 1997). Ibis breeding in California's Klamath Basin also migrate south in winter. However, the proportion of California's breeding population that overwinters outside of California is unknown (E. Kelchlin pers. comm. 1998). White-faced ibis nesting in Louisiana and Texas are mostly resident (Ryder and Manry 1994). Individuals also wander and have been sighted in southern British Columbia, Alberta, Saskatchewan, Ohio, New York, Illinois, Florida, and Hawaii (Hancock *et al.* 1992, Ryder and Manry 1994).

The following species interactions with white-faced ibis have been reported in the literature. Franklin's gulls (*Larus pipixcan*) have been observed attacking nesting adult white-faced ibis in colonies that also included nesting Franklin's gulls (Kotter 1970). Groups of great-tailed grackles (*Quiscalus mexicanus*) are reported to steal crayfish from foraging white-faced ibis in Louisiana (Belknap 1957). Feeding on bulrush by nutria (*Myocastor coypus*) substantially reduced white-faced ibis nesting habitat in Louisiana and may have contributed to delayed ibis breeding (Belknap 1957). Brood parasitism has not been reported in white-faced ibis (Ryder and Manry 1994). Eggs of other bird species experimentally placed in nests were either ignored or rolled out of the nest by the adults (Kotter 1970). Predators of adult white-faced ibis include peregrine falcons (*Falco peregrinus*) and red-tailed hawks (*Buteo jamaicensis*) and probably other raptors (Ryder and Manry 1994).

Habitat and Community Associations

White-faced ibis typically nest over water in emergent vegetation such as hardstem bulrush (*Scirpus acutus*), baltic rush (*Juncus balticus*), and cattail (*Typha latifolia*) (Kaneko 1972, Capen 1976, Ivey and Severson 1984, Cornely *et al*. 1994, Taft *et al.* 1995). The height of the nest above water is variable ranging from near the water's surface to 137 centimeters (53.9 inches) above (Ryder and Manry 1994). Nests are constructed of the dominant emergent plants available (Ryder and Manry 1994).

Foraging occurs in flooded [less than 20 centimeters (7.9 inches) water depth] fields, pastures, open marshes (Kotter 1970, Capen 1976, Bray and Klebenow 1988, Taft *et al.* 1995), mudflats, and edges of canals, ponds and ditches (Belknap 1957, Taylor *et al.* 1989). In Yolo, Sacramento and Colusa Counties, rice is preferred foraging habitat; ibis may be foraging primarily on crayfish (E. Beedy pers. comm. 1998). Flooded alfalfa is reported to be a preferred foraging habitat compared to irrigated pasture, wheat-barley, and corn (Capen 1976, Bray and Klebenow 1988). Nitrogen fixation by alfalfa and reduced tillage practices may contribute to greater invertebrate abundance for foraging ibises (Bray and Kebenow 1988).

White-faced ibis communally roost in dense vegetation over shallow water and in open sites. They are reported to roost in dense emergent vegetation such as reed (*Phragmites communis*), bulrush, and cattail (Belknap 1957, Kaneko 1972, Ryder and Manry 1994). They also roost in open marshes and small shallow ponds surrounded by dense emergent vegetation, and on exposed islands in the middle of ponds (Hancock *et al.* 1992, Shuford and Hickey 1996).

Other bird species that have been reported to nest in mixed colonies with white-faced ibis include great blue heron (*Ardea herodias*), double crested cormorant (*Phalacrocorax auritus*), great egret (*Casmerodius albus*), snowy egret (*Egretta thula*), cattle egret (*Bubulcus ibis*), black-crowned night heron (*Nycticorax nycticorax*), Franklin's gull, Forster's tern (*Sterna foresteri*) and American coot (*Fulica americana*) (Ryder 1967, Kotter 1970, Ivey and Severson 1984, Cornely *et al*. 1994, Taft *et al.* 1995).

Numbers of overwintering white-faced ibis in the major wintering areas of California have tended to increase from the 1970s to the 1990s (Shuford and

Hickey 1996). In the Sacramento Valley, wintering ibis were rare in the 1970s with the highest counts of 11 birds in 1978 and 1979 (Shuford and Hickey 1996). In the 1980s, flocks of 225 were frequently seen at or near Colusa and Delevan National Wildlife Refuges, Colusa County. At Delevan National Wildlife Refuge in January and December 1994, 1,100 and 1,370 ibis were reported, respectively (Shuford and Hickey 1996). Aerial surveys of the Grasslands wetlands complex near Los Banos showed increases in ibis numbers from 100 to 300 in the early 1980s, to 500 to 700 in the mid to late 1980s, to 2,000 to 2,200 during 1992 to 1994 (Shuford and Hickey 1996). In 1985, Beedy (pers. comm. 1998) estimated about 800 adult ibis at the Woodland Sugar Ponds in Yolo County. Shuford and Hickey (1996) estimated that a minimum of 10,000 to 11,000 ibis wintered in California's Central Valley in 1994-1995. Between 2,000 to 3,000 ibis were in the Sacramento Valley, and up to 8,000 in the Grasslands wetlands complex during this time.

Overall numbers of white-faced ibis breeding pairs have tended to increase in the Central Valley of California since 1985 (Table 1B). Ibis are not reported to have bred at Mendota Wildlife Area during 1985 to 1991. However, breeding ibis numbers at Mendota Wildlife Area represented approximately 95 percent of breeding ibis in the Central Valley during 1992 to 1997. Ibis numbers at Colusa National Wildlife Refuge increased from 1985 to 1989 but no nesting has been reported there from 1990 to 1997 (Table 1B).

Reasons for Decline

Low numbers of white-faced ibis in the western United States including California during the 1950s and 1960s have been attributed to a variety of human induced factors including destruction of breeding habitat and pesticide effects (Ryder 1967, Booser and Sprunt 1980, Ryder and Manry 1994).
Approximately 91 percent of wetlands [more than 1.8 million hectares (4.5 million acres)] in California have been lost to agricultural and urban development since the 1780s (Dahl 1990). About 98,000 hectares (243,000 acres) of potential ibis nesting habitat (emergent wetlands) were lost in the California Central Valley between 1939 and the 1980s (Frayer *et al.* 1989). Wetlands were also lost at high rates in other western states with important white-faced ibis breeding colonies: Idaho (56 percent wetland loss), Nevada (52 percent wetland loss), Oregon (38

percent wetland loss) and Utah (30 percent wetland loss) (Dahl 1990).

The agricultural pesticide DDT was used widely in the United States until its ban in the 1970s. DDE, a metabolic biproduct of DDT is positively associated with egg shell thinning and cracking, and crushed eggs in birds including white-faced ibis (Capen 1976, Steele 1984, Henny and Herron 1989, Dileanis and Sorenson 1992, Dileanis *et al.* 1996). DDE concentrations greater than or equal to 3 to 4 parts per million have been associated with lower hatching success and reproductive output in white-faced ibis (Steele 1984, Henny and Herron 1989). White-faced ibis are considered highly susceptible to the toxic effects of DDE because DDE concentrations in body tissues have remained relatively high in this species, and the levels of DDE resulting in reproductive failure are lower in white-faced ibis compared to other bird species (Capen 1976, Henny *et al.* 1985).

<u>Threats to Survival</u>

White-faced ibis continue to experience high concentrations of DDE, egg shell thinning, and reproductive failure in California and adjacent western states (Henny and Herron 1989, Dileanis and Sorenson 1992, Cornely *et al.* 1994, Dileanis *et al.* 1996). Ibis may be exposed to DDT used in agricultural fields in Mexico (Shuford and Hickey 1996). In the Imperial Valley of California, a major wintering area for white-faced ibis, DDE residues are among the highest reported in the United States (Setmire *et al.* 1993). DDE concentrations (11 micrograms per gram wet weight) in white-faced ibis are among the highest of the birds sampled at the Salton Sea, California (Setmire *et al.* 1993).

A wide variety of agricultural pesticides are currently used as algicides, fungicides, herbicides and insecticides in California (Dileanis *et al.* 1996). Many pesticides in use are moderately to highly toxic; synergistic effects are largely unknown. White-face ibis are at risk to direct contact with pesticides during and shortly after application because they feed in and nest near agricultural lands (King *et al.* 1980). Ibis wintering in Mexico are at potential risk from pesticide contamination, excessive hunting, and habitat destruction (Hancock *et al.* 1992). The magnitude of these risks for white-faced ibis wintering in Mexico, however, has received little attention (Ryder 1967).

Because white-faced ibis depend on wetland habitat for nesting, increased competition in the Central Valley for water by urban, industrial, and agricultural uses, may threaten the integrity of breeding habitat in the future. White-faced ibis wintering and breeding colonies close to large human populations such as the southern Sacramento Valley, San Joaquin Valley and the southern California region may be at risk from increasing human disturbance and loss of foraging habitat to urban development.

Conservation Efforts

The white-face ibis was formerly included as a Category 2 candidate for listing as endangered or threatened (U.S. Fish and Wildlife Service 1991), but is now considered a species of concern. The white-faced ibis is a Species of Special Concern in the State of California because of population declines in the 1960s and 1970s (Remsen 1978).

Wetlands restoration by Ducks Unlimited and the Modoc National Forest substantially improved habitat for white-faced ibis and other wading birds at the Fairchild Swamp at Devil's Garden Ranger District, Modoc National Forest (D. Shuford pers. comm. 1997). About 1,600 hectares (3,952 acres) of planted grain crops were converted to marshes and changes to water management have improved foraging habitat for ibis at Lower Klamath National Wildlife Refuge, California (Shuford and Hickey 1996). The Federal National Wildlife Refuge system, State Wildlife Management Areas, California Waterfowl Association, The Nature Conservancy, and private duck club marshes, through wetland conservation and management of waterfowl habitat, have also contributed to providing habitats, which are also important for white-faced ibis.

The Point Reyes Bird Observatory's Pacific Flyway Project conducts aerial and ground surveys for shorebirds including ibis in all important wetlands in California (Shuford and Hickey 1996). Research and monitoring by the U.S. Fish and Wildlife Service and U.S. Geological Surveys of contaminants (e.g., pesticides, lead, and selenium) in sediment, water and wildlife, including white-faced ibis, are being conducted at important ibis breeding and wintering areas in California (Dileanis and Sorenson 1992, Dileanis *et al.* 1996). The U.S. Fish and Wildlife Service periodically reviews and assesses the status of white-face ibis breeding colonies in the western United States including California (Booser and Sprunt 1980, Volks and English 1981, U.S. Fish and Wildlife Service 1985, Earnst *et al.* 1998, in preparation). Work is currently being done to assess and develop management strategies and recommendations for white-faced ibis (S. Earnst pers. comm. 1998). Bray and Klebenow (1988) give recommendations for management of white-faced ibis foraging habitat: (1) fields should be large [greater then 30 hectares (74 acres)], relatively level (less than 5 percent slope), and close [less than 6 kilometers (3.7 miles)] to ibis colonies; (2) soils should be of low permeability; (3) pesticide spraying, burning, discing and mowing of fields should be minimized; and (4) organic fertilizers should be used to enhance white-faced ibis foods. Beedy (pers. comm. 1998) noted that ibis nesting at the Woodland Sugar Ponds foraged in the Yolo Bypass over 8 kilometers (5 miles) away.

The U.S. Fish and Wildlife Service (1985) suggests management guidelines for ibis that include: (1) managing water to maintain stable breeding vegetation in wet and dry years; (2) providing shallow water [less than 15 centimeters (5.9 inches) deep] in feeding areas especially during the fledgling stage; (3) reducing or eliminating cattle grazing in ibis breeding colony areas; (4) including ibis nesting requirements in marsh/grassland/fire management; (5) providing at least a 4:1 ratio of breeding vegetation size to colony size at State and Federal wildlife areas; (6) acquiring in fee or easement, ibis colonies that are threatened on private land; (7) providing technical assistance and educational materials to private land owners; and (8) monitoring ibis nesting annually.

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Table 1B. Number of white-faced ibis breeding pairs at active breeding colony sites in California (Adapted from Earnst *et al.* 1998, in preparation).

Location	**Year**												
	1985	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Colusa National Wildlife Refuge	50	80	125	400	500	0	0	0	0	0	0	0	0
Mendota Wildlife Area	0	0	0	0	0	0	0	463	1057	890	1672	2047	2950
Other northern California[a]	30[b]	0	0	25	0	0	0	0	0	0	0	0	0
Other southern California[c]	0	0	0	0	0	0	0	0	0	0	50	0	460
Total	80	80	125	425	510	0	0	463	1057	890	1722	2047	3410

[a] Includes Woodland Sugar Ponds (12 pairs 1985, 25 pairs 1988).
[b] E. Beedy (pers. comm. 1998)
[c] Includes Tulare Lake Basin (460 pairs 1997); San Luis National Wildlife Refuge Complex (50 pairs 1995).

WESTERN POND TURTLE
(*Clemmys marmorata*)

Taxonomy

The western pond turtle belongs to the box and water turtle family Emydidae. It was first described as *Emys marmorata* in 1841 in the vicinity of Puget Sound, Washington, by Baird and Girard (1852). Two subspecies are currently recognized (Seeliger 1945): the northwestern pond turtle (*Clemmys marmorata marmorata*) and the southwestern pond turtle (*Clemmys marmorata pallida*).

Description

The western pond turtle is a small (9 to 19 centimeters, 3.5 to 7.5 inches) aquatic turtle characterized by an olive, dark brown, or black shell with a spotted head and neck (Stebbins 1985). The northwestern subspecies is defined on the basis of mottled head and neck coloration and a relatively high frequency of inguinal shields. The southern subspecies is defined on the basis of light head and neck coloration with more prominent markings in these areas, and a reduced frequency of occurrence of large inguinal shields.

Identification

The western pond turtle is the only native box turtle widely distributed in the western United States (Stebbins 1985). The painted turtle (*Chrysemys picta*), which is found primarily in the midwestern United States, ranges into the Pacific Northwest. The painted turtle can be distinguished from the western pond turtle by the presence of yellow lines on the head and limbs, and red markings on the shell (Stebbins 1985). The slider (*Pseudemys concinna*) an eastern United States box turtle, has been introduced in the west. The slider can be distinguished from the western pond turtle by the presence of lengthwise wrinkles and streaks on the shell and the absence of spotting on the head and neck, typical of the western pond turtle (Stebbins 1985).

Distribution

The northwestern pond turtle historically and currently ranges from Puget Sound, Washington, south through Oregon, generally west of the Sierra-Cascade crest, to the American River drainage in central California. The southwestern subspecies ranges from the vicinity of Monterey Bay, California, south through the coast ranges to Baja California Norte, Mexico. The area of the Central Valley of California between the American River drainage and the Transverse Ranges is considered to be a zone of intergradation between the two subspecies (Seeliger 1945). Historically, the western pond turtle inhabited the vast permanent and seasonal wetlands on the Central Valley, with the Tulare Lake Basin being a stronghold for the species. Today, the western pond turtle remains in 90 percent of its historic range, but at greatly reduced numbers (Holland 1991a).

Records of *C. m. marmorata* from Grant County, Oregon, and British Columbia, Canada, are believed to represent introduced animals (Nussbaum *et al*. 1983, Storer 1937). Outlying populations of *C. m. marmorata* occur in Nevada primarily in the Carson River drainage. Whether or not these populations are native or represent introduced animals is debated by the experts (Holland 1991a, W. Molini *in litt*., 1992). Outlying populations of *C. m. pallida* occur in the Mohave River drainage, California.

<u>Life History</u>

The diet of the western pond turtle is comprised primarily of small invertebrates (Holland 1985a, 1985b, Bury 1986). Pond turtles may consume small vertebrates, including fish and amphibians (Holland 1985a, Bury 1986) and small amounts of plant material (Evenden 1948, Holland 1985a, Bury 1986). Feeding on carrion is common (Evenden 1948, Carr 1952, Holland 1985a, Bury 1986), but live prey is preferred (Bury 1986). Juvenile turtles feed primarily on small invertebrates, whereas adults, particularly females, consume a greater percentage of plant material than do juveniles (Bury 1986).

The age of first reproduction is 7 to 9 years of age for the southwestern pond turtle and 10 to 14 years of age for the northwestern pond turtle (D. Holland unpubl. data). Most females lay eggs in alternate years. Clutch size ranges from 1 to 13 eggs, with larger females generally laying larger clutches (Holland 1985a, 1991a). From May through July, females move into upland habitat to nest. Nest locations range from 12 to 402 meters (39 to 1,319 feet) from aquatic habitat (Storer 1930, Holland 1991b, Rathbun *et al*. 1992). Nest sites are typically located in open areas dominated by grasses and forbs. Soils are dry and generally well drained with significant clay/silt content and low slope. Nests on sloping terrain often have a southern or southwestern exposure. Females excavate their nests in the ground, deposit the eggs, and cover the nest by scraping soil and vegetation over the eggs. Females tend to be very wary during overland nesting movements and may abandon nesting attempts if disturbed (Holland 1991a, Rathbun *et al*. 1992). Incubation requires from 96 to 104 days in the wild (Holland 1991a). In captivity, Feldman (1982) noted an incubation period of 73 to 80 days. Although some hatchlings have been observed to leave the nest in September (Holland 1991b), the majority of hatchlings probably overwinter in the nest (Holland 1985a, 1991b), then move to water in March to April.

Bury (1972a) found home ranges of western pond turtles to average 1 hectare (2.5 acres) for males, 0.3 hectare (0.7 acre) for females, and 0.4 hectares (1 acre) for juveniles. Within the northern California stream system studied by Bury (1972a), males moved greater distances than females or juveniles. Pond turtles rarely move between drainages (Holland 1991a).

Survivorship in western pond turtles apparently is dependent upon age and sex. Hatchlings and first year juveniles are subject to low survivorship, averaging 8 to 12 percent; survivorship may not increase significantly until turtles are 4 to 5 years old (D. Holland unpubl. data). Once turtles reach adult size, survivorship improves with an average adult turnover rate of 3 to 5 percent per year (D. Holland unpubl. data). On the average, adult males have a higher probability of survivorship than adult females, with skewed sex ratios observed as high as 4:1 males to females (Holland 1991a). The most plausible explanation for these observed sex ratios is that females suffer higher rates of predation during overland nesting attempts (Holland 1991a). Adults are long lived, with the maximum known age approximately 39 to 40 years (B. Bury unpubl. data, D. Holland unpubl. data). Holland (1991a) estimated that the potential life span of western pond turtles may be 50 to 70 years.

The western pond turtle is preyed upon by a wide variety of native and introduced predators, including large and small mammals, raptors, herons, corvids, snakes, frogs, and fish. Of the native predators, the raccoon (*Procyon lotor*) is a ubiquitous and effective predator, taking animals of all sizes, including eggs and hatchlings. The spotted skunk (*Spilogale putorius*) is also a suspected predator of nests. In Oregon, over 90 percent of the 100 nests examined in 1991-1992 were destroyed by predators, most likely raccoons or skunks (Holland 1992). Raccoon populations, in particular, respond favorably to urban environments, where human refuse may support larger populations than normal. Larger populations of raccoons and other predators combined with reduced nesting habitat for pond turtles adjacent to aquatic habitat results in concentrations of nests which are more easily detected by predators. Other native predators observed to have locally significant effects on pond turtles are the black bear (*Euarctos americanus*), river otter (*Lutra canadensis*), and mink (*Mustela vison*) (S. Sweet pers. comm. *in* Holland 1991a, Holland 1991a). Two introduced predators of particular concern are the bullfrog (*Rana catesbeiana*) and the largemouth bass (*Micropterus salmoides*). Both species have been observed to feed on juvenile western pond turtles (Moyle 1973, S. Sweet and T. Pappenfuss, pers. comm., *in* Holland 1991a, Holland 1991a).

In the majority of its range, western pond turtles are active from about March through October with the peak of activity in May and June. Turtles on the central and southern coast of California are active year-round. Turtles may overwinter in undercut areas or holes in the banks of watercourses or move to upland habitat. Turtles may move up to 250 meters (820 feet) from aquatic habitat to overwinter under dense vegetation, logs or leaf litter (Holland 1991a).

Habitat and Community Associations

The western pond turtle is found in fresh to brackish permanent to intermittent aquatic habitats, including marshes, rivers, ponds, streams, and vernal pools. Pond turtles also may occur in man-made habitats, such as irrigation ditches, reservoirs, and sewage and mill ponds. Preferred aquatic habitat is characterized by slow moving or quiet water, emergent aquatic vegetation, deep pools with undercut banks for refugia, and partially submerged rocks and logs, open mud banks and matted floating vegetation for thermoregulatory basking. Hatchling and young turtles (1 year) require shallow water areas (less than 30 centimeters [11.8 inches] deep) dominated primarily by emergent aquatic reeds (*Juncus* sp.) and sedges (*Carex* sp.) (Holland 1991a).

Reasons for Decline

Habitat loss and alteration are the primary factors that caused the historic decline of western pond turtles throughout its range. In California, over 90 percent of historic wetlands have been diked, drained and filled primarily for agricultural development and secondarily for urban development (Frayer *et al*. 1989). Much of the wetland habitat lost, such as in the Tulare Lake basin, was prime habitat for the western pond turtle. Historic wetland losses in Oregon and Washington were less severe. Water projects in the mid 1900s, which accompanied agricultural growth, also had a negative effect on pond turtle populations. Construction of reservoirs directly eliminated pond turtle habitat and isolated or fragmented remaining populations.

Historically urbanization also has significantly altered or eliminated pond turtle habitat, with the greatest impact occurring in southern California within the range of the southwestern pond turtle, C. *m. pallida*. In the Los Angeles basin, pond turtles have been eliminated from many streams, including the type locality (Coyote Creek) of the southwestern subspecies, by channelization and cementing of these streams (Brattstrom and Messer 1988, Holland 1991a).

Records of harvesting western pond turtles for food dates back to an account by Lockington (1879) of the commercial harvest of this species for the San Francisco market. At the time, commercial harvest had already depleted populations of the western pond turtle in the San Francisco area, resulting in commercial operations focusing on populations in the San Joaquin Valley, particularly Tulare Lake (Elliot 1883, Brown 1940). Over 18,000 pond turtles were offered for sale in San Francisco markets, presumably in one year in the 1890s (Smith 1895). This practice continued at least through the 1920s (Storer 1930).

Threats to Survival

A variety of factors, including habitat loss and modification, commercial exploitation, disease, introduced predators and competitors, and other natural and man-made factors working together have resulted in a significant decline in western pond turtle populations throughout 75 to 80 percent of its range (Holland 1991a). Although the western pond turtle still exists in about 90 percent of its original range, this species has been completely or ecologically extirpated from a number of areas. These include the Puget Sound area of Washington, the Willamette River drainage in Oregon, the Klamath River drainage of Oregon and California, the San Francisco metropolitan area, the southern San Joaquin Valley, the Los Angeles and San Diego metropolitan areas, and Nevada (Holland 1991a).

Wetlands that have persisted are often indirectly affected by adjacent agricultural practices. Many of these aquatic habitats are utilized to convey or store agricultural water and, therefore, are subject to changes in the timing and amount of water flow. These wetlands often are channelized and periodically cleaned of aquatic vegetation rendering them unsuitable for pond turtles. Where pond turtles persist adjacent to agricultural lands, upland nesting opportunities may be limited or nonexistent because of the practice of farming up to the edge of the aquatic habitat. Because the pond turtle is long-lived, populations may persist in these areas long after recruitment of young has ceased. According to Holland (1991a), turtle populations in agricultural settings tend to be very small and heavily adult biased.

Changes in the nature and timing of water releases from reservoirs adversely affects downstream habitat by eliminating or altering basking sites, refugia, foraging areas, and particularly, hatchling microhabitat. High releases of water in the Trinity River in late May to early June in 1991 scoured out several miles of hatchling turtle habitat (Holland 1991a). A similar incident occurred in Piru Creek in southern California (S. Sweet, pers. comm. *in* Holland 1991a). Reservoirs also are typically stocked with exotic species of fish, which may expand into previously isolated turtle habitat. Reservoirs, in general, provide poor habitat for turtles because of the lack of emergent aquatic vegetation, basking sites, high recreational use, and presence of exotic species. Only small groups of adults are seen (Holland 1991a).

Water diversions for agriculture and urban uses also have negatively affected pond turtle populations. Many rivers, particularly in more arid regions such as the San Joaquin Valley of California, have had significant portions of their flows diverted for agriculture resulting in very low flows or no flows for several miles of stream during summer months. This has resulted in elimination of pond turtles from these stream stretches and isolation of turtle populations located in other portions of the drainage (Holland 1991a).

Another significant source of habitat alteration throughout the range of the western pond turtle is livestock grazing. Livestock have been documented as a major cause of excessive habitat disturbance in riparian areas (Behnke and Raleigh 1978, Kauffman and Krueger 1984). Cattle have a disproportionately greater adverse affect on riparian and other wetland habitats because they tend to concentrate in these areas, particularly during the dry season (Marlow and Pogacnik 1985). Cattle trample and eat emergent vegetation (Platts 1981) that serves as foraging habitat for turtles of all sizes and as critical microhabitat for hatchlings and first year animals. Streambanks also are trampled by cattle often resulting in the collapse of undercut banks (Platts 1981, Kauffman *et al*. 1983) that provided refugia for turtles. Cattle grazing results in increased erosion in the stream (Winegar 1977) which fills in deep pools, increases stream velocity, and adversely affects aquatic invertebrates (Behnke and Raleigh 1978, Platts 1981). Cattle may also crush turtles (Holland 1991a).

In-stream and streamside mining operations for sand and gravel also unfavorably alter pond turtle habitat. These operations may directly eliminate or modify aquatic habitats and adjacent riparian habitat; alter the pattern of water flow; increase siltation, which fills in pools and alters the prey base; and disrupt normal behavior patterns or force displacement (Holland 1991a).

Removal of basking sites (e.g., logs, snags, and rocks) for aesthetic reasons or to facilitate recreational pursuits has a negative effect on pond turtles. Loss of basking sites changes thermoregulatory behavior of turtles and reduces available foraging and refugial sites. According to Holland (1992), this activity is a primary factor in the observed decline of western pond turtles in several lakes in Oregon.

Collection of pond turtles for food still exists today with numbers from 20 to over 100 taken in a single instance (H. DeLisle and S. Sweet pers. comms. *in* Holland 1991a). A commercial pet market exists for pond turtles despite state prohibitions. Holland (1991a) noted western pond turtles for sale by a Florida dealer in 1991 and in some California pet stores through at least 1985. Bury (1982) noted removal of over 500 turtles from one lake in southern California for the pet trade.

Incidental collection of pond turtles by fisherman may be a significant mortality factor in some areas. Approximately 3.6 percent of turtles captures by Holland (1991a) at an Oregon site had ingested fish hooks. At a California site, about 6 percent of captured turtles showed evidence of trauma related to removal of hooks, had hooks in place, or were found dead with hooks embedded in the esophagus or stomach (Holland 1991a). A turtle captured by Holland (1991a) in Oregon before and after ingestion of a fish hook had lost a significant amount of weight, suggesting that hooked turtles may eventually starve to death. Hooked turtles are often killed by fisherman, who mistakenly presume that pond turtles are competitors for fish or consume ducklings (Holland 1991a).

The only documented instance of disease outbreak in the western pond turtle occurred in an isolated Klickitat County population in southern Washington in 1990 (Holland 1991b). A significant portion of the population displayed symptoms of upper respiratory disease syndrome, a disease previously observed in desert tortoises (*Gopherus agassizi*). A minimum of 42 to 47 percent of the population died from the disease despite extensive efforts to treat diseased animals in captivity (Holland 1991b). The agent and mechanism responsible for the epidemic are unknown. Given the highly contagious nature of this disease and the high observed rates of mortality, the potential exists for significant population declines should this disease appear in contiguous pond turtle populations. Evidence of this or a similar disease was found in a turtle from the Willamette River drainage in Oregon (T. DeLorenzo pers. comm. *in* Holland 1991a).

Two introduced predators, the bullfrog and largemouth bass have been observed to feed on juvenile western pond turtles (Moyle 1973, S. Sweet and T. Pappenfuss pers. comm. *in* Holland 1991a, Holland 1991a). Both species were introduced into the western United States in the latter part of the 19th century, and through range expansions, reintroductions, and transplants these species have become established across most of the western United States (Moyle 1973). Bullfrogs forage primarily in shallow water, the microhabitat favored by hatchling and juvenile pond turtles. Examination of a number of sites in Washington, Oregon, and California by Holland (1991a) indicates a negative correlation between the abundance of bullfrogs and the abundance of small pond turtles. In aquatic habitats containing largemouth bass, but no bullfrogs, a fringe of emergent vegetation around the pond edge may protect hatchling and juvenile pond turtles from predation by bass (Holland 1991a).

Indiscriminate shooting of western pond turtles can be a significant mortality factor, particularly in areas adjacent to urban development. In southern California, a substantial proportion of a pond turtle population under study was shot by two individuals carrying rifles (S. Sweet pers. comm. *in* Holland 1991a). In Washington, shooting of turtles for sport was reported in the early 1970's (Milner 1986).

Construction of roadways adjacent to pond turtle habitat adversely affects pond turtles in several ways. First, roads often present a partial or complete barrier to turtles traveling overland to nesting or overwintering sites. In studies in California, Oregon and Washington, western pond turtles have been observed crushed on roadways (Holland 1985a, 1992), with the majority of these being gravid or post-partum females. In addition to hampering access to nesting areas, the road bed itself reduces the area of potential nesting. Roads constructed on south-facing slopes adjacent to the Umpqua River in Oregon probably eliminated both existing and potential nesting habitat (Holland 1992).

Train tracks may have similar adverse affects on pond turtles. At two locations in Oregon, pond turtles were found dead between railroad tracks. In both cases the railroad tracks paralleled the north side of the watercourse and were located between the watercourse and potential nesting habitat (M. Dahlgreen and R. Lewis pers. comms. *in* Holland 1992). Holland (1992) hypothesized that the turtles became trapped between the railroad tracks when unable to find a way to exit under the rail.

Off-road vehicle activity poses a threat to western pond turtles both directly and indirectly. Direct impacts include crushing of individual turtles or nests and access to remote populations of the turtle for the purposes of collection or shooting. Off-road vehicle activity indirectly impacts pond turtles by interfering with normal foraging and basking activities, and by altering or restricting overland or instream movements of turtles. Long-term impacts of off-road vehicle activity include increased soil erosion, soil compaction, vegetation removal, siltation of the watercourse, and alteration or loss of refugia. According to Holland (1991a), western pond turtle populations located in off-road vehicle areas in California tend to be small and disjunct, and occur in very limited habitats. Poor habitat quality combined with a very low probability of maintenance or reestablishment by immigration, renders these populations highly susceptible to extirpation.

Boat traffic also may adversely affect pond turtles. Observations on the Rogue River in Oregon by Holland (1992) indicate that high levels of boat traffic may detrimentally alter basking and other behavior patterns. In addition, turtles that become acclimated to boat or vehicle traffic are potentially more susceptible to shooting. Holland (1991b) found that flight distances were significantly less in turtle populations acclimated to low or moderate levels of vehicle traffic than for populations in isolated areas. Boat propellers may also injure or kill pond turtles (Holland 1992).

Another factor that may adversely affect pond turtle populations is the introduction of nonnative competitors. Numerous species of nonnative aquatic turtles have been observed within the range of the western pond turtle (Jennings 1987). These include the painted turtle, red-eared slider (*Pseudemys scripta elegans*), common snapping turtle (*Chelydra serpentina*), spiny soft-shelled turtle (*Apalone spinifera*), alligator snapping turtle (*Macroclemys temmincki*), stinkpot (*Sternotherus odoratus*), diamondback terrapin (*Malaclemys terrapin*), and the Mississippi map turtle (*Graptemys kohni*). Most of these turtles represent animals imported for the pet or food trade that have been released or escaped captivity. In addition to competition for food, exotic turtles also may carry new pathogens for which pond turtles exhibit no immunity.

Additional exotic competitors of particular concern are carp (*Cyprinus carpio* and *Carassius auratus*), sunfish (*Lepomis* spp. and *Pomoxis* spp.), and crayfish (*Cambarus*, *Procambarus*, and *Pacifasticus*). Carp alter aquatic habitats by consuming emergent and floating vegetation. Their activities also produce turbid water conditions. These alterations of the aquatic habitat may have a significant impact on hatchling turtle habitat, may reduce the availability of invertebrate prey, and decrease turtle foraging success as turtles rely primarily on vision to capture prey (Holland 1991a). Sunfish, which are capable of reaching large population sizes in aquatic habitats may modify or compete for the available invertebrate prey base (Holland 1991a). Although direct scientific data are unavailable to support this hypothesis, Holland (1991a) noted that several sites lacking native or non-native fishes support the largest known western pond turtle populations. Crayfish, which also may prey on young pond turtles, may compete with pond turtles for both the invertebrate prey base and carrion (Holland 1991a).

The exact role that contaminants play in western pond turtle mortality is unknown. Only one documented instance of contaminant related mortality of pond turtles was reported by Bury (1972b). Turtle mortality resulted from a spill of diesel fuel. In Oregon, pollution of several tributaries to the Willamette River (i.e., the Tualatin and Clackamas Rivers) in the late 1950s and 1960s may be related to the disappearance of pond turtles from these rivers (Holland 1991a). The long life span and food habits of the pond turtle could render this species prone to bioaccumulation of contaminants, such as heavy metals; however, no data are available to support this hypothesis (Holland 1991a).

The most significant natural factor affecting pond turtle populations is drought. The 6-year drought in California had a major effect on pond turtle populations, particularly in central and southern California within the range of the southwestern pond turtle. Surveys of eight sites conducted by Holland (1991a) from 1987 to 1991 in central and southern California indicated that turtle populations had declined from 65 to 100 percent as a result of drought. One population in the Pajaro-Salinas River drainage of central coastal California, which contained the highest recorded density of turtles, suffered an 85 percent population decline (Holland 1991a). Drying of the habitat resulted in 1) concentrating large numbers of turtles in the few remaining pools, 2) major increases in the distance between pools, 3) exhaustion of the prey base, 4) increased exposure to predators, and 5) a general increase in stress suffered by the turtle population (Holland 1991a). Observations of additional sites by Holland (1991a) within the range of the southwestern pond turtle indicated that drought related declines in populations of this subspecies were widespread. Where non-native predators and competitors were present, the adverse affects of drought were probably magnified (Holland 1991a).

Fire, which is often associated with drought and the overaccumulation of combustible plant material, adversely affects pond turtles in several ways. Unseasonal fires may kill overwintering turtles or hatchlings in the nest. Sweet (pers. comm. *in* Holland 1991a) reported that the Sespe Creek fire in fall 1991 probably killed any adult or hatchling turtles overwintering in the uplands. Excessive siltation of streams following fires may alter the prey base and eliminate refugial habitat, generally decreasing the suitability of the stream for turtles (Holland 1991a).

Conservation Efforts

The southwestern pond turtle was included as a category 1 candidate species in the Service's November 21, 1991, Animal Notice of Review (U.S. Fish and Wildlife Service 1991). The northwestern pond turtle was included as a category 2 candidate (U.S. Fish and Wildlife Service 1991). In 1993, the U.S. Fish and Wildlife Service reviewed the status of the western pond turtle and found that listing was not warranted (U.S. Fish and Wildlife Service 1993). Both subspecies of the western pond turtle, however, are species of concern.

In the State of Washington, the western pond turtle is listed as endangered. In Oregon, the western pond turtle is currently considered a Sensitive Species, subcategory "critical" by the Oregon Department of Fish and Wildlife under Oregon's Sensitive Species Rule. In California, the western pond turtle is a protected reptile under provisions of the California Fish and Game Code. The pond turtle also is classified as a "Species of Special Concern" (Steinhart 1990). In Mexico, a scientific collecting permit is required prior to any work on or collection of the species.

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PACIFIC FLYWAY WATERFOWL

Distribution and Abundance- Resident Waterfowl

Geese

The western Canada goose (*Branta canadensis moffetti*) is the only goose species that nests in the Central Valley, and only small numbers do so, most favoring the Sierra Nevada and Cascade mountains, and the northeastern plateau. Most Central Valley nesting geese are associated with ponds and reservoirs wherever they are found, but especially in the foothills of the Sierra Nevada and Coast Range mountains, flood basins in urban areas, islands in the Sacramento-San Joaquin River Delta (Delta), and wetlands and rice fields in the Sacramento Valley (California Department of Fish and Game, unpublished data). There are no annual surveys conducted specifically for nesting Canada geese in the Valley, and the annual California Waterfowl Breeding Population Survey conducted in May (California Department of Fish and Game, Sacramento, California, unpublished data), is very inefficient for geese; however, the California Waterfowl Association (California Waterfowl Association, Sacramento, California, unpublished data) conducted a pre-hunting season survey in the Valley in fall 1997, and recorded a total of only 3,400 Canada geese. Thus, the nesting population is probably about 1,500 pairs in the surveyed area. There are no data available on nesting success of local goose flocks in the Valley or on population trends.

Many nesting flocks have expanded from small numbers of escapees from captive flocks and from transplant operations. For example, Canada geese originally used as live decoys were released when this practice became illegal, and now form small nesting flocks in the Suisun and Rio Vista areas. Also, geese originally obtained from Lake Almanor formed the nucleus of a research flock at the University of California, Davis in the 1970s, but have since escaped and are expanding across Yolo and Solano Counties. Geese from Reno, Nevada have been translocated to Mandeville Island in the Delta west of Stockton, and now form a local nesting flock. There are volunteer efforts to expand goose nesting populations throughout the foothill region (e.g., California Waterfowl Association's Canada goose restoration program). Nesting is facilitated on islands in ponds, lakes, and rivers, and Canada geese readily accept nesting structures, such as tubs, old tires, hay bales, and floating rafts (Dill and Lee 1970). Nesting geese and goslings probably forage on growing grass, forbs, and aquatic vegetation in the Valley, but food habitats data are not available. Growing Canada goose flocks pose potential problems for growing rice and other crops, and urban parks, golf courses, and lawns (Conover and Chasko 1985).

Ducks

Mallards (*Anas platyrhynchos*) nest throughout California, from the coast to near-alpine areas in the Sierras and from the Oregon border to southern California, they are also the most common ducks nesting in California (Small 1994, California Department of Fish and Game, unpublished data). The Central Valley, especially the Sacramento Valley portion, is the most important nesting region for mallards in the state based on the annual aerial surveys conducted in May (California Waterfowl Breeding Population Survey, Department of Fish and Game, Sacramento, California, unpublished data). The Central Valley Habitat Joint Venture (Central Valley Habitat Joint Venture Implementation Board) (1990), a part of the North American Waterfowl Management Plan (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1986), has set an objective of 400,000 breeding ducks for the Central Valley, including 300,000 mallards. Recent annual breeding population estimates of mallards in the Central Valley in May obtained from California's May survey, which includes corrections for visibility (Zezulak *et al*. 1991), has increased from 217,000 in 1994 to 401,000 in 1997 (California Department of Fish and Game, Sacramento, California, unpublished data). These Central Valley totals account for 67 to 78 percent of the statewide total. Thus, Central Valley Habitat Joint Venture objectives for mallards are being met. In years when spring rainfall is high and extended, nesting populations in the Central Valley, especially the Sacramento Valley portion, are high relative to populations in drier years (Mayhew 1955).

Within the Central Valley, nesting mallards are particularly abundant in the Sacramento Valley, the Grasslands area of the San Joaquin Valley, and the Delta region. In the Sacramento Valley, mallards are most associated with rice fields, National Wildlife Refuges, State Wildlife Areas, and private duck clubs in the heart of the Valley, and they also nest along the canals and levees associated with rice farming and water delivery to a variety of crops (Earle 1950). Mallards are also common in the foothills of the Sierra and Coast Range mountains, wherever ponds, lakes, and reservoirs can be found in association with adequate upland nesting habitats.

McLandress *et al*. (1996) studied nesting mallards in the Sacramento Valley on Gray Lodge Wildlife Area, and Sacramento, Delevan, and Colusa National Wildlife Refuges, and in the San Joaquin Valley on Mendota Wildlife Area and the Grasslands area. They found that the nesting season for mallards in the Central Valley began in February, peak nest initiations occurred in early April, and few nests were initiated after early June. Nests began to hatch in March and this continued through the first week in July (California Waterfowl Association, Sacramento, California, unpublished data). Nest success (Mayfield 1961) was 22 to 36 percent in the Sacramento Valley and 23 to 50 percent in the San Joaquin Valley. Breeding pair density ranged from 25 to 28 per square kilometer (16 to 17 per square mile) in the Sacramento Valley and 13 to 17 per square kilometer (8 to 11 per square mile) in the San Joaquin Valley; also, nest density ranged from 90 to 113 nests per square kilometer (56 to 70 per square mile) in the Sacramento Valley and 35 to 46 nests per square kilometer (22 to 29 per square mile) in the San Joaquin. Yarris *et al*. (1994) found that most adult female mallards leave nesting areas in Suisun Marsh after brood rearing, making a molt migration to northern California and Oregon. This pattern is likely repeated from Central Valley nesting regions as well.

In the Sacramento Valley, in past years when farm programs held out acreage from rice in favor of cover crops, mallards nested heavily in these "set-aside" lands. McLandress *et al*. (1996) documented nesting densities exceeding 170 nests per square kilometer (106 per square mile) in these set-aside lands, which is far in excess of densities reported for the best habitats in the Prairie Pothole Regions of Canada (means of 3 to 35 nests per square kilometer [2 to 22 per square mile]; Greenwood *et al*. 1987, Fleskes and Klaas 1991, Higgins *et al*. 1992). Unfortunately, and of concern to the future of mallards in the Sacramento Valley, rice farm programs are being phased out by the most recent Federal farm bill, so set-aside lands will soon no longer be available. However, another excellent nesting substrate for mallards is in the many growing winter-wheat fields scattered throughout the Sacramento Valley in association with rice. Nest densities in these wheat fields averaged 183 nests per square kilometer (114 per square mile) in recent work (McLandress *et al*. 1996). After the wheat field or set-aside land nests hatch, the hens use adjacent rice fields, flooded with the current year's growing rice crop, to rear their ducklings. When broods hatch, they move to the rice fields before the wheat is harvested (late May-June).

Mallards also nest in native upland cover present on National Wildlife Refuges, Wildlife Areas, and private wetlands, such as duck clubs and other holdings, and there often is associated permanent or summer water ponds in which to rear ducklings. In particular, the uplands and wetland complexes on Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges, Gray Lodge and Upper Butte Sink Wildlife Areas, and the duck clubs in Butte Sink offer excellent mallard nesting opportunities in the Sacramento Valley. In the Delta, mallards nest in growing wheat fields and odd natural areas present throughout this agricultural region, such as slough banks, slough islands, levees, etc. Mallards also nest in upland habitats on the Cosumnes River Preserve. The new Stone Lakes National Wildlife Refuge, Yolo Basin Wildlife Area, and the expanding Cosumnes River Preserve will be providing additional mallard nesting habitats in the Delta region. Projects for wetland restoration in the Delta being considered by the CALFED Bay-Delta Program (CALFED 1998) will benefit mallards and other duck species by providing much needed upland cover for nests and wetlands for brood rearing. Much of the region is intensively farmed (corn, asparagus, tomatoes, wheat) making successful mallard nesting problematical. For example, alfalfa fields, though attractive to mallards, do not produce successful nests because cutting activities destroy them prior to hatch.

Brood survival from early hatched mallard nests in the rice growing region of the Sacramento Valley is low, ranging from 10 to 15 percent (G. Yarris, California Waterfowl Association, Sacramento, California, unpublished data). This is because brood habitat is limited early in the nesting season to water in canals and ditches and some permanent wetlands on National Wildlife Refuges, Wildlife Areas, and duck clubs. In these environments, predators can be very efficient, and most of the ducklings are caught and consumed, especially in the canals and ditches. Later in the nesting season, hens can lead their ducklings to flooded rice fields, in which rice plants grow above the water surface, and there, brood survival becomes relatively high (nearly 60 percent) (G. Yarris, California Waterfowl

Association, Sacramento, California, unpublished data). Thus, there is a need to provide more permanent or seasonal wetlands early in the nesting season to improve early brood survival. In this regard, because of the large loss of mallard and other duck nests to agricultural activities, primarily cultivation, private landowners have organized duck egg salvage operations. During spring, before fields are worked up for the new crop of rice or other grains, volunteers walk through the fields and retrieve eggs, which are transported to incubation and rearing facilities. After a few weeks, the ducklings are released on suitable brood habitats. The program is resulting in provision of summer brood water in the Sacramento Valley that otherwise would not be present.

In the San Joaquin Valley, mallards nest in association with the vast wetlands and uplands within the Grasslands Resource Conservation District around Los Banos and the Mendota Wildlife Area to the south. Hens nest in the uplands and rear their broods in wetlands that are flooded through the summer. Here, mallard brood success has been variable in recent studies (Chouinard 1997). Federal and State programs are critical to assist in the maintenance of these wetlands because water costs are high, and few if any naturally occurring permanent marsh areas are present. The latter would include natural sloughs and back waters along the San Joaquin River and smaller waterways, and some permanent wetlands on San Luis and other National Wildlife Refuges, and Los Banos and other state Wildlife Areas.

The annual California Waterfowl Breeding Population Survey is not efficient for species other than mallards, because these species occur in low or highly variable numbers, often reflecting the presence of migrating flocks. For example, 15,000 to 30,000 cinnamon teals (*Anas cyanoptera*) and 21,000 to 50,000 gadwalls (*Anas strepera*) were counted on these surveys during 1993-97 (California Department of Fish and Game, unpublished data), and can be considered as breeding birds. However, variable numbers of northern shovelers (*Anas clypeata*) (14,000 to 80,000), and northern pintails (*Anas acuta*) (1,500 to 9,000) were also present. The high numbers of these species reflected the presence of migrating birds and did not indicate local nesting populations. Cinnamon teals, gadwalls, and pintails nest commonly in the managed marsh areas within the Central Valley, but are more common in the San Joaquin Valley than in the Sacramento Valley or Delta (75 percent of teals and 65 to 85 percent of gadwalls); virtually all Central Valley nesting pintails are found in the San Joaquin Valley (Anderson 1956, 1957; California Waterfowl Association, unpublished data). Teals nest closer to water than do other local species and are found in close association with marshes, sloughs, and irrigated pastures and other wetlands throughout their range, including the foothills.

Few diving ducks nest in the Central Valley because of the rarity of permanent marshes. Redheads (*Aythya americana*) traditionally nested in the Central Valley, using bulrush (*Scirpus acutus et al*.) in which to place their floating nests. As the extent of permanent wetlands has dwindled, so too has the redhead nesting population. The California Breeding Population Survey (California Department of Fish and Game, unpublished data) recorded 0 to 1,400 redheads annually during 1993-97. With the provision of additional permanent wetlands, redhead populations should increase, as shown by the recent increase in the white-faced ibis (*Plegadis chihi*), which also nests in permanent marshes (Small 1994). Ruddy ducks (*Oxyura jamaicensis*) are counted in small numbers (2,100 to 8,000) during the California Breeding Population Survey, and the higher counts reflect migrant populations. Ring-necked ducks (*Aythya collaris*) do not regularly nest in the Central Valley.

Wood ducks (*Aix sponsa*) frequent dense wooded wetlands during spring, especially in Butte Sink, and along the many wooded streams and rivers in the Central Valley. There are no formal surveys designed to inventory breeding populations of wood ducks in California, and wood ducks are not efficiently counted in the California aerial surveys, which recorded 0 to 12,000 wood ducks annually during 1993-97 (California Department of Fish and Game, Sacramento, California, unpublished data). The best data are provided by volunteers working as part of the wood duck nesting program sponsored by the California Waterfowl Association. Volunteers erect and maintain nest boxes and record information on production over the nesting season. The project has expanded greatly in recent years, and about 5,000 boxes have been erected, maintained, and monitored, and have produced nearly 115,000 ducklings since 1990 (Johnson and Lauridson 1997). Nesting hens and broods feed on insect larvae, other aquatic invertebrates, and seeds (Bellrose and Holm 1994) in sloughs and marshes along Central Valley streams.

Distribution and Abundance - Wintering Waterfowl

California’s Central Valley is most noted for its wintering waterfowl populations, and historically, wetland management has emphasized the role of this region to provide winter, not nesting, habitat (Heitmeyer *et al*. 1989). The Central Valley is the most important wintering region in the Pacific Flyway in terms of the total numbers of birds supported (about 60 percent of the flyway’s total waterfowl), and the Central Valley is the only, or most significant, wintering area for a number of species, such as Ross’(*Chen rossii*), Pacific white-fronted (*Anser albifrons*), tule white-fronted (*Anser albifrons gambelli*), and Aleutian Canada geese (*Branta canadensis leucopareia*), and northern pintails (U.S. Fish and Wildlife Service 1978). In general, wintering waterfowl depend upon managed public and private wetlands, and dry and flooded rice, corn, and wheat for roosting and feeding habitats. Some flocks also use foothill lakes and reservoirs, and some species use urban sewer ponds. California’s Central Valley probably supported upwards of 4 million acres of wetland habitats before settlement (U.S. Fish and Wildlife Service 1978). This acreage ultimately dwindled to only about 4 percent of the original amount before restoration began in the late 1980s with North American Waterfowl Management Plan programs managed by the local Central Valley Habitat Joint Venture (Central Valley Habitat Joint Venture Implementation Board 1990). Since this time, several new National Wildlife Refuges (e.g., Stone Lakes, Llano Seco, Arena Plains) and State Wildlife Areas (Yolo Basin, Upper Butte Basin, Mud Slough), and additions to existing areas have been created. As well, thousands of acres of agricultural lands have been converted to wetlands by private interests, primarily duck clubs, and up to 160,000 acres of rice has been flooded postharvest to provide feeding and roosting areas for wintering waterfowl (Central Valley Habitat Joint Venture Technical Committee 1996). About 70 percent of existing wetlands are in private ownership as duck clubs, with virtually all of the rest in public ownership as National Wildlife Refuges and Wildlife Areas (Heitmeyer *et al*. 1989).

Swans[3]

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Note: Population counts of the most abundant waterfowl were obtained from 4 sources: 1) Concept Plan for Waterfowl Wintering Habitat Preservation - Central Valley of California (U.S. Fish and Wildlife

The tundra swan (*Cygnus columbianus*) is abundant in the Central Valley throughout the wintering period, especially in the Delta, where about 90 percent are recorded, and the Sacramento Valley. Recent data from the annual midwinter inventory, show a range of 25,000-80,000 swans present in the Central Valley in January. Trumpeter swans (*Cygnus buccinator*) occur in California in winter, but their numbers are few, probably less than 50 (California Department of Fish and Game, Sacramento, California, unpublished data). Tundra swans arrive in the Central Valley beginning in late November and small numbers remain into early March (Table 2B). Swans are more associated with agricultural lands, especially harvested corn fields in the Delta and rice fields in the Sacramento Valley, than with marshlands. This may be why few swans winter in the San Joaquin Valley, where these kinds of food resources are less abundant. Thus, swans are more associated with private lands than are ducks and geese, and are more dependent upon these lands than National Wildlife Refuges and State Wildlife Areas.

Geese

There are 8 species of geese present in the Central Valley during winter. Lesser snow (*Chen caerulescens*) and Ross' geese arrive in the Central Valley in November, and many flocks are still present in April (Table 2B). Snow geese and Ross' geese are counted during the special white goose survey in December each year, and populations recorded in California have ranged from 320,000 to 700,000 since 1981. White goose counts in December show that most are located in the Sacramento Valley. For example, in December 1997, only about 40,000 white geese were found in the San Joaquin Valley or the Delta, compared with 360,000 counted in the Sacramento Valley. Similarly, the midwinter inventory the previous January (1997) recorded 404,000 white geese in the Sacramento Valley, 8,000 in the Delta, 56,000 in the San Joaquin Valley, and 20,000 in southern California. Snow and Ross' geese are strongly associated with the harvested rice fields in the Sacramento Valley, using these fields to forage for rice and other seeds, sprouting

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Service 1978); 2) special 'white goose' (lesser snow and Ross'), white-fronted goose, and cackling Canada goose surveys (Drut and Trost 1997); 3) unpublished summary data ('Form A') of the annual midwinter waterfowl survey done in January in Pacific Flyway states (available from Sacramento National Wildlife Refuge, Willows, California); and 4) Pacific Flyway Fall and Winter Survey Reports (Trost 1997, 1998). Items 2 and 4 are available from the Pacific Flyway Representative (Office of Migratory Bird Management), U.S. Fish and Wildlife Service, Portland, Oregon.

seeds, and straw left after harvest (Hobaugh 1984, Miller *et al*. 1989). Snow geese prefer burned conventionally harvested rice fields and are deterred from use of strip-harvested (Bennett *et al*. 1993) fields because the standing plants are a physical barrier (J. H. Day, U.S. Geological Survey, Dixon, California, unpublished data; Miller and Wylie 1996). White geese forage in managed wetlands on National Wildlife Refuges and State Wildlife Areas, obtaining grasses and subterranean tubers, but the food obtained from rice fields, and corn fields in the Delta, are critical to survival and may promote an adequate body condition prior to spring migration.

Pacific white-fronted geese arrive in the Central Valley in September (Table 2B). These early flights are associated with birds migrating to Mexico, and the larger numbers arriving in November are birds that have first staged in the Klamath Basin (Ely and Takekawa 1996). Pacific white-fronted geese are inventoried in a special survey in October and November, and counts have increased markedly from about 75,000 in 1979 to almost 350,000 in 1996; about 90 percent of these geese winter in the Central Valley. Pacific white-fronted geese are very abundant in the Central Valley during midwinter, and most of these are found in the Sacramento Valley. For example, in January 1997, of the 217,000 white-fronts in California, 205,000 were located in the Sacramento Valley, 5,200 in the Delta, and 2,400 in the San Joaquin Valley. White-fronted geese forage extensively in harvested rice fields in the Sacramento Valley and corn fields in the Delta, obtaining rice, corn, and other seeds (Ely and Dzubin 1994). White-fronted geese prefer to forage in conventionally harvested, burned and untreated rice fields especially if they are puddled, but these geese avoid unmodified strip-harvested fields (Day 1996). Pacific white-fronted geese also forage on growing grasses and forbs, especially in late winter and into the spring months, and will consume green shoots of bulrushes (*Scirpus* spp.) in early fall. Thus, pacific white-fronted geese depend upon National Wildlife Refuges and State Wildlife Areas and wetlands in duck clubs for roosting and foraging for marsh foods, but select harvested corn and rice on private lands during most of the wintering period. Tule white-fronted geese constitute a small population that winters primarily in the Sacramento Valley on Sacramento and Delevan National Wildlife Refuges, and secondarily in Suisun Marsh (Wege 1984). The population has remained at about 6,000 for a number of years (Drut and Trost 1997). Tule white-fronted geese also use harvested rice fields, as well as wetlands on National Wildlife Refuges, in which to forage for seeds and rhizomes (Ely and Dzubin 1994). Cackling Canada geese arrive in the Sacramento Valley in November and some may linger as long as early May (Table 1). This species had reached very low numbers in the 1980s (26,000 in 1983), but has now increased to over 200,000; however, the proportion of these geese found in California and the Central Valley has steadily decreased. For example, until the 1980s, fewer than 1,000 Cacklers were present in Oregon/Washington on surveys, compared with over 100,000 in California. Since 1995, however, over 90 percent are found in the Willamette Valley of Oregon, joining large flocks of Taverner's (*Branta canadensis taverneri*) and Dusky (*B. c. occidentalis*) Canada geese. A change from small grains to commercial grass farming in Oregon has been advanced to explain this shift in wintering grounds. These goose species favor grazing on grasses and other growing crops during winter in contrast to the seed consumption patterns of snow, Ross', and white-fronted geese. The Willamette Valley is a center for blue grass production, and these geese have adapted well. Thus, it is likely the Cackler will continue to decline in the Central Valley in future winters. Those that remain, however, graze extensively on native pastures maintained by National Wildlife Refuges, especially in the Sacramento Valley, and on refuges and private duck clubs in the Grasslands area of the San Joaquin Valley. On the midwinter inventory in January, about 80 percent of the Cacklers will be found in the San Joaquin Valley after having been more abundant in the Sacramento Valley in early winter. This predictable seasonal shift reflects increased availability of extensive pastures and other grasslands in the San Joaquin Valley. Western Canada geese numbered 7,400 to 14,500 during the midwinter inventories of 1996 and 1997. These geese migrate to the Sacramento Valley from the Sierra Nevada mountains and northeastern plateau (part of the Pacific population) and to the San Joaquin Valley and southern California from the Rocky Mountain states (Rocky Mountain population) (Caithamer and Dubovsky 1997). Lesser Canada geese (*Branta canadensis parvipes*) and Taverner's Canada geese are rare in the Central Valley, numbering no more than 1,000 birds total. Most of these geese winter in Washington and Oregon. The Aleutian Canada goose, being considered for delisting from threatened status, has increased markedly since the 1980s from less than 1,000 to about 24,000 in 1997 (Drut and Trost 1997) in response to various conservation measures. This goose winters in Butte Sink in the Sacramento Valley and in the northern San Joaquin Valley grasslands. Annual surveys are conducted in the San Joaquin Valley near Modesto.

Ducks

The Central Valley has wintered from 3 to 6 million ducks annually since the 1970s, and this accounts for 51 to 63 percent of the Pacific Flyway total. All species of ducks present in the Pacific Flyway are present in California during winter, and most of these are represented in the Central Valley. Beginning in early August for some species, migrant ducks, mostly adult males, begin to arrive in the Valley from northern nesting regions to join the resident mallards and other ducks. Later, females and young arrive, and peak populations are attained in December and January. Wintering ducks use the extensive marshes provided on National Wildlife Refuges, State Wildlife Areas, and private duck clubs, and flooded rice and corn fields to forage and roost.

Wood ducks are primarily nonmigratory (about 75 percent) in the Pacific Flyway (Bellrose and Holm 1994), but Central Valley resident wood duck numbers are bolstered by migrants from Washington, Oregon, and British Columbia, which arrive beginning in early October (Bellrose and Holm 1994) (Table 2B). Banding data show that the Central Valley is the most important wintering area for wood ducks in the Pacific Flyway, although periodic and winter surveys do not adequately account for them because of limited visibility in their wooded habitats. The principal wintering region for wood ducks is Butte Sink and north along Butte Creek in the Sacramento Valley, as well as south through the wooded portions of the Sutter Bypass. This region consists of the extensive flooded forests of willow (*Salix* spp.) and cottonwood (*Populus fremontii*) that wood ducks favor. Wintering wood ducks are also found in the many wooded or partially wooded rivers, streams, and sloughs throughout the Sacramento Valley, Delta, and San Joaquin Valley. The only requirements are flooded trees and nearby food resources, which include rice, acorns, and moist soil wetland seeds, such as watergrass (*Echinochloa crusgalli*) (J. Holloway pers. comm. 1998). Acorns appear to be most important in the Central Valley in September and early October after mast fall. Wood ducks begin their spring migration from the Central Valley in late February, with few remaining after mid-March (Bellrose and Holm 1994).

American wigeons (*Anas americana*) are usually the third most abundant waterfowl in the Central Valley during midwinter, ranging from 250,000 to 500,000 birds. Adult males begin to arrive in the Central Valley in August and peak numbers are attained in December and January (Table 2B). Wigeon are particularly abundant in the Sacramento Valley, with about 85 percent of all wintering wigeon found there. The Butte Sink area, including Gray Lodge Wildlife Area, Upper Butte Basin Wildlife Area, and the Colusa Basin, including Sacramento, Delevan, and Colusa National Wildlife Refuges, account for 80 percent of all wigeon in winter. Wigeon feed heavily in harvested rice fields and in marshes on National Wildlife Refuges, State Wildlife Areas, and duck clubs. In late winter, after significant rains have fallen, wigeon begin to graze on new shoots of grasses and forbs.

Gadwalls are common in the wintering populations, but they are not particularly abundant overall, ranging from 120,000 to 145,000 in recent midwinter inventories. Gadwalls begin to arrive in late September and early October, and populations peak in December and January (Table 2B). Gadwalls seek out wetlands with dense emergent vegetation, especially that of cattail . Food consists almost entirely of wetland plant materials including algae and the vegetative portions of various aquatic plants. Gadwall will frequent harvested rice fields and consume rice and other seeds in midwinter. Gadwall are particularly drawn to alkaline marshes on Sacramento and Delevan National Wildlife Refuges, and like habitats in the San Joaquin Valley.

Green-winged teals (*Anas crecca*) are very abundant winter visitors to the Central Valley, and because of their small size, are probably underestimated on periodic surveys. Teal favor some of the same foods documented for pintails (Eulis and Harris 1987), and like pintails, select shallow, open ponds in which to forage and roost. Teal also will use more heavily vegetated wetlands. Like most Central Valley wintering waterfowl, green-wing teal numbers generally peak in the December-January period (Table 2B), and estimates have ranged from 150,000 to 300,000 on the midwinter inventory. Teal generally consume seeds smaller than those eaten by the larger ducks, but they will also forage in harvested rice fields, especially in the coldest part of winter (December-January).

Mallard winter populations are not often markedly higher than the breeding population because few mallards from northern breeding grounds (e.g., Canada) find there way this far south, stopping instead in Washington and Oregon along the Columbia River. Only during particularly cold and snow laden winters in this region, do large numbers of mallards migrate to the Central Valley. In these instances, winter counts have been as high as 850,000, but more common winter counts record from 350,000 to 500,000. Mallards begin to migrate from northeastern California and southern Oregon into the Central Valley in late October, however, mallards from farther north may not reach California until December (Table 2B). Mallards favor the emergent and forested wetlands of the Butte Sink area above all other wetland areas in the Central Valley, and about 50 percent of the mallards present in the Valley will be found in the Butte Sink on the winter inventories. Mallards roost on Butte Sink National Wildlife Refuge, Gray Lodge Wildlife Area, and Upper Butte Basin Wildlife Area in this region, and feed in the vast acreage of marshes located on private duck clubs that form the bulk of this region, and in flooded rice fields. In the Delta, large mallard populations winter on Mandeville and other islands, feeding at night in flooded wheat and corn fields, and in some marsh areas that have developed recently. Mallards are also common in winter on Stone Lakes National Wildlife Refuge and the Cosumnes River Preserve. In the San Joaquin Valley, mallards are found most abundantly on San Luis National Wildlife Refuge and the other National Wildlife Refuges and State Wildlife Areas in the region. Many private clubs throughout the Central Valley manage specifically for mallards by developing dense emergent marshes dominated by tule bulrush, cattail, smartweeds (*Polygonum* spp.), and watergrass. Wintering mallards forage in marshes and rice fields in the Sacramento Valley, and in corn and wheat fields in the Delta, and marshes in the San Joaquin Valley.

Northern pintails (adult males) begin to arrive in the Central Valley in the first week of August (Miller 1987) (Table 2B). They can be found on any Valley wetlands at that time, but are most predictable on the National Wildlife Refuges and State Wildlife Areas in the Sacramento and San Joaquin Valleys, because few other areas are flooded so early. These birds will be found on the wetland units that have been managed for summer water to produce watergrass, and on early flooded units devoted to swamp timothy (*Heleochloa schenoides*) production (Connelly and Chesemore 1980, Miller 1987, Eulis and Harris 1987). Pintail populations peak in December or January in the Central Valley (U.S. Fish and

Wildlife Service 1978), and midwinter counts in January have ranged from 750,000 to 4,000,000 since the 1970s. During winter, pintails favor open, shallow marshes with little emergent vegetation, and flooded rice, corn, and wheat fields although at night and in early fall, pintails will use heavily vegetated wetlands (Eulis and Harris 1987, Miller 1987). Pintails that winter in the Suisun Marsh, San Joaquin Valley, and the Delta, migrate northward to the Sacramento Valley during late winter, potentially in response to changing weather or patterns of food availability. The most important foods during the midwinter period in the Sacramento Valley are rice seed, watergrass, swamp timothy, and other moist soil foods. In early and late winter, invertebrates, with midge (Chironomidae) larvae predominating (Miller 1987, Eulis and Harris 1987), become important. Foods are obtained in flooded and dry rice fields and the many marshes found on National Wildlife Refuges, State Wildlife Areas, and private duck clubs.

Cinnamon teals are common summer residents in the Central Valley, but during midwinter they are not very abundant because locally nesting and migrant teal funnel through the Central Valley on the way to their primary wintering grounds in Mexico. Recent midwinter counts have ranged from 2,500 to 8,500 birds. Cinnamon teal are more numerous on these midwinter counts in the Sacramento Valley than in the San Joaquin Valley. Also, cinnamon teal are early migrants, and most are gone before hunting seasons begin in late October. In late January, cinnamon teal again become noticeable as flocks begin to return from Mexico (Bellrose 1980). Thus, the midwinter counts in California record only a fraction of the total population. Cinnamon teal favor emergent to moderately open marshes that supply an abundance of the seeds, vegetative matter, and the invertebrates they prefer; cinnamon teal diets in winter consist of a large proportion of invertebrates (Gammonly 1996). Cinnamon teal rarely visit rice or other grain fields, being more linked with marsh habitats, much like gadwalls. The most important areas for cinnamon teal during winter include Sacramento and Delevan National Wildlife Refuges in the Sacramento Valley, and the flooded areas of the south San Joaquin Valley, such as Kern National Wildlife Refuge.

Northern shovelers are abundant in winter. Shovelers begin to arrive in the Central Valley in late September, and are common in October peaking in December and January (Table 2B). Shovelers are common in the Valley through March and well into April. Recent midwinter counts have recorded about 300,000 shovelers in the Central Valley, with about two thirds of those in the San Joaquin Valley, where there is abundant shallow freshwater wetlands on National Wildlife Refuges, State Wildlife Areas, and private duck clubs. Shoveler diets are dominated by invertebrates obtained by surface feeding in marshes, sewer ponds, evaporation ponds, and flooded grain fields (Dubowy 1996).

Canvasbacks (*Aythya vallisneria*) are most common in San Francisco Bay and other coastal embayments during fall and early winter, but can be common in the Central Valley in mid to late winter, especially after winter rains have flooded the bypass system. For example, on 1996 and 1998 midwinter inventories, canvasback numbers ranged from 3,600 to 16,000 in the Sacramento Valley, 6,000 to 7,600 in the San Joaquin Valley, and 4,000 to 22,400 in San Francisco Bay. In early fall, virtually all canvasbacks in California will be found in the northeastern plateau and in San Francisco Bay (Klamath Basin National Wildlife Refuge, Tule Lake, California; San Francisco Bay National Wildlife Refuge, Fremont, California, unpublished data). While inland, canvasbacks roost on deep marshes, flooded bypasses and grain fields. Foraging opportunities are exploited in these same areas. Good food habits data are not available for canvasbacks while they are in the Central Valley, but birds have been seen foraging in flooded rice fields and marshes in the Sacramento Valley, flooded corn fields in the Delta, and in wetlands in the San Joaquin Valley.

Ring-necked ducks, in contrast to other diving ducks, are found in greatest numbers on inland freshwater wetlands and lakes, and often in flooded agricultural lands. Winter counts of ring-necks have been increasing over the last 2 decades, and counts have reached 50,000. Of the 25,000 ring-necks counted in January 1997 in California, 15,000 of them were in the San Joaquin Valley and 7,000 in the Sacramento Valley. The most important regions included the reservoirs and lakes of the east Sacramento Valley (4,000), Delevan National Wildlife Refuge (3,000), San Luis National Wildlife Refuge (7,600), West Grasslands duck clubs (5,600), and Mendota Wildlife Area (1,800). Ring-necked ducks consume a largely vegetarian and seed diet.

Redhead ducks rarely exceed 1,000 birds during midwinter counts in the Central

Valley, and 90 percent of these are found in the San Joaquin Valley. The scaups (*Aythya affinis, A. marila*) are always uncommon in the Central Valley, being highly oriented toward coastal saline environments. About 100,000 ruddy ducks are counted on midwinter inventories, and these are most common in the San Joaquin Valley (greater than 50 percent). Ruddies favor sewer and evaporation ponds and some managed wetlands on National Wildlife Refuges and State Wildlife Areas, but are not common in agricultural habitats. Goldeneyes (*Bucephala islandica, B. clangula*) and buffleheads (*B. albeola*) are not common in the Central Valley in winter, together numbering only about 20,000, with bufflehead making up 90 percent of the total. Buffleheads use wetlands on National Wildlife Refuges, Wildlife Areas, and duck clubs, and both they and goldeneyes are also found on lakes and reservoirs, and water conveyances. Goldeneyes are most common along the major rivers of the Central Valley, and only occasionally do these species venture into flooded agricultural lands.

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Table 2B. Seasonality of use[1] of waterfowl species in the Central Valley of California.

Species/Relative Abundance[2]	May-Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Tundra swan/**c**				x	xxx	xxx	xxx	x	
White-fronted goose/**a**		x	x	xx	xxx	xxx	xxx	xx	x
Tule White-fronted goose/**u**		x	x	xx	xxx	xxx	xxx	x	
Lesser Snow goose/**a**				x	xxx	xxx	xxx	xx	x
Ross' goose/**a**				x	xxx	xxx	xxx	xx	
Cackling Canada goose/**u**				x	xxx	xxx	xxx	xx	x
Aleutian Canada goose/**u**				x	xxx	xxx	xx	x	
Western Canada goose/**u**	x	x	x	xx	xxx	xxx	xx	x	x
Wood duck/**c**	x	x	x	xx	xxx	xxx	xx	x	x
American wigeon/**a**		x	xx	xxx	xxx	xxx	xxx	xx	x
Gadwall/**c**	x	x	xx	xxx	xxx	xxx	xx	x	x
Green-winged teal/**a**		x	xx	xxx	xxx	xxx	xx	x	
Mallard/**a**	xx	xx	xx	xxx	xxx	xxx	xx	xx	xx
Northern pintail/**a**	x	xx	xx	xxx	xxx	xxx	xxx	xx	x
Cinnamon teal/**u**	xx	xx	xx	x	x	x	xx	xx	xx
Northern shoveler/**a**	x	x	xx	xxx	xxx	xxx	xxx	xx	x
Canvasback/**c**			x	xx	xxx	xxx	xx	xx	
Redhead/**u**	x	x	x	xx	xxx	xxx	xx	x	x
Ring-necked duck/**c**			x	xx	xxx	xxx	xx	x	
Lesser and Greater scaup/**u**				x	xxx	xxx	x		
Bufflehead/**u**				x	xxx	xxx	xx	x	
Barrow's goldeneye/**u**				x	xxx	xxx	xx	x	
Common goldeneye/**u**				x	xxx	xxx	xx	x	
Hooded merganser/**u**				x	xxx	xxx	xx	x	
Common merganser/**u**				x	xxx	xxx	xx	x	
Ruddy duck/**c**	x	x	x	xx	xxx	xxx	xx	x	x

1) Seasonality of use (within species only): x = present or may be present, xx = common, xxx = abundant/peak population; 2) Relative abundance: u = uncommon, c = common, a = abundant

Appendix C. Guidelines for Procedures and Timing of Activities Related to the Modification or Relocation of Giant Garter Snake Canal or Stream Habitat.[1]

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 (GIANT GARTER SNAKE) habitat. The timing is based on present knowledge of the GIANT GARTER SNAKE seasonal activity cycle which may vary somewhat from year to year depending upon the weather.

GIANT GARTER SNAKE Activity Cycle

* GIANT GARTER SNAKE begin emerging from winter retreats around April 1.

* By April 15, most GIANT GARTER SNAKE are active and beginning to search for food.

* By May 1, all GIANT GARTER SNAKE have usually emerged and are actively foraging.

* Around October 1, GIANT GARTER SNAKE begin seeking winter retreats. Foraging and other activities are sporadic at this time and dependent upon weather conditions.

* By November 1, most GIANT GARTER SNAKE are in winter retreats and will remain there until spring.

Habitat Relocation Procedures and Timing

* No grading, excavating, or filling may take place in or within 30 feet of GIANT GARTER SNAKE habitat between October 1 and May 1 unless authorized by the Department of Fish and Game.

* Construction of replacement habitat may take place at any time of the year, but summer is preferred.

* Water may be diverted as soon as the new habitat is completed, but placement of dirt dams or other diversion structures in the existing habitat will require on-site approval by the DFG.

---

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

* The new habitat will be revegetated with suitable plant species as directed by DFG or as stipulated in the environmental documents.

* Dewatering of the existing habitat may begin any time after November 1, but must begin by April 1.

* Any GIANT GARTER SNAKE surveys required by the DFG will be completed to the satisfaction of the DFG prior to dewatering.

* 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.

* 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.

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

Appendix D. Protocols for Pre-project Surveys to Determine Presence or Absence of the Giant Garter Snake and to Evaluate Habitats (California Department of Fish and Game Inland Fisheries Division).

1. Qualifications of surveyors:

   A. Surveyors must demonstrate previous field experience with GIANT GARTER SNAKE or ecologically similar species. The Department shall evaluate and approve all surveyors. Persons lacking appropriate related field experience shall not be authorized to conduct pre-project surveys for GIANT GARTER SNAKE.

2. All surveyors must possess a valid Scientific Collecting Permit and appropriate Endangered Species permits.

3. Survey Protocols:

   A. Time of year: April 15 - June 1.

   B. Minimum effort: Ten surveys shall be conducted per mile of canal, slough or marsh edge *or* until GIANT GARTER SNAKE are positively identified (captured and photographed).

   C. Methodology: Surveys shall be conducted on foot between 0900 and 1400 hours. Surveyors shall carry binoculars to aid in detecting GIANT GARTER SNAKE. Surveys shall be conducted on different days with alternating starting points. GIANT GARTER SNAKE survey logs will be completed for each survey. Surveys shall not be conducted during rain or winds of 20 mph or greater.

   D. Surveys may be conducted during other times of year, but absence of GIANT GARTER SNAKE will not be accepted if-habitat evaluation indicates suitability.

   E. Trapping may be used to augment foot surveys upon prior written approval of the Department. Approval shall be based upon demonstrated previous trapping experience with GIANT GARTER SNAKE or ecologically similar species or proof of training by another person authorized by the Department to trap GIANT GARTER SNAKE. Trap design and methodology must be approved by the Department.

capture of GIANT GARTER SNAKE is considered trapping.

4.

A. Submit completed GIANT GARTER SNAKE Field Survey Report Form, Habitat Evaluation form, and GIANT GARTER SNAKE Survey

Prepared by: John M. Brode, Department of Fish and Game, Inland Fisheries Division, March, 1993.

Appendix D. con't. Giant Garter Snake (GIANT GARTER SNAKE) Habitat Evaluation Form 1/

Site Name:____

Surveyor's Name and Affiliation:____

____

____

Factor	Present (+) or Absent (-)
1. Still or slow--flowing water over a mud or silt-substrate.	( )
2. Flowing water over sand, gravel, rock, or cement substrate.	( )
3. Water available:	
a) April through October only (irrigation).	( )
b) All year.	( )
c) During winter only (runoff).	( )
4. Banks are sunny.	( )(%)
5. Banks are shaded by overstory vegetation (large trees, willow thickets)	( )(%)
6. Aquatic or emergent vegetation present.	( )
7. Terrestrial vegetation present:	
a) On banks.	( )
b) In adjacent uplands.	
8. Subterranean retreats (broken concrete or animal burrows) present:	
a) in banks.	( )
b) In adjacent uplands.	( )
9. Small fish present.	( )
10. Introduced gamefish are present.	( )
11. Amphibians present.	( )
12. Site is subject to severe seasonal flooding.	( )
13. Site receives polluted runoff.	( )

Notes and Comments (attached additional pages if necessary):

____

____

____

1/ Complete this form for each site surveyed. If site has been recently disturbed (channel maintenance, bank repair), survey the nearest undisturbed similar site, preferably on the same water course.

Appendix D. con't. Giant Garter Snake (GIANT GARTER SNAKE)
Field Survey Report Form I/

Surveyor's Names and Affiliations:____

____
__

Site Name: ____
__Location: County ________________ Directions______________________________
___
____
__ ____
______
Quad Name:_______________7 ½_____ 15 min___ T___ R ___ 1/4 sec________
-
Estimated Size: Acres of Marsh _____________

Miles of Canal/Slough _____________________

Land Uses (include 1/8 mile radius): _______________________________________
____
____

Habitat Description (general) 2/: ____
-
____
__
____
__ ____
______
Dominant Plant Species Present: ____
____
____

Prey Species Present: ____
____
_____
Intro. Gamefish Present (basses, catfishes, sunfishes):_________________________

____
__
Dates of Surveys (attached survey logs): 1__________ 2___________
3___________4 ___________ 5 __________ 6 __________ 7 __________ 8 _________

_
9________ __________

____

____
__
____
__
____
__

1/ Fill out this form for each site surveyed.

Appendix D. con't. Giant Garter Snake (GIANT GARTER SNAKE) Survey Log

____
__
and Affiliation: ______________________________________
____
____
___________ ______________ Start Time: ________
_
End Time: ____________ Air Temp. at Start: ______ Finish: _________

________ Wind:____________ MPH from: _________
-
No. GIANT GARTER SNAKE Captured: ________

No. other Garter Snakes Captured: ______________

____ No. _____

Other Observations 2/: ____
-
____
__
____
__
____
__
____
__

Survey No.:__________ Date: _______________ Start Time: _______________

% Cloud Cover: _______ Wind: _______________ MPH from: _______________
-

No. GIANT GARTER SNAKE Captured: _____

No. Other Garter Snakes Captured: ___________

Photographs 1/: Yes _____ ______

Other observations 2/: ____
_
____
__

1/ All garter snakes captured shall be color photographed as follows: 1) close-up of the head and anterior 1/3 of the body, 2) close-up of the left side of the head,

2/ Include number of snakes observed but not captured.

Production Trends
The following Tables 1E, 2E and 3E detail rice production trends, measuring

the lowest level of production occurred in 1991, which was the worst of a 7-year drought occurring in California. By and large acres planted has moved upward

Table 1E. California Rice Production, 1986-1996.

Year	Hundred Weight's	Metric Tons
1986	27,727,000	1,157,669
1987	27,935,000	1,267,104
1988	29,840,000	1,353,513
1989	32,390,000	1,469,178
1990	30,429,000	1,380,229
1991	30,260,000	1,372,563
1992	33,490,000	1,519,073
1993	36,371,000	1,664,216
1994	41,224,000	1,869,879
1995	35,352,000	1,603,531
1996*	38,332,000	1,738,701

* Forecast
Source: Rice Situation & Outlook Yearbook, November 1996, Economic Research Service, USDA.

Table 2E. California Rice Acres Harvested, 1986-1996.

Year	Acres	Hectares
1986	360,000	145,800
1987	370,000	149,850
1988	425,000	172,125
1989	410,000	166,050

Year	Acres	Hectares
1990	395,000	159,975
1991	350,000	141,750
1992	394,000	159,975
1993	437,000	176,985
1994	485,000	196,425
1995	465,000	188,325
1996*	500,000	202,500

Sources: California Field Crop Review, Vol. 18. No. 2, California Agricultural Statistics Service. California Field Crops Statistics 1983-92, California Agricultural Statistics Service. Rice Situation & Outlook Report, October 1994, Economic Research Service, USDA.

Table 3E. California Average Paddy Rice Yields, 1977-1996.

Year	Pounds per Acre	Kilograms per Hectare
1977	5,810	6513
1978	5,220	5,852
1979	6,520	7,309
1980	6,440	7,219
1981	6,900	7,735
1982	6,700	7,511
1983	7,040	7,892
1984	7,120	7,982
1985	7,300	8,183
1986	7,700	8,632
1987	7,550	8,464
1988	7,020	7,869
1989	7,900	8,856
1990	7,700	8,632
1991	8,500	9,529
1992	8,500	9,529

Year	Pounds per Acre	Kilograms per Hectare
1993	8,300	9,304
1994	8,500	9,529
1995	7,600	8,520
1996*	7,400	8,295

*Projected
Source: Rice Situation & Outlook Yearbook, November 1996, Economic Research Service, USDA

Economic Outlook
In 1996, the University of California produced an analysis of the economic prospects of the California rice industry. It concluded that despite changes in federal farm policy and other world market factors, rice planting is not likely to diminish in California.

Factors leading to the optimistic appraisal about the future of the California rice industry:

Strong demand for imports of high-quality japonica rice in Northeast Asia is emerging as a result of the recent Uruguay Round GATT agreement.

Lower rice supply from the South is likely as a result of reduced farm program payments and increased flexibility to plant other crops.

Use of rice continues to expand in the US and domestic competition from long grain rice will moderate because of lower rice supply from the South. The result is continued strong domestic demand for California rice at prices above those experienced in recent years. The increases in demand imply that there will be little incentive to reduce rice acreage in California despite reduce farm program benefits.

Under this set of domestic and international supply and demand factors, the average market priced for California rice may be expected to be in the range of $9.00 - $10.00 per hundredweight in normal years.

The composition of rice farm income will shift away from government payments and towards market returns. Market prices in the range of $9.00 per hundredweight are more than enough to offset the reductions in farm program payments likely under current reform options.

Under the composition of the new farm program and new international market developments, California rice farm revenues are likely to be a least as large as they have been in the last decade (Sumner 1996).

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Appendix F. Repatriation as a Recovery Tool for the Giant Garter Snake.

Repatriation is a tactic that is recommended in the majority of animal recovery plans, usually under the term "reintroduction." [reintroduction is defined here as releases into an area where previous introductions (or reintroductions) have failed] Unequivocal endangered species success stories due largely to repatriations, such as the widespread return of the peregrine falcon (*Falco peregrinus*) and the reestablishment of the Gila trout (*Onchorhynchus gilae*), are rare; the effectiveness of most repatriations, such as the California condor (*Gymnogyps californianus*), red wolf (*Canis rufus*), and black-footed ferret (*Mustela nigripes*), has not been proven.

Griffith *et al.* (1989) analyzed intentional releases of birds and mammals in North America, Hawaii, New Zealand, and Australia between the years 1973 and 1986. They determined that habitat quality was the best predictor of the success of the translocation (relocation - all situations where organisms are moved from one place to another) of endangered, threatened, or sensitive species, followed by position of release (core or periphery or outside of the historic range), and fecundity of the species.

The number released was also important; the more animals released, the better the chance of success, up to an asymptote that was different for each kind of animal. For "sensitive" bird species, releases more than about 80 to 120 at one site did not increase the probability of success. If more than the asymptotic number of propagules are available, they should be released in two or more sites of equal habitat quality, thus increasing the probability that at least one translocation will succeed. Veltman *et al*. (1996) analyzed the factors associated with the success or failure of bird introductions (releases into an area where the species has never occurred) to New Zealand before 1907. The factor most important in determining success was the release of a relatively large number of propagules at many sites.

With respect to reptiles, the usefulness of repatriation as a recovery measure is controversial (Dodd and Seigel 1991, Burke 1991, Reinert 1991), and remains to be demonstrated in the majority of cases where it is being used. An important point emphasized by Burke (1991) is that it is dangerous to extrapolate generalities about translocation characteristics among taxa; each species reacts differently to the process.

Snakes seem to be unusually resistant to translocation; certain snake introductions have been spectacularly successful [e.g., the brown tree snake (*Boiga irregularis*) on Guam (Fritts 1988) and a blind snake (*Rhamphotyphlops bramina*) throughout the coastal tropics (McDowell 1974)], but other examples are few (Burke 1991). Wilson and Porras (1983) recorded 49 species of amphibians and reptiles that have been successfully introduced into four areas of the United States: south Florida, south Texas, California, and Hawaii. There are only two snakes on the list: a watersnake (*Nerodia fasciata*), which may have originated during the first half of the century from releases by a Brownsville snake dealer (Conant 1977), and the aforementioned *Rhamphotyphlops bramina*, now well established in Florida and Hawaii, probably via the tropical plant trade (Wilson and Porras 1983). Most recently, and most pertinently, the diamondback watersnake (*Nerodia rhombifera*) has established reproducing colonies in the Central Valley of California.

The ecology of *Thamnophis gigas* is most similar to many members of the eastern watersnake genus *Nerodia*, and experience with their translocation is probably most relevant to the present case. The origins of the Texas and Central Valley *Nerodia* introductions are not documented and offer no guidance to a repatriation program for the giant garter snake. One case does have relevant data; that of the repatriation of the northern watersnake, *Nerodia sipedon*, in a national park in New York (Cook 1989).

Conclusions from the scant translocation information available are:

> 1) Most repatriations will fail. Repatriation of an aquatic snake makes the probability of success a little greater.
>
> 2) A "reasonable" number of snakes should be released at each site over a number of years. For bird species, this number is between 80 and 120 (Griffith *et al*. 1989); for the giant garter snake, 100 to 200 may be more appropriate. The greater number of sites, the greater the probability of success at some of them (Griffith *et al*. 1989).
>
> 3) Repatriation using adult snakes is probably inefficient (Reinert 1991).
>
> 4) Habitat quality is probably the most important variable determining the success or failure of a translocation (Griffith *et al*. 1989).

Literature Cited

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Wilson, L.D. and L. Porras. 1983. The ecological impact of man on the South Florida herpetofauna. University of Kansas, Special Publication No. 9.

Appendix G. Public Funding Information.

Funding Source	Funds Available/ Deadline	Program Contact	Comments/ Restrictions
Farm Bill Programs (NRCS): **Environmental Quality Incentive Program**	$200 million/year nationally $6.0 million available for FY 1998 for California	Contact local/County NRCS Office or call State Office (916) 757-8382	
Farmland Protection Program	$35 million over 5 years nationally	Contact local/County NRCS	Subject to existing offer for protection by state or local agency
Wildlife Habitat Incentives Program	$35 million over 5 years nationally ($18 million available this fiscal year)	Contact local/County NRCS Office	
Wetlands Reserve Program	$50 million/year nationally over through 2002. $2,000/acre cap, approx. 75% provided by program	Contact local/county NRCS office	Purchase of 30 year. or permanent easements or cost-share for restoration

Funding Source	Funds Available/ Deadline	Program Contact	Comments/ Restrictions
Central Valley Improvement Act (USFWS, USBR): **(b1)(Other)**	Up to $2.0 Million	Marie Sullivan (916) 979-2760	Purchase of land and easements; programmatic support for brochures and pamphlets
USBR Conservation Program for Endangered Species	Sharing funds with (b1)(Other) for 1998. Funding appropriation for program 1999	Chuck Solomon (916) 978-5052	Purchase of acquisitions/easements and funding for restoration
National Fish & Wildlife Foundation: **Federal restoration/acquisition partnerships**	About $50,000 per award	Contact Greg Elliott 916/448-0666 or Eric Hammerling 916/448-0667	Two cycles per year for funding proposals December and July
Initiatives focused on wetlands, fisheries, wildlife, species of concern, neotropical birds	Up to $250,000 per award		

Funding Source	Funds Available/ Deadline	Program Contact	Comments/ Restrictions
U.S. Fish & Wildlife Service:			
Migratory Bird Fund	$20 million annually nationwide; $1 million per project; funds derived from duck stamps; regions of country compete	Howard Stark - Sacramento 916/979-2085	
Land and Water Conservation Fund	Budgeted to both FWS and BLM annually		
North American Wetlands Conservation Act (NAWCA)	<$1 million 8/2/96, early 4/97	Dave Paullin, 916/979-2085	Peripheral benefits for giant garter snake
Wildlife Conservation Board:			
Inland Wetlands Conservation Program	$2 million/year, applications accepted on continual basis	Marilyn Cundiff-Gee, 916/445-1093	Purchase of wetlands easements
California Riparian Habitat Conservation Program	up to $150,000 per award, applications accepted continually	Scott Clemons, 916/445-1072	Acquisition and restoration of riparian areas
California Department of Parks and Recreation:			
Habitat Conservation Fund	approx. $400,000 per award, 10/98	Keith Steinhart 916/653-7423	

Funding Source	Funds Available/ Deadline	Program Contact	Comments/ Restrictions
Resources Agency: **Environmental Enhancement and Mitigation Program (EEMP)**	approx. $250,000 per award, 12/8/97	Bill Borden, 916/653-5656	Project must be tied to a current or planned transportation project and provide enhancement over and above mitigation requirements
CALFED: **Category III -** (Flood plain restoration, meander belts, riparian areas, any project associated with anadromous fish restoration)	Budget approximately $85-100 million for FY 98	Cindy Darling (916) 657-2666	Next cycle Spring 1998
Environmental Protection Agency: **Sustainable Development Challenge** Grants)	$500,000 1997, asking for $10 million for next year, $100,000 per project, 8/15/97 deadline--probably same time next year	Debby Schecter (415) 744-1624	Money cannot be used for easements
Wetlands Geographic Initiative	about $50,000 per award	Suzanne Marr 415/744-1974	For Central Valley vernal pool work and North Bay wetlands work

Appendix H. Maps of Basins Defined in the Central Valley Habitat Joint Venture Implementation Plan (Central Valley Habitat Joint Venture Implementation Board 1990).

Figure 1H. Butte Basin Map

Figure 2H. Colusa Basin Map

Figure 3H. American Basin Map

Figure 4H. Sutter Basin Map

Figure 5H. Yolo Basin Map

Figure 6H. Sacramento-San Joaquin Delta Map

Figure 7H. San Joaquin Basin Map

Figure 8H. Northern Tulare Basin Map

Appendix I. Surveying Guidelines for the Giant Garter Snake Prior to Repatriation Efforts.

At a given location, proper surveying for presence or absence of giant garter snakes will consist of:

1. Using at least 50 floating traps along the edges of ditches, canals, wetlands, and other habitat;

2. Checking these traps daily for 2 consecutive weeks some time from mid-March through June; and

3. Conducting visual ground searches and hand captures in the area along the edges of canals, ditches, wetlands, riprap, and other habitat, by at least two people each day during the same 2-week period.

Appendix J. Repatriation Guidelines for the Giant Garter Snake.

General Guidelines

Repatriation as a conservation measure for snake populations is unproven. However, it could be an important tool for repopulating large areas, especially in the lower San Joaquin Valley, that have lost their giant garter snake populations. Repatriation can also be used for the rapid population of newly created habitats that cannot be easily reached from existing populations. Programs of repatriation should not be entered upon lightly; they are expensive, and a long-term commitment of time and funds is imperative.

Attempts to repatriate the giant garter snake should be made only if the following list of criteria applies. Detailed explanations and amplifications of these criteria follow the list:

1.) The giant garter snake formerly occupied the general area.

2.) The habitat appears to be suitable, it is under long-term protection, and the diamondback watersnake is not present.

3.) The reasons for the species' absence have been determined and eliminated;

4.) No reproducing populations of giant garter snake remain in the area, and it is not likely to be reinvaded from surrounding populations in the near future;

5.) The effort can commit to:

   a. Releases of many animals (50+ per year?) at each site through at least five consecutive years, preferably at several sites within the area,
   b. Head starting young individuals (do not release neonates or adults),
   c. Releasing only young individuals that are free of disease or parasites,
   d. Monitoring for at least 10 years after the last release.

<u>Explanations and amplifications:</u>

1) The historic range of the giant garter snake encompassed the floor of the Central Valley of California (see Historic Distribution). Repatriations can be considered for all sites, including newly created habitats, in the Central Valley that are currently unoccupied by the giant garter snake, as long as

the other criteria are fulfilled. We do not recommend augmentation of any giant garter snake populations.

2) Habitat quality is defined in the section on Habitat and Community Associations. A favorable community of prey, competitor, and predator species are key elements of habitat quality. Sites with populations of the introduced diamondback watersnake should be avoided until it is shown that they do not seriously affect giant garter snake populations. Sites must be protected from threats and incompatible uses into the foreseeable future. Biologists must be assured of access to the entire habitat block for monitoring purposes. Top priorities for repatriation should be those sites that appear to be high quality habitat and that are most remote from existing populations.

3) The team must be convinced that the reasons for the original disappearance or absence of the giant garter snake have been correctly identified and corrected.

4) Usually repatriation will not be considered if there are populations present in the same recovery unit, unless the sites are isolated by habitats that are not easily crossed by the giant garter snake. Exceptions may also be made for newly created habitats that do not have an extant population nearby. To verify the absence of giant garter snakes in the proposed repatriation site, the surveying guidelines in Appendix I should be used.

5) A range-wide "phylogeographic" study of genetic variability is needed to establish the source of genetic variability prior to any repatriation attempts. If this study reveals that the majority of overall genetic diversity is attributable to intergroup differences, this is an indication that such groups have been more or less genetically isolated for some time, and in some sense, represent very early stages of speciation and may have evolved local adaptations. Such evolutionary processes should be conserved. Repatriation propagules, therefore, should come from the nearest extant population to the repatriation site.

6) Repatriation can be expensive, and unless the parties involved are dedicated to spending the necessary funds over a suitable time period, it is better not to embark on a program. This commitment must include the monitoring phase.

   a. Releases of 50 to 100 juveniles should be made at each site for each of 5 years. If these goals cannot be achieved, the project should not be considered. In an emergency (extreme drought, flooding), a year might be skipped, in that case the intended releases should be made in the sixth year instead. If more than 100 juveniles are available, other sites should be considered for repatriation. Each site should receive at least 50 but not more than 100 propagules each year.

b. The cheapest and most efficient way to secure propagules for repatriation is to capture gravid females in the summer and hold them in heated cages until they give birth (N. Scott pers. comm. 1998). The young can be kept warm and fed the first winter, and could be released the following summer. Rotate the take of neonates among several subpopulations if at all possible. Repatriate only healthy juveniles; however, do not select against individuals that may have an unusual genetic makeup, but are otherwise functioning and healthy.

c. The health of potential propagules should be determined prior to repatriation attempts. Natomas Basin giant garter snakes should not be introduced to areas outside the basin because they harbor a high parasite load not known to occur in other populations (G. Hansen pers. comm. 1998).

d. Monitoring repatriated populations is critical. If the fate of the population is not known, the effort is wasted. Much can be learned by monitoring even a failed repatriation effort. Detailed monitoring is especially important during the first repatriation efforts; the lessons learned will be used to guide all future efforts.

Implementation
Repatriation as a Recovery Strategy should be considered in the areas identified in the Stepdown Narrative section. The steps to be taken are:

1. Survey within the historic range and determine suitability of repatriation sites based on the above criteria. Select suitable release sites.

2. Locate source populations. Determine that enough adult females are present in each to provide the necessary neonates. As a rule of thumb, litters from no more than one-quarter of the adult females should be taken for repatriation. Three to five gravid females need to be captured for each anticipated release site.

3. Capture and hold gravid females in individual cages until they give birth. The cages should be fitted with heat strips that allow the snake to maintain a maximum body temperature of at least 32 degrees Centigrade (90 degrees Fahrenheit). The females should always have access to water, and should be given food if they will take it. Live minnows are convenient because they can be removed and reused if the snake is not feeding. Snakes should be weighed weekly and food intake recorded to make sure that they are maintaining their condition.

4. At birth, a total litter weight should be taken, including all dead embryos or undeveloped eggs. Individual neonates should be weighed, sexed, and measured. Once neonates have doubled their birth weight, passively induced transponder (PIT) tags should be implanted.

5. Neonates should be kept in groups of six or less, with access to heat tape, water, and a regular supply of live minnows. The groups should be closely observed. Individuals that appear to be sick or that are not growing as they should be are to be removed to an individual cage for closer observation. Starting in March of the release year, the juveniles should be exposed to an approximately normal photoperiod.

6. Juveniles should be released during the summer following birth. The timing of the releases are dependent on the stability of the habitat where they will be released. They should be liberated at a time when the water supply is assured for at least several months, when temperatures are sufficiently high for at least 2 months (mid-March through mid-August), and where juvenile habitat is available (shallow water with minnows and vegetative cover).

7. Monitoring should consist of annual trapping sessions wherein all giant garter snakes captured are sexed, weighed, measured, and examined for PIT tags. Tags should be inserted in those that lack them. Insertion of PIT tags in neonates should only be carried out by individuals with experience successfully PIT tagging neonates. The data should be immediately analyzed to examine the survival of the snakes originally liberated and the success of subsequent reproduction. At the same time, the entire habitat block should be examined or trapped to document the rate of spread from the original release sites.

Personal Communications

Hansen, George. 1998. Herpetologist, Sacramento, California

Scott, Norm. 1998. U.S. Geological Survey, Biological Resources Division, San Simeon, California

Appendix K. Northern California Water Association Draft Operation and Maintenance Guidelines for Sacramento Valley Water Users Having Verified Giant Garter Snake Populations.

(For questions relating to this document, please contact
Dan Keppen, Northern California Water Association)

Irrigated rice and the vast network of irrigation ditches and canals in the Sacramento Valley provides some of the last remaining habitat for the Giant Garter Snake (GIANT GARTER SNAKE). Generally, the timing of irrigation, agricultural practices and maintenance activities associated with irrigation in the Sacramento Valley coincides with the biological needs of the GIANT GARTER SNAKE. While these canals and ditches do provide important habitat, maintenance activities are necessary to ensure the delivery of irrigation supplies, prevent flooding, and drain fields. In some cases, maintenance activities may adversely impact the habitat of GIANT GARTER SNAKE. These reasonable and prudent alternatives are consistent with conserving the Giant Garter Snake by preventing the unreasonable destruction or adverse modification of essential GIANT GARTER SNAKE habitat. Activities described herein ensure that "take" incidental to otherwise legal activities will not occur.

1. <u>CANAL AND DITCH MAINTENANCE</u>

A. In those service areas where verified GIANT GARTER SNAKE populations are known to exist, each year from October 30 to March 1, limit, if practical, the scope of all ditch or canal maintenance operations, excluding vegetation control, road maintenance and rodent control, to not more than 10 percent of the total miles of canals and ditches within that entity's service area. Ditch and canal maintenance includes activities designed to physically improve the canal or ditch channel caused by erosion or other factors.

The above 10 percent limitation only applies from October 30 to March 1.

B. Whenever practical, all ditch or canal maintenance operations shall be restricted to one side of the ditch or canal from October 30 to March 1.

C. Before a water user fills an existing canal or ditch with soil, the water user's representative shall de-water the ditch or canal to the extent possible. The water user's representative shall view the ditch or canal and determine, to the extent possible, whether the GIANT GARTER SNAKE appears to be present. If based on this review the GIANT GARTER SNAKE is found to be present**,** the water user shall not fill that portion of the canal or ditch occupied by the GIANT GARTER SNAKE until the GIANT GARTER SNAKE is no longer present, or it has been removed or relocated by a individual approved by Department of Fish and Game and the U.S. Fish and Wildlife Service.

Water users are encouraged to contact the area Fish and Game warden prior to filling an existing canal or ditch. Nothing in this paragraph obviates the need to acquire appropriate permits for State and Federal agencies to accomplish this activity.

2. VEGETATION CONTROL

Water users utilize many different types of vegetation control on canals and drains. The following is a list of several different types of methods and guidelines for their use. However, the absence of a particular method of removal from these guidelines does not preclude the water user from using that method to control vegetation. If other methods of vegetation removal are found to cause substantial adverse impacts to the GIANT GARTER SNAKE, the California Department of Fish and Game shall work with water users to reduce the impact of those activities.

A. Mowing. If mowing is used to control terrestrial vegetation cover, vegetation after mowing shall be at least 6 inches in height on top of and inside canal and ditch banks to the water line.

B. Aquatic Herbicides. If aquatic herbicides are used to control aquatic vegetation, the water user shall comply with label requirements and applicable laws and regulations. The use of Magnacide H (Acrolene) shall be limited to canals or ditches where such use has been approved by the California Department of Fish and Game.

C. Burning. The use of burning is an appropriate method of controlling vegetation on ditches and canals. These guidelines do not exempt water users from following any other state or county laws, regulations or ordinances regarding burning activities.

D. Herbicides. If herbicides are used to control vegetation, the water user shall follow instructions printed on the herbicide label and applicable laws and regulations.

3. EDUCATION PROGRAM

The California Department of Fish and Game, in cooperation with the U.S. Fish and Wildlife Service, Department of Pesticide Regulation, the Bureau of Reclamation, the State Water Resources Control Board and the Regional Water Quality Control Board, interested water users, and other interested parties, shall develop and implement a GIANT GARTER SNAKE education and awareness program. The program should educate water users on how to best avoid negative impacts to the GIANT GARTER SNAKE and its habitat, including, but not limited to, canal and ditch maintenance guidelines, vegetation control, traffic, ditch/canal fill-in, emergency operations, and chemical applications for rodent control. Water users shall designate a representative to work with State and Federal agencies to carry out the intent of these Guidelines.

4. TRAFFIC

Water users shall be encouraged to minimize unauthorized traffic on roads on ditch and canal banks.

5. PUBLIC SAFETY AND HEALTH

Notwithstanding the guidelines set forth above, it may be necessary and/or legally required of the water user to maintain water conveyance systems, including canals, ditches, and levees, to provide for public health and safety and/or property protection. In maintaining these irrigation facilities under these circumstances, the district or company will give consideration, where practical, to feasible alternatives which may limit impact to the GIANT GARTER SNAKE.

6. RODENT CONTROL

A. When using approved fumigants for the control of rodents on canal and ditches, the water user shall follow instructions found on the label and any applicable State or Federal laws and regulations.

B. In areas where there are verified GIANT GARTER SNAKE populations, the use of fumigants to control rodents should be used only from March 1 to October 30, if consistent with label restrictions.

C. These guidelines do not prohibit other methods of rodent control.

7. APPLICABILITY

These guidelines do not apply to flood control levees.

Appendix L. Vector Control Activities in Potential Giant Garter Snake Habitat.

It has been suggested the giant garter snake, which historically inhabited emergent marshlands throughout most of the Central Valley, has been relegated in recent years to irrigation supply canals, flooded rice fields, and irrigation drainage canals. All of these sites can be tremendous sources of mosquitoes. The intent of this paper is to identify the control measures used in each of these sites using integration pest management techniques, and identify the potential impacts upon the species, as well as the potential impacts on public health, from these various control measures.

Mosquito and Vector Control is generally achieved through a combination of the following components of integrated pest management (IPM): physical control, biological control, and chemical control. Before any of these methods are utilized a surveillance program, which may consist of trap counts, dipping records, landing rates, resident complaints, or any combination of the four, is used to initiate a control response. This surveillance program may actually have the greatest impact on the giant garter snake, due to the snake's habit of sunning itself on roads or the tops of banks that need to be used by personnel in vehicles conducting surveillance. This appears to be an unavoidable impact, since all control measures must utilize a means of surveillance. One solution would be to simply treat fields on a schedule without monitoring actual populations. This is contrary to effective IPM programs and is therefore unacceptable. Another potential solution would be to restrict the speed of vehicles in known giant garter snake habitat. This may be effective, but will require more manpower to adequately survey areas where giant garter snakes reside, resulting in increased cost to the local government and the people in that area.

It needs to be mentioned that not all mosquito control districts are created equally. Due to different funding mechanisms provided for mosquito control in areas of the state, programs may be adequately funded to implement all of the above control measures on a relatively equal basis, or may be forced to rely more heavily on one aspect of control to achieve the desired results.

The control measures typically used by mosquito control districts will be outlined below.

Physical Control

Physical control means physically changing the environment in which mosquito larvae occur to prevent, limit, reduce, or eliminate mosquito production. Physical control is often the most effective mosquito control method in an integrated control program. Draining a pond completely of water, regrading a pasture to eliminate pools of water standing after an irrigation event, or simply modifying irrigation techniques can prevent water from pooling long enough to allow for complete mosquito development. Vegetation management in aquatic sources may be sufficient to prevent mosquito production by allowing the water to flow more freely, thus preventing stagnation, or making the larvae more available to natural predators in the water.

Giant garter snakes utilize habitats such as irrigation supply canals, rice fields, and irrigation drainage canals. While the best way to eliminate mosquito breeding from sites such as these would be to eliminate standing water, in most cases it is impractical or would have a significant impact on the giant garter snake. Guidelines should be established that would allow for vegetation management along canals that are producing significant numbers of mosquito larvae and preventing biological control methods or pesticides from being effective. While highly "clean" vegetation control methods would be preferred, it may be possible to perform vegetation management in strips or sections at a time to minimize mosquito production. These activities could be performed during the months the giant garter snake is not active. There should be a provision, however, that in the event of intolerable mosquito production and/or imminent threat of disease outbreak, measures would be taken to protect the public health of the community around the habitat.

<u>Biological Control</u>

Biological control generally consists of maintaining or adding predators to a site to control mosquitoes. Biological control organisms can catch a tremendous number of mosquitoes, but the reproductive potential of mosquitoes is so great that other measures must be added if mosquitoes are to be effectively controlled. Natural enemies are generally effective only when the environment is favorable to them and unfavorable to the mosquitoes. An example of this would be a canal free of vegetation and well stocked with mosquito fish. As vegetation is increased, the ability of the mosquito fish to effectively search and feed on mosquito larvae diminishes. There does not appear to be any conflict with this portion of an integrated control program and the giant garter snake, since predatory fish are responsible for the majority of the biological control measures used by mosquito and vector control districts and the giant garter snake feeds on small fish. It should be recognized, however, that this control measure alone will not work effectively as vegetation is increased in the aquatic habitat, and will need to be supplemented with either a physical control program or chemical control program.

<u>Chemical Control</u>

Chemical Control of mosquitoes has significantly improved the health and comfort to humans. In many situations the application of chemicals provides immediate relief from mosquitoes and may be the only practicable method for averting or terminating an epidemic of mosquito transmitted disease. The principal concerns on the use of pesticides for mosquito and vector control relative to the giant garter snake are the potential effect on the snake itself.

This concern does not appear to be valid due to the fact that mosquito and vector control has been performed in giant garter snake habitat for years without any noticeable effects. The principal threats to the giant garter snake are conversion of rice habitat and changes in agricultural management of irrigated cropland. Pesticides used for mosquito and vector control are applied at such low dosage rates that there is minimal, if any, effect on the giant garter snake. Pesticides such as malathion or pyrethrins are applied at rates well below those used by the agricultural industry. The use of pesticides such as *Bacillus thuringiensis* and methoprene further minimize any direct impact on the snake.

Adulticiding applications by truck mounted ultra low volume (ULV) machines may pose a threat to giant garter snakes sunning themselves on road ways or levees. These events generally occur during the late evening or early morning hours when adult mosquitoes are most active. Trucks generally do not exceed 10 miles per hour during these pesticide applications, which should allow ample time for a snake to avoid being run over.

It is important to note that any chemical control measure used for larval control is limited in its effectiveness if it cannot reach its target. Excessive vegetation will minimize effectiveness of even the "harshest" pesticides used, and severely limit the effectiveness of the "safer" pesticides due to their mode of action. Comprehensive mosquito control incorporates all aspects of an integrated pest management plan to minimize mosquito control numbers. Leaving one aspect of a plan out generally results in a greater reliance on another portion of the plan. It is therefore important that any management plan work closely within the parameters of the local mosquito and vector control district to maximize the effectiveness of a mosquito control program and ensure the safety and health of the surrounding community.