# Giant Garter Snake
# (*Thamnophis gigas*)

## 5-Year Review:
## Summary and Evaluation

U.S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office
Sacramento, California

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# 5-YEAR REVIEW
## Giant Garter Snake (*Thamnophis gigas*)

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## 1.0 GENERAL INFORMATION

### 1.1. Reviewers

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### 1.2. Methodology used to complete the review:

This review was an effort by Sacramento Fish and Wildlife Office (SFWO) staff using information from species survey and monitoring reports, the 1999 Draft Recovery Plan for the Giant Garter Snake, peer-reviewed journal articles, documents generated as part of section 7 and section 10 consultations, and grant proposals generated under the Central Valley Project Improvement Act/Habitat Restoration Project grant program. We interviewed recognized giant garter snake experts for their knowledge and suggestions for recommendations to assist in the recovery of the species. Survey data, peer-reviewed journal articles, the Draft Recovery Plan for the Giant Garter Snake, and personal communications with snake experts were our primary sources of information used to update the species status and threats sections of this review.

### 1.3. Background:

#### 1.3.1. FR Notice citation announcing initiation of this review:

The FR notice initiating this review was published on July 7, 2005 (70 FR 39327). This notice opened a 60-day request for information period, which closed on September 6, 2005. A second FR notice was published on November 3, 2005 (70 FR 66842), which extended the request for information period for an additional 60 days until January 3, 2006.

#### 1.3.2. Listing history

**FR notice**: 58 FR 54053
**Date listed:** October 20, 1993
**Entity listed:** species, *Thamnophis gigas*
**Classification**: Threatened

#### 1.3.3. Associated rulemakings

Since the time of listing, no rulemakings, such as 4(d) rules or proposal or designation of critical habitat, have been completed.

#### 1.3.4. Review History

No status reviews have been completed since the time of listing.

#### 1.3.5. Species' Recovery Priority Number at start of 5-year review

Giant garter snake has been assigned a recovery priority of "2C," meaning that this species has a high degree of threat but also a high potential for recovery. The "C" after the number indicates the conflict of the species with construction or other development projects or other forms of economic activity.

#### 1.3.6. Recovery Plan or Outline

**Name of plan:** Draft Recovery Plan for the Giant Garter Snake
**Date issued:** 1999
**Dates of previous revisions:** none

## 2.0 REVIEW ANALYSIS

### 2.1. Application of the 1996 Distinct Population Segment (DPS) policy

#### 2.1.1. Is the species under review a vertebrate?

Yes

#### 2.1.2. Is the species under review listed as a DPS?

No

#### 2.1.3 Is there relevant new information that would lead you to consider listing this species as a DPS in accordance with the 1996 policy?

No

### 2.2. Recovery Criteria

#### 2.2.1. Does the species have a final, approved recovery plan containing objective, measurable criteria?

No. The Draft Recovery Plan for the Giant Garter Snake was published in 1999 (USFWS 1999) and a final plan has not yet been written. The draft recovery plan is being revised to incorporate new information.

### 2.3. Updated Information and Current Species Status

#### 2.3.1. Biology and Habitat

The giant garter snake (*Thamnophis gigas*) is one of the largest garter snakes, reaching a total length of at least 162 centimeters (63.7 inches) (58 FR 54053). Once identified as a subspecies of the western terrestrial garter snake, giant garter snake was accorded the status of a full species in 1987, and its taxonomy is unchanged today.

Endemic to the valley floor wetlands of the Sacramento and San Joaquin Valleys, the snake inhabits marshes, sloughs, ponds, small lakes, low gradient streams and other waterways and agricultural wetlands. Habitat consists of (1) adequate water during the snake's active season, (2) emergent herbaceous wetland vegetation for escape and foraging habitat, (3) grassy banks and openings in waterside vegetation for basking, and (4) higher elevation upland habitat for cover and refuge from flooding. Giant garter snakes feed on small fishes, tadpoles, and frogs (G. Hansen 1988). They breed in March and April with females giving birth to live young from late July though early September (Hansen and Hansen 1990).

Although growth rates are variable, young typically more than double in size by one year of age. Sexual maturity averages 3 years for males and 5 years for females (58 FR 54053). Researchers have noticed significant differences in the size of giant garter snakes between different populations. The largest, most robust snakes have been observed in the newly discovered population at Yolo Bypass, discovered in 2005, and the population at Badger Creek in southern Sacramento County (E. Hansen pers. comm. 2006).

A recent survey report (TNBC 2006b) indicated, however, that the size, and thus age distribution and fecundity, of giant garter snakes in the Natomas Basin may be decreasing. The TNBC report indicated that the mean size of both female and male giant garter snakes in the Natomas Basin has decreased with time. Further, snakes from the Natomas Basin appear to be smaller than snakes from other populations in the northern area (e.g., Badger Creek and Middle American Basin) (TNBC 2006b, E. Hansen, pers. comm. 2006). While the TNBC report suggested that the apparent trend of decreasing size, as well as the smaller size, of giant garter snakes in the Natomas Basin could be related to differences in sampling methodology (e.g., hand-capture technique versus aquatic sampling, exploratory versus standardized sampling), Eric Hansen (pers. comm. 2006) suggested these trends may also be attributed to a high rate of mortality and decreased fitness for giant garter snakes in the Natomas Basin that results from nematode infestations and vehicular traffic. The more recent use of standardized sampling methods should provide additional information as to whether or not a size and age shift is occurring in the Basin.

**Distribution**

At the time of listing, the species was known from 13 populations: (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) Burrell – Lanare. Each population represented a cluster of discrete locality records. Population clusters 1 through 4 above were associated with rice production areas, especially channels and canals that delivered or drained agricultural irrigation water. These populations were determined to be extant in 1993. Population clusters at Butte, Sutter, and Colusa Basins (1, 2, and 3) were determined to be not imminently threatened with extirpation.

Population clusters 5 through 13 were smaller, discontinuous, and located on isolated patches of limited quality habitat. The status of populations 10 through 13 was not known at the time of listing. Surveys for giant garter snakes at North and South Grassland Wetlands (11) in 1986, 1987, and 1992 did not find any giant garter snakes, although this species had been recorded at this locality prior to 1976 (California Natural Diversity Database [CNDDB] 2006). Surveys for the snake at Mendota Wildlife Area (12) in 1988 and 1992 were also negative, although the giant garter snake had been recorded there in the late-1970s and early-1980s. Observations of deteriorating habitat at Burrell—Lanare (13) in 1992 led to the conclusion in the final listing that this population, if it was not already extirpated, was severely and imminently threatened. Populations 4 though 13 were determined to be threatened with extirpation. The area covered by these populations (4 though 13) included the San Joaquin Valley, portions of the eastern fringes of the Delta, and the southern Sacramento Valley; an area encompassing about 75 percent of the species' known geographic range (USFWS 1993).

The known range of the giant garter snake has changed little since the time of listing. In 2005, three giant garter snakes were observed at the City of Chico's wastewater treatment facility, approximately ten miles north of what was previously believed to be the northernmost extent of the species' range (D. Kelly pers. comm. 2006, E. Hansen pers. comm. 2006). The southernmost known occurrence is at the Mendota Wildlife Area in Fresno County. Many of the populations north of Stockton are relatively stable (E. Hansen 2002, Wylie 2003, Wylie 2004, Wylie *et al.* 2005, G. Wylie pers. comm. 2006) but habitat has been lost to urban development, most notably in the Natomas Basin, located in Sacramento and Sutter Counties. The two known population clusters south of Stockton (Grassland Wetlands, Merced County, and Mendota Wildlife Area, Fresno County) remain small, fragmented, and unstable, and are probably decreasing (Dickert 2003, Dickert 2005, G. Wylie pers. comm., 2006). No sightings of giant garter snakes south of Mendota Wildlife Area within the historic range of the species have been made since the time of listing (E. Hansen 2002). A summary of recent surveys and sightings for each population follows:

*Northern Sacramento Valley Populations (Butte, Colusa, Sutter Basins)*

(1) Butte Basin: In 1996, Wylie *et al.* (1997b) surveyed rice fields in the Butte Basin near Butte Sink (Butte County) but failed to find giant garter snakes. Three occurrences of the snake have been recently discovered in the vicinity of the City of Chico in Butte County (E. Hansen pers. comm. 2006, D. Kelly pers. comm. 2006). The northernmost sighting extends the extant range of the species to the north by approximately 9.5 miles.

(2) Colusa Basin: Within the Colusa Basin, the U.S. Geological Survey (USGS) has conducted trapping surveys of giant garter snakes at the Sacramento National Wildlife Refuge Complex (Wylie *et al.* 1997b, 2000, 2002b). Wylie, in conjunction with Refuge staff, observed giant garter snakes at each of the Federal

wildlife refuges (Colusa, Delevan, and Sacramento) that comprise the Sacramento complex. It is likely that giant garter snakes occur outside of Refuge lands in the adjacent rice production areas. Wylie *et al.* (2001, 2002b) located 81 and 102 giant garter snakes, respectively, in the years 2000 and 2001 within the Colusa National Wildlife Refuge.

(3) Sutter Basin: Giant garter snake occurrences were documented in the wetlands and canals within the Sutter Basin in the 1990's and, in 2005, in portions of Gilsizer Slough, Sutter County (Wylie *et al.* 1996, CNDDB 2006).

*Southern Sacramento Valley Populations (American, Yolo, and Delta Basins)*

(4) American Basin: The American Basin includes portions of Butte, Yuba, Placer, Sutter, and Sacramento Counties. Two Habitat Conservation Plans (HCPs) developed in this basin collectively permit the loss of 8,512 acres of snake habitat and preserve and restore 6,562 acres of habitat for the snake (USFWS 2003). Although a report of giant garter snake surveys conducted between 2000 and 2003 states that it is still too early to determine whether the HCP mitigation efforts have resulted in increasing the numbers of giant garter snake, positive trends have been observed in some areas (City of Sacramento 2004, TNBC 2006b). Mitigation properties reported to support the giant garter snake continue to do so and four acquisition sites on which no giant garter snake were found during baseline surveys reported giant garter snake sightings in 2003 (City of Sacramento 2004). On the other hand, Paquin *et al.* (2006) suggested that the El Centro population (Fisherman's Lake) within the Natomas Basin suffered catastrophic population declines due to habitat loss since the beginning of her study in 1998; however, no population estimates subsequent to 1998 are currently available. Within the Natomas Basin, good quality giant garter snake habitat is found scattered mostly in the northern region, generally north of Elverta Road (Wylie *et al.* 2002a), although suitable snake habitat is found throughout most of the basin.

(5-6) Yolo Basin: Giant garter snakes were documented in the late 1980's within the Willow Slough and Willow Slough Bypass area in Yolo County (CNDDB 2006). In 2005, a new snake location was discovered in the Yolo Wildlife Area in Yolo County (E. Hansen, pers. comm. 2006). The density of snakes found at the Yolo Wildlife Area was greater or approximately equal to that observed in the American Basin (Natomas Basin and Middle American Basin) (E. Hansen, in litt. 2006). Surveys conducted by the USGS in 2004 and 2005 at many locations in eastern Solano County, including two historic locations near Liberty Farms, found no giant garter snakes and very few prey animals (e.g., small fish, frogs, and tadpoles) (Wylie and Martin 2004, Wylie and Martin 2005). Giant garter snakes were last seen in the Yolo Basin-Liberty Farms population in 1987 (CNDDB 2006). Wylie and Martin (2005) concluded that the species may no longer occur in Solano County. Surveys for giant garter snakes conducted at locations one to two miles west of Natomas Basin in 2005 were also negative (E. Hansen, in litt. 2006).

(7-10) Delta Basin: The Delta Basin includes portions of Sacramento, Yolo, Solano, Contra Costa, and San Joaquin Counties. Giant garter snakes have been detected since the listing at Badger Creek, in the southern portion of Sacramento County (Wylie *et al.* 1997b, E. Hansen 2001). During 1997, the USGS also surveyed for giant garter snakes at Stone Lakes National Wildlife Refuge, Sacramento County, where four locality records dating from 1965 to 1992 occur on or within close proximity to the Refuge (CNDDB 2006). Although suitable habitat is present at Stone Lakes National Wildlife Refuge, the USGS did not find giant garter snakes during their trapping efforts (Wylie *et al.* 1997a). 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, Sacramento County (S. Schoenberg pers. comm. 1998), and in April 2002, another giant garter snake was positively identified on the southwestern levee of Webb Tract (Patterson and Hansen 2003, CNDDB 2006). Prior to the 1998 sighting, 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, CNDDB 2006). Surveys conducted in 2003 and 2004 by E. Hansen and L. Patterson on Bacon Island and Webb Tract in the Delta did not detect giant garter snakes in this area. The authors concluded that "even though both islands possess habitat that has the potential to support populations of giant garter snake, such populations do not appear to currently exist [there]" (Patterson 2004), and the giant garter snake that was observed in the vicinity was likely washed down by high-water events from a population upstream. Giant garter snakes also were observed in the Caldoni Marsh/White Slough State Wildlife Area in San Joaquin County during 1995 surveys (G. Hansen 1996).

*San Joaquin Valley Populations (includes (11) North and South Grasslands (12) Mendota and (13) Burrell – Lanare)*

Giant garter snakes currently occur in the northern and central San Joaquin Basin within the northern and southern Grassland Wetlands. The Grassland Wetlands is a complex of protected lands in Merced County, which includes private lands managed under conservation easements, lands under the management of the Grassland Water District, and State- and Federally-owned and managed lands. Giant garter snakes have been detected in Los Banos Creek west of Kesterson National Wildlife Refuge and in Volta State Wildlife Area in Merced County, in rice production zones in Fresno and Merced Counties and at Mendota Wildlife Area in Fresno County (G. Hansen 1996, G. Hansen pers. comm. 1998, Wylie 1998a, Dickert 2003). The sighting at Mendota Wildlife Area in 2001 was the first observation of the giant garter snake there since the mid-1970's (Dickert 2005).

In 1998, Paquin *et al.* (2006) revisited historical locations in the San Joaquin Valley that had been characterized as suitable habitat for giant garter snake in a 1986-88 survey (G. Hansen 1988). They found that the habitat of approximately 60 percent of the sites had been degraded, either through the loss of terrestrial cover or water. The small numbers of giant garter snakes found may reflect continued degradation of wetland habitat and the abundance of invasive predators. Dense populations of bullfrogs, which are known to prey upon young giant garter snakes (Wylie *et al.* 2003), were observed during field surveys in the southern region. Low numbers of giant garter snakes in the San Joaquin Valley populations places these populations at high risk of extinction.

**Habitat or ecosystem conditions**
Endemic to wetlands in the Sacramento and San Joaquin valleys, the giant garter snake inhabits marshes, sloughs, ponds, small lakes, low gradient streams, and other waterways and agricultural wetlands, such as irrigation and drainage canals, rice fields and the adjacent uplands (USFWS 1993).

The primary threats to the giant garter snake continue to be habitat loss and degradation. For example, the American Farmland Trust projects a loss of more than one million acres of Central Valley farmland to urbanization by the year 2040 if current changes in land use continue (USGS 2003). This farmland includes land that is cultivated in rice. The relatively abundant populations of giant garter snake in the Sacramento Valley may reflect the expansion of available habitat that is provided from rice cultivation. Dependence of the Sacramento Valley populations on agricultural croplands leaves the giant garter snake vulnerable to wide-scale habitat loss in the event of changes in agricultural management such as a change in crops or fallowing large areas of rice fields (Paquin *et al.* 2006) or encroaching urbanization, which may inhibit rice cultivation (J. Roberts pers. comm. 2006).

Despite the steady loss and degradation of giant garter snake habitat, some habitat has also been protected, restored, or created. Acquisition and restoration of giant garter snake habitat has been conducted in the Natomas Basin, as part of the Natomas Basin Habitat Conservation Plan (NBHCP) and the Metro Air Park Habitat Conservation Plan (MAPHCP). Of the total amount of giant garter snake habitat existing in the Natomas Basin (24,567 acres of ponds seasonally wet areas, rice fields and canals), 8,512 acres of giant garter snake habitat have been permitted to be lost through the two HCPs (USFWS in litt. 2003). To date, the Natomas Basin Conservancy has acquired over 3,950 acres of reserve lands for the snake and other covered species that include managed marsh, upland habitat, and rice land (TNBC 2006b). Upon full implementation of the two HCPs, at least 6,562.5 acres of habitat (2,187.5 acres of managed marsh and 4,375 acres of rice) will be protected and managed for the snake (USFWS 2003). Although the report of giant garter snake surveys conducted between 2000 and 2003 on lands that were restored states that it is still too early to determine whether the NBHCP mitigation efforts have resulted in increasing the numbers of giant garter snakes, some positive trends have been observed. Mitigation properties reported to support the giant garter snakes continue to do so and four acquisition sites on which no giant garter snakes were found during baseline surveys reported giant garter snakes sightings in 2003 (City of Sacramento 2004).

A restored wetland area on the Colusa National Wildlife Refuge showed increased numbers of snakes during the 2005 trapping season (Wylie *et al.* 2006). The USGS determined that, with the provision of a stable source of summer water in the restored area, these restoration efforts resulted in a decrease in reliance by the radio-marked snakes on adjacent rice fields for summer water. This resulted in possible decreased exposure to risk factors such as traveling greater distances and crossing roads (Wylie *et al.* 2006). Home ranges and movements were also reduced in recent years, likely because the giant garter snakes did not have to travel as far for food and shelter (Wylie *et al.* 2000 in Wylie *et al.* 2006).

Two habitat conservation banks have been established, in Colusa and Yolo Counties, in part for the purpose of selling giant garter snake credits to developers or others who need to compensate for environmental impacts to the species from their projects. Both of these conservation banks, Pope Ranch, a 391-acre conservation bank in Yolo County, and Dolan Ranch, a 251-acre ranch in Colusa County, have sold all of their giant garter snake credits, ensuring that the habitat on both sites is managed for the benefit of the species and protected in perpetuity. Although the giant garter snake has not yet been observed on either bank, known occurrences of the snake are located approximately 5 miles from Pope Ranch and Dolan Ranch Conservation Banks. Other giant garter snake habitat has also been preserved, created, or restored as a result of section 7 consultations between the Service and other Federal agencies as described under *2.3.2.*

**Genetics, genetic variation, or trends in genetic variation**

A study of giant garter snakes in six watersheds in the Sacramento Valley found significant genetic variation between watersheds. Paquin *et al.* (2006) found that interpopulation and interregion gene flow is relatively low. Badger Creek, the most central population of those studied and located in the Sacramento-San Joaquin Delta, contained high frequencies of mitochondrial DNA haplotypes (single copies of DNA inherited from an individual's mother) not shared with any other populations. Cyclical rising and lowering of water in the Delta during glacial expansion and retreat may have caused aquatically isolated refugia in the Delta, thereby resulting in genetic isolation of populations in the central region (Paquin *et al.* 2006). Regional watershed boundaries may have acted as partial gene flow barriers (Paquin *et al.* 2006); therefore, watershed regions may define population sets with unique adaptive alleles. The central population, Badger Creek, is genetically different and relatively physically isolated from both northern and southern populations (Paquin *et al.* 2006). Each population has the potential to evolve selectively advantageous characters that are different from those of other populations. This potential should be considered when making decisions that involve mixing populations or permitting development that might cause local population extinction (Paquin *et al.* 2006). The final rule to list the species (USFWS 1993) and the Draft Giant Garter Snake Recovery Plan (USFWS 1999) identify 13 populations that represent clusters of discrete locality records but that largely coincide with historical riverine flood basins and tributary streams throughout the Central Valley. Paquin *et al.* (2006) defined giant garter snake population boundaries more narrowly using field observations of giant garter snake movements collected during USGS radio telemetry studies conducted at multiple study sites. A distance of at least 5 kilometers separated populations (M. Paquin in litt., 2006).

### 2.3.2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

#### 2.3.2.1. Present or threatened destruction, modification or curtailment of its habitat or range:

At the time of listing in 1993, significant reductions in Central valley wetland habitat due to land reclamation, agricultural practices and water management (U.S. Department of Interior 1994) had resulted in habitat loss, fragmentation and isolated habitats throughout the snake's range. Fragmentation continues to be a serious threat to the giant garter snake. Small clusters of giant garter snakes confined to limited habitat areas are likely vulnerable to extirpation from random environmental, genetic, and demographic events (Schonewald-Cox *et al.* 1983).

The 1993 listing final rule (58 FR 54053) identified the following the threats to giant garter snake habitat: urban development and expansion, particularly near the Sutter basin, American Basin, Badger/Willow Creek, East Stockton and Grasslands populations; U.S. Army Corps of Engineers flood control projects in Sacramento, Yuba and Sutter Counties; and agricultural practices such as canal maintenance and livestock grazing. New information on each of those risks, as well as new risks identified since the time of listing are discussed below:

**Urbanization**

Urbanization is one of the greatest threats to the giant garter snake throughout much of its extant range. Environmental impacts associated with urbanization are loss of habitat, introduction of non-native species with a resulting loss of biodiversity, alteration of natural fire regimes, fragmentation of habitat due to road construction, and degradation of habitat due to pollutants. Within the current range of the giant garter snake, cities that are rapidly expanding and, in some instances, intruding upon or otherwise impacting giant garter snake habitat include, but are not limited to: Chico, Woodland, Yuba City/Marysville, Sacramento, Galt, Stockton, Gustine, Los Banos, Merced, and Fresno. Urbanization increasingly threatens the viability of giant garter snake populations as urban landscapes encroach on ever-diminishing habitat for this listed species. For example, the City of Los Banos, Merced County, experienced a 74.7 percent increase in population between 1990 and 2000 (U.S. Census Bureau, www.census.gov). This city lies between the northern and southern divisions of the Grasslands Ecological Area (within the Grassland Wetlands) and its growth could affect the giant garter snake populations there (Dickert 2005). California Department of Transportation has proposed rerouting State Route 152 in Merced County. One of the alternative routes would bypass the City of Los Banos to the north, bringing the highway closer to the northern and southern divisions of the Grasslands Ecological Area, impacting the northern division, and facilitating further growth in this area (K. Forrest, in litt. 2005).

The American Farmland Trust projects a loss of more than one million acres of Central Valley farmland to urbanization by the year 2040 if current changes in land use continue (USGS 2003). This trend implies a loss of rice agriculture and the associated wetlands where giant garter snakes currently occur. Further, viable rice production is subject to influences from encroaching urban and residential development. Potential changes in adjacent land use are likely to occur throughout the region, as demonstrated by the burgeoning growth of northern California's population. Rice farmers in the Natomas Basin have indicated that there are difficulties associated with farming rice on land adjacent to urban development because crop dusters can no longer obtain insurance to fly so close to new homes (J. Roberts pers. comm. 2006).

Since the time of listing, the Service has issued five section 10(a)(1)(B) permits for projects anticipated to impact the giant garter snake. Three of the five permits are for projects in the Sacramento Valley; the others are for projects located in the San Joaquin Valley. Four of the five permitted projects authorize urban development-related activities. Since the time of listing, the Service also issued 174 section 7 permits for take of the snake. The majority of these permits were for projects that would affect the American Basin and Sacramento area populations.

**Flood Control and Canal Maintenance**

Ongoing maintenance of artificial or natural aquatic habitats for purposes of flood control and agriculture may result in direct mortality to giant garter snakes (G. Hansen 1988, Brode and Hansen 1992, California Department of Fish and Game [CDFG] 1992, Hansen and Brode 1993). Maintenance activities may also fragment and isolate available habitat, prevent dispersal of giant garter snakes among habitat units, and reduce the availability of cover and giant garter snake prey. Much of the remaining giant garter snake habitat is subject to flood control and canal maintenance activities, subjecting the snake to on-going risks of mortality and injury and the effects of habitat degradation.

Maintenance activities may include weed eradication, which destroys surface cover, and rodent eradication, which indirectly eliminates the occurrence and abundance of underground burrows and retreats for giant garter snakes. Giant garter snakes depend upon rodent burrows to thermoregulate, to provide cover during ecdysis (the shedding of skin), and for over-wintering. The coexistence of burrowing mammals greatly benefits giant garter snakes

(Wylie *et al.* 1996, Wylie *et al.* 1997b). Other types of maintenance activities occurring in irrigation canals include: (1) de-silting, (2) excavation and re-sloping of ditches and channels, (3) deposition of ditch and canal spoils materials on adjacent property, (4) placement of fill material within the canal, and (5) control of vegetation in and around canals, ditches, and drains by mowing and other measures. These activities can injure and kill giant garter snakes.

A four-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 mechanical scraping of 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 burrows and crevices suitable for giant garter snake retreats became established sooner where weed eradication was not practiced. Giant garter snake recolonization in relocated canals was not detected during this four-year study.

The flood control practice of lining streams and canals with large and extensive quantities of concrete or rock riprap is detrimental to wetland ecosystems (USFWS 2000). Though giant garter snakes have been observed to use riprap to thermoregulate, large quantities of riprap eliminate a natural thermal mosaic, and may be composed of material that degrades and pollutes water. Also, riprap may be installed in conjunction with ground cloth that is impermeable to rodents thereby preventing rodent burrowing.

**Grazing and Agricultural Practices**
Although no studies have been conducted that specifically examine the potential effects of grazing on the giant garter snake, grazing is a concern for the giant garter snake, particularly in preserves that are managed for this species (E. Hansen pers. comm. 2006). Grazing can result in the removal of upland refugia and the trampling of aquatic and terrestrial vegetative cover that provide cover and thermal mosaic environment for the snake (E. Hansen pers. comm. 2006), and giant garter snakes have been observed to avoid areas that are grazed (E. Hansen 2003). Additional research is needed to better understand the effects of grazing on giant garter snakes.

The relatively abundant populations of giant garter snake in the Sacramento Valley may reflect the expansion of available habitat that is provided from rice cultivation. Dependence of the Sacramento Valley populations on agricultural croplands leaves the giant garter snake vulnerable to wide-scale habitat loss in the event of changes in agricultural management such as a change in crops or fallowing large areas of rice fields (Paquin *et al.* 2006). Giant garter snakes found in rice fields or agricultural canals are threatened by conversion of rice crops to non-agricultural land uses and other crops such as grape-producing vineyards, fruit or nut producing orchards, or annual row crops (e.g., cotton). Unlike flood irrigated rice fields, other agricultural cropping systems do not hold sufficient water for long enough time periods to create artificial, temporary wetlands.

California rice producers annually cultivate approximately 202,343 hectares (500,000 acres) of wetland-like habitat (California Rice Commission 2002) located primarily in the Sacramento Valley. Rice production is estimated to contribute $540 million to California's economy yearly, a result of more than 1.7 million metric tons (1,904,000 tons) of rice. California contributes to the global rice market, with U.S. rice production for export to Brazil, the European Union, Mexico, and other countries accounting for about 12 percent of the global rice trade (U.S. Department of Agriculture 2003). However, agriculture commodities are subject to market fluctuations and rice production fluctuates on a yearly basis. Additionally, California rice producers are subject to Federal regulation such as the Clean Air Act, which seeks to limit pollutants from burning rice stubble. Rice growers must weigh the restrictions and subsidies provided by the State and Federal governments to determine the profitability of their commodity. Future restrictions could reduce California's rice production industry.

There are some indications that the amount or pattern of rice cultivation may change in upcoming years. In the Natomas Basin, the quality and quantity of giant garter snake habitat has declined due to rice fields along the Sacramento River being replaced by orchards, an increase in the fallowing of land east of the Sacramento Airport, and increased fallowing and urbanization in the southern part of the Basin (Wylie *et al.* 2002a). In 1997, the Federal Aviation Administration published an Advisory Circular recommending that a distance of five statute miles be maintained between a wildlife attractant and the airport's approach or departure airspace if the attractant may cause hazardous wildlife to move into this airspace (FAA 1997 as cited in City of Sacramento et al. 2003). In a meeting with the Service on January 18, 2006, the Federal Aviation Administration has stated that they prefer that no wetlands exist within a 5-mile radius of the Sacramento Metropolitan Airport and that all rice fields on Sacramento County Airport System lands should be removed, as that crop is incompatible with airport systems (K. Fitzgerald in litt. 2006).

Mitigations for the loss of rice fields associated with urban development have included managed marsh construction and growing rice by the Natomas Basin Conservancy. Economic yields from rice farming by the Natomas Basin Conservancy are decreasing due to increased water costs and increased resistance of weeds (particularly rice mimic [*Echinochloa phyllopogon*] and *Monochoria vaginalis*) and insect pests to available herbicides and pesticides (J. Roberts in litt. 2006; J. Roberts pers. comm. 2006). The chemical resistance of these pests is partially from repeated exposure to the herbicides and pesticides in rice crops grown on the same lands every year over a period of years (J. Roberts in litt. 2006). A suggested solution for this decline in yield is fallowing of a portion of the rice fields to combat the weeds and insects which are water or plant dependent (J. Roberts in litt. 2006).

**Wetland Management for Waterfowl**

Clusters of giant garter snakes occur on State and Federal refuges managed for wildlife purposes; however, some management actions may not benefit the giant garter snake habitat or its prey base (Dickert 2005, Paquin *et al.* 2006). Giant garter snakes require water during the active phase of their life cycle in the summer; however, some refuge areas are managed to provide water for waterfowl during the winter and spring months, and are drained during the summer months (Paquin *et al.* 2006). Summer aquatic habitat is essential because it supports the frogs, tadpoles, and small fish on which the giant garter snake preys. However, permanent water that provides suitable giant garter snake habitat generally supports populations of largemouth bass or other non-native fish that prey upon giant garter snakes.

A reduction of wetland habitat during the driest part of the year may have a substantial impact on the survival of giant garter snake populations in the San Joaquin Valley (Paquin *et al.* 2006). For example, Beam and Menges (1997) evaluated historic wetland management practices on State Wildlife Areas and private duck clubs in the Grassland Wetlands of Merced County and concluded that several historic changes in the landscape may be linked to the observed decline of giant garter snakes in this region. Changes in the landscape that did not favor giant garter snakes included: (1) wetland management techniques that did not provide summer water, (2) use of contaminated agricultural drain water on wetland areas, and (3) lack of flood control.

Irrigation of private duck clubs for cattle once provided summer water in canals, sloughs, and other water conveyance systems throughout the basin. Maintaining pastures in summer for cattle grazing required regular irrigation and flooding of pastures (Paquin *et al.* 2006). 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). This change from water grass (*Echinochloa* species) production to moist-soil management for swamp timothy (*Heleochloa schoenoides*) and smartweed (*Polygonum* species) resulted in earlier spring irrigation and decreases in summer water in the Grassland Wetlands. These land management changes resulting in reduced summer water coincided with the apparent declines of giant garter snake populations in the Grassland Wetlands (Beam and Menges 1997, G. Hansen 1988, G. Hansen 1996, Paquin *et al.* 2006). The changes in the seasonal availability of water have apparently resulted in the decline of what G. Hansen (1980) once considered a widespread giant garter snake population in the Grasslands region. This population has not recovered and returned to its previous levels of abundance (G. Hansen 1988, Paquin *et al.* 2006).

**Introduction and Eradication of Non-Native Plants**
Introduced, non-native plants may adversely affect the giant garter snake. For example, water primrose (*Ludwigia peploides* ssp. *montevidensis*) may concentrate giant garter snake prey in select pockets. Introduced water primrose has also been observed to constrain movements of giant garter snakes (M. Carpenter pers. comm. 2001), thereby increasing their vulnerability to predation. However, there is a lack of agreement among giant garter snake researchers regarding whether proliferation of the water primrose may adversely affect the species. Some believe that the native water primrose (*Ludwigia peploides* ssp. *peploides*) is a beneficial species that is not as invasive and provides habitat for the snake (E. Hansen pers. comm. 2006).

Efforts to reduce the invasion of non-native terrestrial plants may further disturb or injure the giant garter snake if herbicides or mechanical removal is not compatible with giant garter snake requirements and behavior. Mechanical removal, discing, mowing, or burning may result in direct injury or death to giant garter snakes. Loss of vegetative terrestrial cover and the thermal mosaic of shaded and unshaded areas which plants provide may result in a reduction in habitat used by the giant garter snakes for cooling or warming their body temperature (G. Hansen 1988, Hansen and Brode 1993).

Efforts to eradicate invasive water plants may also disturb or injure the giant garter snake. The invasive water hyacinth (*Eichornia crassipes*) is considered one of the most productive plants on earth and its ability to invade and displace native plants quickly allows it to degrade wetland habitats. Water hyacinth forms dense mats that competitively exclude native submersed and floating plants. Low oxygen conditions develop beneath water hyacinth and the dense floating mats impede water flow and create good breeding conditions for mosquitoes (Western Aquatic Plant Management Society 2006). Mosquito abatement measures include spraying herbicides in aquatic environments to eliminate water hyacinth. The effect of herbicides upon the giant garter snake is unknown.

However, herbicides are suspected to reduce the prey base for the giant garter snake (Brode 1996). For example, when herbicides are applied to aquatic plants and the plants die, the subsequent decomposition process may decrease dissolved oxygen levels in the water, which, if reduced sufficiently, could suffocate the snake's prey (Thayer *et al.* 2003). Additionally, herbicides eliminate wetland plants, whose surfaces are colonized by algae, protozoa, rotifers and other small organisms that serve as a food supply for amphibian larvae (Hurlbert 1975), thereby adversely affecting the primary production level of the food chain upon which giant garter snakes ultimately depends. Further, some research has documented the detrimental effects of the commonly used herbicide Atrazine, on the sexual development of larval amphibians (Hayes *et al.* 2002), which may affect the availability of prey for the giant garter snake.

**Natural gas exploration**

Natural gas exploration on National Wildlife Refuges in both the Sacramento and San Joaquin Valleys in 2002 and on privately-owned lands in the Butte Basin in Glenn, Colusa, and Butte Counties in 2003 (USFWS in litt. 2002) has likely impacted giant garter snakes. Seismic exploration for natural gas may include the following activities: (1) surveying; (2) drilling; (3) lying of detectors and lines; (4) recording; and (5) equipment removal. Survey work during which the extensive array of detectors and lines are laid out is accomplished primarily on foot. However, four-wheel drive trucks, all-terrain vehicles (ATVs) and a helicopter may be used for accessing the project area. Explosive charges buried in holes are often used as the energy source for recording seismic data at predetermined source points. The giant garter snake can be disturbed by workers walking through their habitat as they conduct surveys, deploy and retrieve source and receiver lines, and remove equipment. Snakes could also be disturbed or killed by helicopters deploying drilling equipment in potential snake habitat. Snakes could also be crushed in their burrows by drilling equipment or caused to flee by the wind disturbance from the helicopters (USFWS in litt. 2002).

In summary, the primary threats to giant garter snake under this factor are loss and degradation of habitat due to urbanization and loss of habitat due to changes in rice production (because rice farming provides important giant garter snake habitat). The other threats mentioned above are secondary because they either occur in fewer areas (e.g. oil and gas exploration) or are of lesser magnitude (e.g., grazing) than the loss of habitat to urbanization and the loss of rice production.

**2.3.2.2. Overutilization for commercial, recreational, scientific, or educational purposes:**

At the time of listing in 1993, the threats noted in the final rule from overutilization or recreation included harassment caused by recreationists, such as crayfish collectors and anglers. A discussion on this is included under section 2.3.2.5 ("Other natural or manmade factors affecting its continued existence"). At the time of the 1993 listing, the species had been found in pet shops but collection for commercial purposes did not apparently threaten the species. No new information is available regarding an increase in threats to the snake from collectors, although new information is available on the effects of scientific collection, as discussed below:

**Scientific collection**

Qualified individuals may obtain permits to conduct scientific research activities on the giant garter snake under section 10(a)(1)(A) of the Endangered Species Act of 1973, as amended. Specific activities that may be authorized include: capturing, confining, tagging, handling, obtaining tissue or blood samples, and measuring. These activities may be done in conjunction with radio telemetry tracking studies, genetic studies, contaminant studies, and behavioral, ecological, and life history studies. Short term impacts of these activities may include accidental injury or death of a limited number of giant garter snakes; however, these activities are not a significant source of loss of giant garter snakes. Specifics of activities associated with capture, use of transmitters and holding of giant garter snakes are discussed below.

Capture. Most reptiles experience stress in response to capture and short-term confinement as indicated by an increase in blood plasma corticosterone levels (Lance 1990). Additionally, trapping techniques that employ the use of floating minnow traps place giant garter snakes at risk for drowning where water quantity or flow fluctuates or being caught in the mesh as they try to escape. At least two giant garter snakes are known to have drowned in separate incidents in defective traps during snake surveys, one in a defective modified eel pot trap in the Volta Wasteway in the Volta Wildlife Area, Merced County (Dickert 2003) and one in the American Basin, Sutter County (E. Hansen in litt. 2005). Trapping may increase the risk of predation while the giant garter snake is retained in the trap or place it at risk due to the loss of the ability to thermoregulate. Transporting and storing giant garter snakes are also sources of risk to the snake. Two giant garter snakes suffocated during transportation in overly wet cotton bags during surveys at Badger Creek and three giant garter snakes died from heat stress while stored in an ice chest during surveys in the Natomas Basin (E. Hansen in litt. 2003). Another potential threat to the snake includes the theft of snake traps while they are deployed in the field (TNBC 2006b). If a snake is in a trap when it is stolen, the snake could be injured or killed, depending on the reaction of the trap thief.

Transmitters. The external attachment of radio transmitters can result in tail loss (Sloan 2003). In a study by Sloan (2003), to find an alternative method to internal implantation of radio transmitters, transmitters were attached to the tails of valley garter snakes, a similar species chosen as a surrogate for the giant garter snake. Five of 14 valley garter snakes in the study lost their tails after the attached transmitters became entangled in vegetation and the tails were torn away with the transmitters (Sloan 2003).

Holding. Researchers who do not retain captive giant garter snakes from separate populations in separate facilities, potentially risk the spread of disease and infection among healthy populations. Infected giant garter snakes held temporarily in the lab or in care facilities while recovering from radio implant surgery, for example, have the potential to spread disease or parasites to healthy giant garter snakes simultaneously held nearby. Upon return to the capture site newly infected individuals could infect a previously healthy population. Similarly, giant garter snakes fed prey (which can act as hosts for parasites) from areas outside their home ranges could be at risk for the spread of parasitism (G. Hansen in litt. 1992).

**2.3.2.3. Disease or predation:**

At the time of listing in 1993, the threats noted in the final rule from disease or predation to the giant garter snake included infestation by parasitic worms in the American Basin population and predation by a variety of animals including raccoons, skunks, foxes, domestic cats, and bullfrogs. Largemouth bass (*Micropterus salmoides*) and catfish (*Ictalurus* species) were listed as potential predators. New information is available on these threats as is information on some new risks from other introduce predators, as discussed below.

**Parasites**

In 1992, George Hansen (in litt. 1992) documented parasite infestations in giant garter snakes from the American Basin in the Sacramento Valley. Giant garter snake necroscopies have shown parasites in a variety of organs and tissues (E. Hansen pers. comm. 2006). These parasites are filarial nematodes (G. Wylie pers. comm. 2006) that are believed to be of the genus *Eustrongylides*. The parasites, which can be fatal, are transferred from mother to young in vitro. George Hansen (in litt. 1992) suggested that the parasites may contribute to low survival of neonate giant garter snakes in the American Basin. Young and adult giant garter snakes with lumps indicating parasitic infestation grew more slowly or exhibited respiratory problems before eventually dying. Since G. Hansen's study (in litt. 1992), apparently similar lumps have been observed in giant garter snakes in the southern Grasslands Ecological Area and in the Mendota Wildlife Area (Dickert 2005).

The snake mite (*Ophionyssus natricis*), an ectoparasite (one which lives externally on animals), is common among garter snakes (Rossman *et al.* 1996). Its occurrence or effects upon the giant garter snake have not been studied but, as with other parasites, may also reduce the survival of neonate giant garter snakes.

The evidence indicates that at least nematodes and snake mites may affect giant garter snake. Nematodes have been identified in giant garter snakes, and snake mites among other garter snakes. However, little information is available that definitively indicates to what extent parasites may decrease the likelihood of giant garter snake persistence. We, therefore, cannot consider it a major threat at this time.

**Predatory fish**

Habitat degradation or alteration that benefits non-native species may increase the vulnerability of giant garter snakes to predation. Introduced game fish such as largemouth bass and catfish eat giant garter snakes. 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 (G. Hansen 1986, CDFG 1992).

**Crayfish**

The crayfish (*Procambarus clarkii*) is an introduced species in California that inhabits giant garter snake habitat. When crayfish molt, they may become the prey of giant garter snakes under certain conditions. Crayfish also may be predators upon the giant garter snake. At the Badger Creek study area, the use of floating minnow traps to capture giant garter snakes resulted in the simultaneous capture of crayfish. On more than one occasion, skeletal snake remains that could not be positively identified as, but were presumed to be, giant garter snakes were observed in traps in which several crayfish were present (M. Owens pers. comm. 2005). We have no data to indicate whether and how often crayfish may prey on giant garter snake outside of traps.

**Bullfrogs**

Several researchers have implicated 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 the: (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) in snout-vent length, and (3) disappearance and subsequent resurgence of garter snake populations coincident with the introduction and decline of bullfrog populations. Schwalbe and Rosen (1989) concluded that bullfrogs have a high potential of eliminating garter snake populations. Although these studies were conducted on garter snake species other than the giant garter snake, it is likely that the giant garter snake may be similarly affected.

Others have found the bullfrog to be a predator of the giant garter snake. 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, Sutter County, where giant garter snakes are known to occur. Wylie *et al.* (2003) examined stomach contents of 99 bullfrogs over three field seasons at the Colusa National Wildlife Refuge, Colusa County. Neonate giant garter snakes contributed about four percent of bullfrog stomach contents. The authors calculated that an annual mortality of 21.5 percent of neonate giant garter snakes was due to bullfrog predation (Wylie *et al.* 2003). Adult bullfrogs were found to eat neonate giant garter snakes (208 and 213 millimeters in length) at the Volta Wasteway in Volta Wildlife Area, Merced County (Dickert 2003).

**Introduced Snake Species**

The Southern water snake (*Nerodia fasciata*) has been introduced into the Folsom, California region, where it has reached high local densities (Balfour and Stitt 2002). This species, whose life history is closely related to the giant garter snake in being primarily aquatic and requiring upland habitat for basking and aestivation, is an opportunistic invasive species, having apparently expanded its range near Folsom since it was first discovered there in 1992 (Stitt *et al.* 2005). It appears to be able to inhabit both small and large bodies of water (Stitt *et al.* 2005). Stitt *et al.* (2005) identified the Southern water snake as a potential threat to the giant garter snake because there is the possibility that the introduced, invasive species may out-compete the endemic giant garter snake to the point of competitive exclusion. Southern water snake has yet to be found within giant garter snake populations, but due to the high risk to giant garter snake populations from this invasive species, this threat should be continued to be monitored.

**Predation by Domestic Cats**

Domestic cats, depending upon the environment, may travel 0.8 kilometer (0.5 mile) or more from their owner's homes for the purpose of hunting. G. Hansen (USFWS 1993) observed numerous snake kills (of several snake species including the giant garter snake) by domestic cats. These observations were in one of his longtime study areas, approximately 3.2 kilometers (2 miles) from the closest urban development in the City of Davis, Yolo County.

**Predation by Native Species**

Predation by native species upon the giant garter snake has not been well documented. No analysis of predation or examination of the stomach contents of suspected predators has been conducted for the giant garter snake. Anecdotal information includes observations of hawks, herons, and river otters preying upon the giant garter snake. Although no quantitative data exist on predation of giant garter snakes by river otters, three to four giant garter snakes have been observed that were believed to be killed by otters (G. Wylie in litt. 2006). River otters (*Lutra canadensis*), which are numerous in Badger Creek and some areas of the Natomas Basin, have also been known to kill giant garter snakes without consuming them (G. Wylie pers. comm. 2006). According to Rossman *et al.* (1996), garter snakes may be important prey for several vertebrate predators including jays (*Cyanocitta cristata*) and crows (*Corvus brachyrhynchos*), carnivorous fish, and small mammals. Small native mammalian predators are likely to include raccoons, skunks, opossums, and foxes. Anthropogenic (human caused) changes in ecosystem dynamics may favor and subsidize these predator populations especially in areas at the urban-interface. The result may be an increase in predation pressure upon the giant garter snake, but we have no specific data to evaluate the risk at this time.

In summary, parasites and introduced predators are likely a small to moderate threat to giant garter snake compared to the threat of habitat loss as discussed above. Of most concern among the predators are bullfrogs, which have been shown to ingest giant garter snakes in the wild (perhaps even resulting in approximately 20% annual mortality of neonate snakes at one site (Wylie *et al.* 2003)).

**2.3.2.4. Inadequacy of existing regulatory mechanisms:**

The Giant garter snake final listing rule discussed the adequacy of a number of regulatory mechanisms in providing protection for this species (58 FR 54053). Specifically, it discussed the adequacy of the National Environmental Policy Act (NEPA), Section 404 of the Clean Water Act (CWA), the California Environmental Quality Act (CEQA) and the California Endangered Species Act (CESA). As discussed in the final rule, each of these laws provides some protection to the snakes, but has provisions or exemptions that could allow activities that would adversely affect the snakes.

NEPA: The National Environmental Policy Act (NEPA) provides some protection for the giant garter snake. For activities undertaken, authorized, or funded by federal agencies, NEPA requires the project be analyzed for potential impacts to the human environment prior to implementation (42 U.S.C. 4371 et seq.). Instances where that analysis reveals significant environmental effects, the federal agency must propose mitigations that could offset those effects (40 CFR 1502.16). These mitigations are usually developed in coordination with the Service during Section 7 consultation and should provide some protection for listed species. However, NEPA does not require that adverse impacts be fully mitigated, and so some impacts could still occur. Additionally, NEPA is only required for projects with a federal nexus, and therefore, actions taken by private landowners are not required to comply with this law.

CWA: Under section 404 of the Clean Water Act, the U.S. Army Corps of Engineers (Corps) regulates the discharge of fill material into waters of the United States, which include navigable and isolated waters, headwaters, and adjacent wetlands (33 U.S.C. 1344). In general, the term "wetland" refers to areas meeting the Corps criteria of having hydric soils, hydrology (either sufficient flooding or water on the soil surface), and hydrophytic vegetation (plants specifically adapted for growing in wetlands). Any actions within giant garter snake habitat that has the potential to impact waters of the United States would be reviewed under the Clean Water Act as well as NEPA and the Endangered Species Act (Act). These reviews would require consideration of impacts to the giant garter snake and its habitat, and when significant impacts could occur, mitigations would be recommended.

CESA: The giant garter snake was listed as a threatened species in 1971 under the California Endangered Species Act of 1984 (CESA) which means that it cannot be taken without a special permit issued for scientific collecting or research. This legislation requires State agencies to consult with the

California Department of Fish and Game (CDFG) on activities that may affect a State-listed species.

CEQA: The California Environmental Quality Act (CEQA) requires review of any project that is undertaken, funded, or permitted by the State or a local governmental agency. If significant effects are identified, the lead agency has the option of requiring mitigation through changes in the project or to decide that overriding considerations make mitigation infeasible (CEQA Sec. 21002). In the latter case, projects may be approved that cause significant environmental damage, such as destruction of listed endangered species or their habitat. Protection of listed species through CEQA is, therefore, dependent upon the discretion of the lead agency involved.

CEQA requires disclosure of potential environmental impacts of public or private projects carried out or authorized by all nonfederal agencies in California. Under CEQA, a significant effect on the environment means "a substantial, or potentially substantial, adverse effect on the environment" (California Public Resources Code §21068). Any project that affects a protected species results in a mandatory finding of significant effect and all the mitigation requirements appurtenant. The lead agency can either require mitigation for unavoidable significant effects. In rare circumstances, and under specified conditions, the lead agency can make a determination that overriding considerations make the mitigation infeasible (California Public Resources Code §21002) and provide other mitigation. CEQA can provide protections for a species that, although not listed as threatened or endangered, meets one of several criteria for rarity (14 California Code of Regulations §15380).

Because of State environmental laws such as CEQA, planned development often provides avoidance, minimization, and mitigation measures which are specifically for, or which may incidentally benefit, giant garter snake, as a result of conformance with local land use plans for providing open space, through working with the California Department of Fish and Game under the authority of CEQA. The avoidance, minimization, and mitigation measures of individual projects nevertheless tend to result in fragmented landscapes and a trend of cumulative regional habitat loss and fragmentation. Mitigation does not create new land, it simply balances land converted with land protected for natural values, so even with mitigation, a net loss of habitat results. So while mitigation provided by developments under CEQA may be offered with the intent to benefit giant garter snake, the resulting fragmentation of regional landscapes over time creates high risk of disrupting or precluding migration patterns, isolating small local populations, and subjecting animals to higher risks from road crossing mortality and other risks associated with urban preserves.

We have no new information indicating that the implementation of these laws has changed since listing.

Additionally, numerous activities do not require compliance with any of these laws. Examples are the drying of rice fields in anticipation of future development or the modification or destruction of wetland habitat prior to application by the project proponent for appropriate permits to develop the land. It is unclear to what extent these unpermitted activities are occurring and what impact it is having on giant garter snakes and their habitat.

Endangered Species Act: The Endangered Species Act of 1973, as amended, is the primary Federal law that provides protection for the giant garter snake since its listing as a threatened species in 1993. Since this designation, many projects have undergone section 7(a)(2) and section 10(a)(1)(B) consultations. Required or recommended minimization and avoidance measures for section 7 and 10 consultations typically include the following: (1) limiting activities to coincide with the giant garter snake's active season, (2) surveying for giant garter snakes prior to disturbance or construction, and (3) restricting canal maintenance practices, such as mowing, to one side of the canal per maintenance period. Most of these conservation measures have not been thoroughly studied for effectiveness. Monitoring to determine the effectiveness of these actions is required of permit holders; however, in general, neither the Service, due to budget limitations, nor the permit holders have fully implemented such monitoring.

The Service has processed section 7 consultations for giant garter snake in two ways, as individual consultations or through programmatic biological opinions for giant garter snake. The Service issued two programmatic biological opinions for giant garter snake, one for projects permitted by the U.S. Army Corps of Engineers (USFWS, in litt. 1997) and the other for Federal Highways Administration projects (USFWS, in litt. 2005). Both programmatic opinions apply only to projects that are likely to have small adverse effects on the giant garter snake. To date, the Service has conducted 174 formal consultations on the giant garter snake through either individual consultations or by appending projects to the two programmatic opinions. The majority of these consultations were for projects in the American Basin and Sacramento areas.

For both individual and programmatic consultations, the effects to the snake are divided into three levels based on whether the effects are permanent or temporary and the duration of the temporary effects. The two programmatic biological opinions articulate specific required compensation measures which must be fulfilled in order for a project to be appended to the programmatic opinion. Compensation measures for individual consultations are somewhat more variable but are generally part of individual biological opinions.

Investigation of the completion and success of the proposed compensation (aside from compensation proposed to occur at Service-approved compensation banks) is incomplete. Therefore, the overall effect to the giant garter snake from the issuance of programmatic and individual opinions is not yet precisely known.

The Service has issued incidental take permits for two habitat conservation plans (HCPs) that cover giant garter snake (Natomas Basin Habitat Conservation Plan [NBHCP] and Metro Air Park Habitat Conservation Plan [MAPHCP]). The incidental take permits associated with the two HCPs collectively permit 17,500 acres of urban development in the approximately 53,000-acre Natomas Basin (American Basin population). The two HCPs include a regional strategy to avoid, minimize, and mitigate the impact of the taking of the giant garter snake, State-threatened Swainson's hawk (*Buteo swainsoni*) and other covered species. Of the total amount of giant garter snake habitat existing in the Natomas Basin (24,567 acres of ponds and seasonally wet areas, rice fields and canals), 8,512 acres have been permitted to be lost through the two HCPs (USFWS, in litt. 2003). To date, the Natomas Basin Conservancy has acquired over 3,950 acres of reserve lands, much of which is managed marsh and rice land for the giant garter snake (The Natomas Basin Conservancy [TNBC] 2006a).

In summary, the listing of giant garter snake resulted in the regulation of activities that impact the giant garter snake under the Endangered Species Act. This is the only change in regulation that has occurred since the listing of the snake. This regulation has resulted in compensation for many projects that would have impacts on the giant garter snake. Monitoring of the implementation and effectiveness of such compensation could be improved, but we expect that overall losses to giant garter snake have been reduced due to listing under the Endangered Species Act.

#### 2.3.2.5. Other natural or manmade factors affecting its continued existence:

Other natural or manmade factors affecting the continued existed of giant garter snakes that were identified in the 1993 listing rule (58 FR 5405) included season fluctuations in rice production, canal management, changes in water management, contaminants, flooding, and habitat fragmentation/population isolation. In addition, the giant garter snake can be subject to harassment during crayfish collection and to disturbance and road kill from anglers. New information about each of those risks (except canal management, which is discussed above) as well new risk factors identified since the time of listing are discussed below:

**Agricultural Practices**

Agricultural practices such as tilling, grading, harvesting, or mowing may kill or injure giant garter snakes (CDFG 1992). Giant garter snakes have been observed to over-winter near canals within or adjacent to rice fields making them especially vulnerable to earth moving activities required to shape flood irrigated fields, form rice checks (small berms that affect water flow) and install irrigation boxes (structures which regulate flow quantity). Giant garter snakes have been captured in ditches with apparent poor habitat and lack of vegetative cover, but that were immediately adjacent to nearby rice fields that are presumably beneficial to the snakes (Wylie *et al.* 2002a). In the Natomas Basin, habitat used by the giant garter snake consisted almost entirely of irrigation ditches and established rice fields (Wylie 1998b; Wylie *et al.* 2004). In the Colusa NWR, snakes were regularly found on or near edges of wetlands and ditches with vegetative cover (Wylie *et al.* 2002b).

As discussed in Section 2.3.2.1, rice farming provides important giant garter snake habitat. However, when the rice market fluctuates farmers may change agricultural practices or grow alternative crops that can reduce the amount of available giant garter snake habitat. These changes can result in additional impact to the snakes because different agricultural practices are used for crops other than rice and even for different types of rice. For example, the growing of wild rice crops may result in more adverse effects than growing the more common long and short grain rice. Long and short grain rice are harvested after irrigation has ceased and fields have dried. Because radio-marked giant garter snakes have been observed moving from rice fields into the nearby canals as water recedes prior to harvest (Wylie 1998b), giant garter snakes are presumed to be absent when mechanical harvesters are driven into the fields. In contrast, wild rice is harvested while the field is inundated with water. The effects of mechanical harvesting upon giant garter snakes in fields with water and prey are present are unknown but, the harvesting is suspected to disrupt hunting, basking, or other behaviors.

**Water Management**

Groundwater pumping in southern Sacramento County has severely depleted regional groundwater, resulting in reduced surface flows in the Cosumnes River during the fall season, north of the Badger Creek giant garter snake population. Fall flows in the Cosumnes River have been so low in recent years that the entire lower river has frequently been completely dry between October and December (Fleckenstein *et al.* 2004). The lowering of the water table may affect surface flows on tributaries such as Badger Creek (E. Hansen 2001) and can also deplete nearby wetland habitats (Dunne and Leopold 1978). Historically, Badger Creek provided persistent year-round surface water in channels; however, the water level is currently dependent on seasonal precipitation and agricultural runoff, which provide no guarantee of sustainable suitable habitat for the giant garter snake (E. Hansen 2001). In 2001, Badger Creek experienced a comprehensive drying of aquatic habitat, which disrupted the connectivity between the western portion of the Badger Creek giant garter snake population and the formerly occupied snake habitat upstream (E. Hansen 2001). The drying of aquatic habitat persisted throughout the active season of the snake and may have resulted in part from water diversion for agricultural use (E. Hansen 2001). Additionally, the drying of aquatic habitat, such as that which occurred in 2001, may also eliminate populations of prey species of the snake (E. Hansen 2001). No information is currently available on the potential effects of lowering of the water table of other watersheds within the range of the giant garter snake.

**Floods**

Though the giant garter snake is an aquatic species, it is subject to the detrimental effects of floods. Giant garter snakes may be displaced during a flood, buried by debris, exposed to predators, and subject to drowning when burrows and over-wintering sites become inundated with water. During the flooding rains of 1998, a dead radio-marked giant garter snake was found apparently drowned in a water conveyance pipe at Colusa National Wildlife Refuge (M. Owens pers. comm. 2006). Giant garter snakes are not known to occupy the area within the Sutter Bypass which is flooded regularly (Wylie *et al.* 2005). However; snakes appear to survive at least some inundation of their burrows. Wylie observed snakes emerging from burrows after a period of inundation (G. Wylie pers. comm. 2006).

**Habitat Fragmentation/Population Isolation**

Habitat loss throughout the range of the giant garter snake has resulted in fragmented and isolated habitat remnants (see further discussions of projects resulting in habitat fragmentation under Habitat Destruction and Urbanization in II.C.2.a and in the final rule to list the species (USFWS1993)). In general, sub-populations of species confined to small habitat areas are likely vulnerable to extirpation from random, unpredictable environmental, genetic, and demographic events (Schonewald-Cox *et al.* 1983). When a sub-population becomes extinct, habitat fragmentation reduces the chance of recolonization from any remaining populations. In addition, the breeding of closely related individuals can cause a genetic reduction in fitness, inbreeding depression, and a loss of genetic diversity (Meffe and Carroll 1994).

While we know giant garter snake habitat has been, and continues to be, fragmented, we have no data that indicate whether or not random environmental, genetic and demographic events have adversely affected giant garter snake at this time. Continued isolation of sub-populations increases the likelihood that such effects will be important in the future.

**Drought and Climate Change**

The giant garter snake's dependence upon permanent wetlands means that water availability is important for their survival and recovery. In a state where wetland habitat is maintained by managed water regimes, competing interests may preclude consistent and timely delivery of water to sustain suitable habitat. Drought conditions will place additional strains on the water allocation system. Where giant garter snakes persist on only marginal habitat, the addition of drought conditions is likely to result in high rates of mortality in the short term with the effects of low fecundity and survivorship persisting after the drought has ceased (E. Hansen pers. comm. 2006). It is unknown how quickly giant garter snake populations may rebound after severe climatic conditions.

**Mosquito Abatement**

Malaria. western equine encephalitis. and the West Nile virus, a disease introduced to California subsequent to the listing of the giant garter snake, are diseases known to be transmitted by mosquitoes (California Dept. of Health Services 2002). By some estimates, the mosquito breeding ground in California's Central Valley has grown more than 50 percent in the last 10 years (Mosquito and Vector Control Association of California 2002). Water managers and mosquito abatement districts throughout the Central Valley work to reduce populations of mosquitoes by not allowing water to stagnate, thereby making it less suitable for mosquito larval development, or by spraying insecticides into inundated areas including flooded rice fields and the surrounding irrigation and drainage canals inhabited by giant garter snakes.

The mosquito abatement district goals, which call for no open shallow water in summer or vegetation in water, can conflict with the design of preserves for the giant garter snake (G. Sutter pers. comm. 2006). Preserves designed to meet the habitat requirements of the giant garter snake contain shallow open water and wide benches of emergent vegetation, such as tules (*Scirpus* sp.) that benefit the giant garter snake by providing summer habitat for the snake and its prey. Early coordination with mosquito abatement districts, however, can resolve many of the issues (G. Sutter pers. comm. 2006).

The reduction or altering of flood irrigation practices to control mosquitoes or other water related pathogens has the potential to adversely impact the giant garter snake and its aquatic prey, and could restrict the abundance of wetland habitat, thereby reducing the giant garter snake's distribution. Furthermore, while the toxicology of the giant garter snake is unexplored, pesticides, such as those used to control larval and adult mosquitoes, may reduce the populations of aquatic prey upon which the giant garter snake depends (Rowe *et al*. 2001, Davis *et al*. 2000, Slotton *et al*. 2000).

Since the documentation of West Nile virus in California in 2003, approximately 68 species of birds, reptiles, and mammals are considered to be at risk (Boyce *et al*. 2004), including the giant garter snake. The only species of garter snake that has undergone laboratory testing with the West Nile virus is the Florida garter snake (*Thamnophis sirtalis sirtalis*). In that case, the species had low viral loading of West Nile virus after being infected (Klenk and Komar 2003), which lowers the likelihood of the species acting as a reservoir host of the virus.

**Roads**
The California Department of Transportation manages 72,420 kilometers (45,000 miles) of freeway and highway lanes (California Department of Transportation 2002). A complex system of roads surrounds or crisscrosses nearly all natural habitats remaining in California. Giant garter snakes are threatened by disturbance or crushing by motor vehicles wherever snake habitat comes into proximity to roads, urban areas, agricultural fields, levees, or other areas that receive vehicle traffic or require maintenance by machinery. For example, two giant garter snakes are known to have been killed by vehicles during spring of 2006 in the Natomas Basin in separate incidences (during routine mowing along roads and by a truck traveling on a county road) (J. Roberts in litt. 2006). Several researchers have reported and collected dead giant garter snakes from roadways. For example, within the Natomas Basin, Hansen and Brode (1993) documented 31 road-killed giant garter snakes during their four-year study. As another example, during a 1999 study of the giant garter snake in the Grassland Wetlands, J. Beam (pers. comm. 2002) reported finding two road-killed giant garter snakes.

In addition to direct mortality from vehicle strikes, Fahig (1997) notes roads function as barriers that reduce ecosystem connectivity and restrict gene flow among metapopulations. Roads can serve as conduits for contaminants and non-native species. Where roads disrupt aquatic systems, altered connectivity can result in changes in water quality and interactions with terrestrial ecosystems (Forman *et al.* 2003). When constructed through wetlands, roads alter or degrade functional attributes including hydrology, nutrient supply, sediment and contaminant retention, and wildlife productivity (Forman *et al.* 2003). As road systems increase in density, surface area, and traffic volume, impacts to the giant garter snake likely also increase (E. Hansen pers. comm. 2006).

**Netting/Erosion Control Products**
Rolled erosion control products are frequently used as temporary berms to control and collect soil eroding from construction sites and other areas of disturbed soil during stormwater runoff. Bird netting, a lightweight plastic netting used to exclude wildlife from crops, and rolled erosion control products containing net-like mesh made of fibers such as nylon, plastic or jute twine, which hold materials such as straw and jute, have been found to be hazardous to several species of snakes (Stuart *et al.* 2001, Barton and Kinkead 2005). The snakes' scales catch on the netting, preventing the snakes from escaping by backing out of the mesh; the snakes then move forward into the small mesh opening which can trap the animals. The resulting lacerations from trying to escape and subsequent overheating or exposure to predators can result in death of the snakes (Stuart *et al.* 2001, Barton and Kinkead 2005). The effects of erosion control products and bird netting have not been studied specifically on the giant garter snake; however, the effects to giant garter snakes are likely similar to the effects on the species found in these studies.

For example, a dead pregnant female San Francisco garter snake (*Thamnophis sirtalis tetrataenia*) was discovered caught in a small piece of jute netting in the San Francisco Bay area (S. Larsen in litt. 2003). The giant garter snake is expected to be particularly vulnerable to the effects of erosion control products that are encased in filament or netting because these products are often used along water ways and other aquatic habitats, which are the giant garter snake's primary habitat (E. Hansen pers. comm. 2006).

**Water Quality**

There is little information specifically addressing the toxicity of contaminants and pesticides on reptiles. However, preliminary studies have documented potential bioaccumulation effects on the giant garter snake or its prey species caused by contaminants derived from agricultural products (CDFG 2005, Hopkins *et al.* 2001). Studies conducted after the listing of the giant garter snake examined the effects of selenium on two other species of snakes, the brown house snake (*Lamprophis fulginosus*, a terrestrial species) and the banded water snake (*Nerodium fasciata*, an aquatic species). A study by Hopkins *et al.* (2004) found that the brown house snake, a species native to South Africa, accumulated selenium from selenium-laden prey, developed high selenium loads within its internal organs, and transferred potentially toxic quantities of selenium to its eggs. The effects to the developing embryos were not thoroughly studied. However, in another study by Hopkins *et al.* (1999), adult snakes from the contaminated site showed much higher rates of metabolic activity than uncontaminated snakes, indicating that extra energy was required for daily activities. More study is needed to address whether contaminants impact giant garter snakes.

**Recreation Associated Impacts**

Giant garter snakes are likely to avoid areas that are routinely disturbed and will actively move out of areas that are subject to repeated disturbance (Hansen and Brode 1993). As snakes move out of areas that are subject to repeated disturbance, they are subject to increased risks of injury and mortality from predation and vehicles (Wylie *et al.* 1997b, E. Hansen pers. comm. 2006). Recreationists, such as anglers, can disturb basking snakes, thereby interfering with thermoregulation (E. Hansen pers. comm. 2006). Anglers may also interfere with predation and hunting behaviors of the giant garter snake as they intrude on areas where the snake's prey is located. Collection of crayfish (*Procambarus clarkii*) for human consumption from roadside canals and rice fields disturbs giant garter snakes and may also alter their behaviors, making them more vulnerable to associated threats, for example, injurious or lethal strikes from automobiles. As urban development increasingly encroaches on remaining giant garter snake habitats, increasing disturbance to the snake and its behavior patterns are expected to occur. However, the magnitude of these threats is unknown.

In summary, we are aware of a number of risks to giant garter snakes under this factor. Those of most concern involve changes in water regimes that may alter availability of giant garter snake habitat (e.g., water management) because these exacerbate the habitat loss discussed in section 2.3.2.1 above. In addition, the presence and impact of contaminants and pesticides may be of concern in some parts of the range. Other threats, such as roads and erosion control measures, are secondary.

### 2.4. Synthesis

The abundance and distribution of giant garter snakes has not changed significantly since the time of listing. Although some snakes have been rediscovered in several southern populations that were thought to be extirpated, these populations remain in danger of extirpation because their numbers remain very low and the habitat is of low quality.

By far the most serious threats to giant garter snake continue to be loss and fragmentation of habitat from urban and agricultural development and loss of habitat associated with changes in rice production. Activities such as water management that are associated with habitat loss are also of particular concern because they exacerbate the losses from development and from loss of rice production. The remaining threats (such as from introduced predators, roads, erosion control) are secondary to such habitat loss although habitat fragmentation could become a critical issue in the snake's survival should large scale habitat changes occur. Populations range-wide are largely isolated from one another and from remaining suitable habitat. Without hydrologic links to suitable habitat during periods of drought, flooding, or diminished habitat quality, the snake's status will decline.

Because the giant garter snake continues to be threatened by various forms of habitat loss, we believe that it continues to meet the definition of a threatened species and recommend that its status be unchanged.

## 3.0 RESULTS

### 3.1. Recommended Classification

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist** (*Indicate reasons for delisting per 50 CFR 424.11):*
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X_ **No change is needed**

### 3.2. Listing and Reclassification Priority Number, if reclassification is recommended

It is recommended that the recovery priority number remain 2C because the species continues to have a high degree of threat but also a high potential for recovery. The "C" indicates that some degree of conflict exists.

## 4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

The following recommendations for future actions were the result of discussions on the status of the species and the species' needs with several recognized giant garter snake experts. All the actions listed below address the threats described in the Five-Factor Analysis and will provide important benefits for the recovery of the giant garter snake.

1. Identify areas of high giant garter snake concentration and corridors of movement to help address the largest threats to the giant garter snake, habitat loss and fragmentation, described in section 2.3.2. Emphasize protection and enhancement of habitat and connectivity between concentration areas. Protect additional suitable habitat in each population where available. Habitat to be protected should include corridors between existing populations, between populations and suitable refugia, and suitable habitat adjacent to existing preserves.

2. Conduct a focused approach to recovery actions in the San Joaquin Valley, with an integrated effort that includes land use, water management, and water quality issues on private and public lands. Conduct extensive surveys to determine presence/absence, habitat use, and activity of snakes at the southern end of the known range. Conduct additional genetic analysis on southern populations to determine their relatedness to populations in northern and central portions of the species range. These areas likely have very little habitat and may need more active management to maintain any populations there. Increase Partners for Fish and Wildlife efforts on private lands in the southern portion of the species range. Restore and protect suitable habitat for giant garter snakes in San Joaquin Valley (South Valley Recovery Unit in the Draft Recovery Plan). Secure water and suitable water management for San Joaquin Valley giant garter snakes. These actions help address the threats of habitat loss, fragmentation, and degradation that result in the San Joaquin Valley populations continuing to be in danger of extirpation as noted in the original rule to list the species and in section 2.3.2.

3. Examine the water quality and toxicology of the giant garter snake's habitat. Conduct a study on whether agricultural pesticides and herbicides and trace elements associated with agricultural runoff (surface and subsurface) pose problems for the giant garter snake.

4. Investigate the long-term response of the giant garter snake to mass loss of habitat, in particular from fallowing of rice fields.

5. As roads and bridges are constructed or repaired within the range of the giant garter snake, larger and more frequent box culverts should be installed to facilitate giant garter snake movement. For example, when possible, efforts should be made to improve connectivity across I-5 and Highway 99 in the Natomas Basin. Potential connectivity issues in the Natomas Basin were discussed in the Biological Opinion for the Natomas Basin Habitat Conservation Plan (Service File No. 1-1-03-F-0225). The use of larger culverts or free-standing bridges (best) that contain some of the minimum habitat

characteristics of the snake (i.e., emergent vegetation up to the culvert entrances, burrows, prey) should provide improved passage opportunities for the snake.

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**U.S. FISH AND WILDLIFE SERVICE**
**5-YEAR REVIEW of Giant Garter Snake (*Thamnophis gigas*)**

**Current Classification**: Threatened

**Recommendation resulting from the 5-Year Review**:

____ **Downlist to Threatened**

____ **Uplist to Endangered**

____ **Delist**

_X_ **No change needed**

**Review Conducted By**: Elizabeth Warne

**FIELD OFFICE APPROVAL:**
Lead Field Supervisor, Fish and Wildlife Service

Approve ________________________________________ Date _________

**REGIONAL OFFICE APPROVAL:**
Lead Regional Director, Fish and Wildlife Service

Approve ________________________________________ Date _________

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**Review Conducted By**: Elizabeth Warne

**FIELD OFFICE APPROVAL:**
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**REGIONAL OFFICE APPROVAL:**
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Approve Steve Thompson Date 9/26/2006