5-YEAR REVIEW
San Francisco garter snake (*Thamnophis sirtalis tetrataenia*)

GENERAL INFORMATION

Species: San Francisco garter snake (*Thamnophis sirtalis tetrataenia*)
Date listed: March 11, 1967
Federal Register (FR) citation: 32 FR 4001 (Department of Interior 1967)
Classification: Endangered

State listing: The San Francisco garter snake was listed by the State of California as endangered in 1971.

BACKGROUND

Species overview:

The San Francisco garter snake is a subspecies of the common garter snake (*Thamnophis sirtalis*) and is taxonomically defined as *T. s. tetrataenia*. The San Francisco garter snake is considered one of the most beautiful snakes in North America, with a greenish-blue or blue belly and red on the top of the head (Stebbins 1985, p. 200). Dorsal background color varies from dark brown to black with a wide cream, yellow, blue, or pale green dorsal stripe bordered on each side by uninterrupted red or brownish-orange stripes between black lateral stripes (Stebbins 1985, p. 200; Fox 1951, p. 260). Ventral color and width of dorsal stripe are individually and geographically variable, and neonates are duller in color than adults (Cover and Boyer 1988, p. 8). The San Francisco garter snake can be distinguished from other syntopic (occurring in the same habitat at the same time) garter snakes, including the Santa Cruz garter snake (*T. atratus atratus*) and coast garter snake (*T. elegans terestris*), based on color patterns including the red head and blue ventral color (Barry 1994, p. 10). The San Francisco garter snake reaches a maximum total length of at least 120 centimeters for females, although the length more commonly reached is around 100 centimeters (Barry 1994, pp. 59–60). Male garter snakes are smaller than females, attaining about 83 percent of female length and 55 percent of female weight (Fitch 1980, p. 1). The San Francisco garter snake is endemic to the San Francisco Peninsula. Individuals are often found in or adjacent to aquatic habitats in association with a terrestrial niche, requiring both shallow freshwater habitat and contiguous uplands, meadows, or riparian habitat (McGinnis 1987, pp. 7–8; McGinnis et al. 1987, pp. 8–10; Barry 1996, p. 19).

Most recent status review:

[Service] U.S. Fish and Wildlife Service. 2020. San Francisco gartersnake (*Thamnophis sirtalis tetrataenia*). 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 5 pp.

We did not recommend a status change in the 2020 status review.

FR notice citation announcing this status review:

[Service] U.S. Fish and Wildlife Service. 2024. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews for 59 Pacific Southwest Species. Federal Register 89:83510–83514.

We did not receive information from the public regarding the San Francisco garter snake in response to the notice.

ASSESSMENT

Information acquired since the last status review:

This 5-year status review was conducted by the U.S. Fish and Wildlife Service's (Service) Sacramento Fish and Wildlife Office. Data for this review were solicited from interested parties through a Federal Register notice announcing this review on October 16, 2024. We also contacted species experts and land managers, performed a literature search, reviewed information from our own files, and obtained data from an occurrence search of the California Natural Diversity Database (Diversity Database) maintained by the California Department of Fish and Wildlife (Department).

Following the Service's 2020 Species Status Assessment (Service 2020a) and status review (Service 2020b) for the San Francisco garter snake, surveying and monitoring has continued at five of the twelve extant population complexes (discussed in **Distribution** and **Abundance).** Snake fungal disease, which was considered an emergent threat at the time of the 2020 Species Status Assessment and status review, has been detected in two San Francisco garter snakes at the West-of-Bayshore population complex (addressed in **Threats)**. Research on growth and survival modeling, reintroduction strategy modeling, and reintroduction site suitability have informed a pilot head-starting program for the species (discussed in **Conservation and research).** Additionally, a recovery working group for the San Francisco garter snake started to meet and multiple habitat restoration projects were completed within the range of the species (also described in **Conservation and research**).

Distribution:

The historical range of the San Francisco garter snake extended from approximately the San Francisco-San Mateo County line south along the base of the Santa Cruz Mountains into northern Santa Cruz County (Service 2020a, pp. 7–8). The San Francisco garter snake was listed as endangered under the Endangered Species Preservation Act in 1967 prior to any systematic range-wide survey effort, and no information on the species distribution was provided in the listing rule (Department of Interior 1967, p. 4001). The 1985 Recovery Plan for the San Francisco Garter Snake *Thamnophis sirtalis tetrataenia* (recovery plan; Service 1985, entire) notes that historical localities of the species were extirpated prior to and following listing due to urban development, especially in the northern portion of the range, including the sag ponds along Skyline Boulevard in Northern San Mateo County, and possibly areas in the eastern portion of the range (Barry 1978, p. 6; Service 1985, p. 10). Later, Barry (1994, p. 55) described the eastern flank of the Santa Cruz Mountains including the Pulgas Ridge region near Upper Crystal Springs Reservoir south to Boronda Lake as a potential intergrade zone with the California red-sided garter snake (*T. s. infernalis*), which is consistent with subsequent genetic analyses (Wood et al. 2020, pp. 18–19).

At the time of the 2006 status review and 2020 Species Status Assessment, the species continued to occur throughout much of its known historical range in populations largely fragmented by urbanization (Service 2006, pp. 5, 43–44; Service 2020a, p. 9). The 2020 Species Status Assessment describes 13 population complexes of the San Francisco garter snake including 12 presumed extant population complexes (Pacifica, West-of-Bayshore, Northern San Francisco Peninsula Watershed, Southern San Francisco Peninsula Watershed, Half Moon Bay, Woodside, San Gregorio, La Honda, Pomponio, Pescadero, Año Nuevo, Northern Santa Cruz County) and one extirpated population complex (Northern San Mateo County) (Service 2020a, pp. 10–12). The 2020 Species Status Assessment also provides a review of the Diversity Database element occurrences for the species which at that time included 63 presumed extant element occurrences and four extirpated element occurrences within northern San Mateo County (Service 2020a, p. 9).

The current distribution of the San Francisco garter snake is similar to as described in the 2020 Species Status Assessment (Service 2020a, pp. 7–11). The species has been documented at 7 of the 12 presumed extant population complexes since 2020 (see **Abundance** for further discussion of survey effort within each population complex). New survey data has not been added to the Diversity Database since the 2020 Species Status Assessment and status review (Diversity Database 2025a, entire). However, one presumed extant occurrence (element occurrence #35), located in Half Moon Bay between Highway 92 and Pilarcitos creek, has been removed from the Diversity Database due to misidentification (K. Swaim, Swaim Biological, in litt. 2007; B. Acord, California Natural Diversity Database, in litt. 2019). The Diversity Database now includes 62 element occurrences of the San Francisco garter snake that are presumed extant and four element occurrences that are extirpated (Diversity Database 2025). In addition, the Diversity Database has a total of 124 unprocessed records for the San Francisco garter snake (A. Chang, California Natural Diversity Database, in litt. 2025), 24 of which were available for review and show additional records of the species within previously known occupied areas (Diversity Database 2025b, unprocessed data). Overall, these data are concordant with the assessment of the species distribution in the 2020 Species Status Assessment (Service 2020a, pp. 7–10).

Abundance:
Little is known about historical abundances of the San Francisco garter snake. As mentioned above, the species was listed as endangered prior to any systematic range-wide survey effort or population studies, and extensive urbanization led to the extirpation of some populations prior to surveying efforts (Barry 1978, p. 6; Service 2020a, p. 26). However, at the time of the 2006 status review most populations were thought to be declining (Service 2006, pp. 5–11). The 2020 Species Status Assessment provides a summary of the historical and current abundance trends for all population complexes in Chapter 4 (Service 2020a, pp. 26–33). At the time of the 2020 Species Status Assessment and status review, the West-of-Bayshore population complex was the only population estimated to have greater than 200 individuals; four population complexes including Northern San Francisco Peninsula Watershed, La Honda, Pescadero, and Año Nuevo were estimated to have core populations of at least 50 individuals; the Pacifica population complex was estimated to have a core population of fewer than 50 individuals; six population complexes including Half Moon Bay, Southern San Francisco Peninsula Watershed, Woodside, San Gregorio, Pomponio, and Northern Santa Cruz County had unknown population sizes; and the Northern San Mateo County population complex was considered extirpated (Service 2020a, p. 77).

Following the 2020 Species Status Assessment and status review, surveys have occurred at five population complexes: Pacifica, West-of-Bayshore, La Honda, Pescadero, and Año Nuevo. Overall, the Pacifica and West-of-Bayshore population complexes have declined, the La Honda population complex has not experienced appreciable change, the Pescadero population complex is thought to be larger than previously understood with snakes found in previously unsurveyed areas, and within the Año Nuevo population complex snakes have been documented in increasing numbers in an area of newly restored habitat. Additionally, the Northern San Francisco Peninsula Watershed and Southern San Francisco Peninsula Watershed population complexes have records of random encounters with San Francisco garter snakes. In the following subsections, we provide a summary of the abundance data available at the time of the 2020 Species Status Assessment and status review and currently for the population complexes for which new data are available. Population complexes are roughly organized from north to south below. No new information is available for the five other presumed extant population complexes of Half Moon Bay, Woodside, San Gregorio, Pomponio, and Northern Santa Cruz County.

Pacifica

Within Pacifica, San Francisco garter snake population records exist for Laguna Salada and Mori Point. Laguna Salada is a managed waterbody within the Sharp Park Golf Course, owned by the City of San Francisco and managed by the San Francisco Recreation and Parks Department. San Francisco garter snakes were last observed at Laguna Salada in 1986 (Service 2020a, p. 27). Mori Point is a 32-hectare undeveloped coastal bluff that is part of the Golden Gate National Recreation Area (National Park Service). As summarized in the 2020 Species Status Assessment, a trapping effort using mark-recapture at Mori Point in 2018 resulted in a population estimate of 47 individuals (33–63 95% Highest Posterior Density Interval, a specific type of credible interval that identifies the narrowest range of plausible values within which there is a 95% probability that the true parameter value lies and equal) (Service 2020a, p. 27; Wood et al. 2020, p. 10). Subsequent surveys at Mori Point indicate the population is in decline. Annual visual encounter surveys from 2019–2024 had low detection rates and analysis of the annual daily mean observation rate of the San Francisco garter snakes over the 12-year survey period (2013–2024) at Mori Point shows a significant negative trend (Fong and Townsend 2025, p. 5). Trapping by the U.S. Geological Survey (Geological Survey) in 2019 and 2024 resulted in population estimates of 32 and 6 (5–11 95% credible interval, which is an equal-tailed interval within which there is a 95% probability that the true parameter value lies and the lower and upper limits of the internal are constructed by cutting off 2.5% of the probability from each tail of the posterior distribution), respectively (Fong and Townsend 2025, p. 5; B. Halstead, Geological Survey, pers comm. 2025a). Trapping results from 2024 indicated 95% certainty that there were fewer than 10 snakes in the sampled area at Mori Point. Even so, the sex ratio was fairly even at 0.87 male/female (0.31–2.46 95% credible interval). One of the three captured females was gravid, indicating that reproduction is still occurring.

West-of-Bayshore

The San Francisco International Airport manages an approximately 73-hectare site known as West-of-Bayshore that is home to one of the largest populations of San Francisco garter snakes (McGinnis 1987, p. 7; Swaim Biological, Incorporated 2018, p. 11; Service 2020a, p. 28). Much of the population at the West-of-Bayshore site consists of snakes intermediate in appearance between the San Francisco garter snake and other garter snake subspecies (Service 2020a, p. 29). However, results from genetic analyses are consistent with individuals from West-of-Bayshore

grouping with other San Francisco garter snake populations (Wood et al. 2020, p. 17). As described in the 2020 Species Status Assessment, mark-recapture trapping surveys are conducted at West-of-Bayshore on a semi-5-year monitoring cycle. Surveys in 2007, 2013, and 2017 resulted in population estimates of 1,520, 1,284, and 1,316 snakes, respectively (Swaim Biological, Incorporated 2018, pp. 1–2; Service 2020a, p. 28). In 2022, trapping at West-of-Bayshore resulted in a population estimate of 405 individuals (313–545 95% credible interval) (SFIA and ESA 2023, pp. 36–37). The observed sex ratio was approximately 1.8 male/female which is the highest observed sex ratio across all survey years (SFIA and ESA 2023, pp. 36–37; SFIA and ESA 2024, p. 45). Reduced numbers in 2022 may be attributed to the multi-consecutive year (2020–2022) drought that may have affected the distribution of aquatic forage habitat and the abundance of prey (Swaim 2022, p. 15). Moreover, San Francisco garter snake activity may peak earlier in warmer, drier years and trapping in 2022 may have missed the period of peak activity (SFIA and ESA 2023, p. 46). Also in 2022, snake fungal disease was detected in San Francisco garter snakes at the West-of-Bayshore property (see **Threats** for further discussion; SFIA and ESA 2023, p. 13; SFIA and ESA 2025, p. 5). The impact of the disease on the vitality of San Francisco garter snake individuals and populations is unknown.

In 2024, a camera trapping study was initiated at West-of-Bayshore as a less invasive method to monitor the San Francisco garter snake population on a more frequent basis (SFIA and ESA 2025, p. 5). The study aimed to (1) assess how effective camera trapping is at monitoring the activity of the San Francisco garter snake; (2) replicate the duration, fencing design, and study location of seven traplines used during live trapping studies to allow comparison to previous population studies; and (3) establish an index of San Francisco garter snake activity to help estimate population trends over time. Seven traplines consisting of wooden drift fences bookended with motion sensing camera traps were installed adjacent to marsh habitat in a layout that replicated seven of the traplines used in the 2007–2022 mark-recapture surveys (SFIA and ESA 2025, Appendix J, pp. 3–13). The camera traps were active from early April to mid-November (SFIA and ESA 2025, Appendix J, p. 21).

Overall, the camera traps were found to be effective at documenting the activity of the San Francisco garter snake and other snakes at the West-of-Bayshore property (SFIA and ESA 2025, Appendix J, p. 21). San Francisco garter snake activity peaked during the first and second weeks of May (SFIA and ESA 2025, Appendix J, p. 16). Active hours varied across seasons; in the spring and fall observations of San Francisco garter snake occurred between 8:00 am – 7:00 pm whereas in mid-summer most observations occurred in the morning (8:00 am – 12:00 pm) or late afternoon (3:00 – 7:00 pm) (SFIA and ESA 2025, Appendix J, p. 21). A 60-minute rule was used to define unique individuals recorded by the camera traps; observations of San Francisco garter snakes captured within 60 minutes of a prior observation were enumerated but were not counted as distinct (SFIA and ESA 2025, Appendix J, p. 21). Using the 60-minute rule, more unique San Francisco garter snake individuals were recorded at the seven active traplines in 2024 (290 snakes) than at all 87 active, live traplines in 2022 (189 snakes) (SFIA and ESA 2025, Appendix J, p. 24). At the seven comparable traplines across survey years, live-trapping in 2022 during the 62-day trapping period from April–June resulted in 81 captures of 55 unique individuals and over the same trapping period in 2024 camera trapping documented 290 unique individuals (SFIA and ESA 2025, Appendix J, Table 2). Furthermore, San Francisco garter snakes were observed on 24 out of 62 trap days (38.7% of days) in 2022 compared with 59 out of 62 trap days (95.2% of days) in 2024, suggesting that there was more San Francisco garter snake activity

at the West-of-Bayshore property in 2024. While the camera trapping data do not directly translate to population estimates for the West-of-Bayshore population complex, the increase in snake observations and number of days that snakes were active and observed in 2024 suggest that the San Francisco garter snake population may be rebounding following the prolonged drought that ended in December of 2022 (SFIA and ESA 2025, p. 6). Camera trapping is planned to continue at West-of-Bayshore in 2025.

Northern San Francisco Peninsula Watershed
As described in Chapter 4 of the 2020 Species Status Assessment, this population complex comprises San Francisco Public Utilities Commission lands north of Highway 92 (Service 2020a, p. 29). Trapping at Skyline Wetlands and at another lake in 2018 yielded population estimates of 48 (33–61 95% Highest Posterior Density Interval) and 50 individuals (35–64 95% Highest Posterior Density Interval) (Wood et al. 2020, p. 10). No monitoring of the species has occurred within the population complex since the 2018 trapping effort. However, 12 random encounters with San Francisco garter snakes, including one juvenile, and four mortalities have been documented in the area since 2020 (C. Rando, San Francisco Public Utilities Commission Water Enterprise, in litt. 2025; Rando and Dudek 2025, unpublished data).

Southern San Francisco Peninsula Watershed
As described in Chapter 4 of the 2020 Species Status Assessment, this population complex includes all habitat in the San Francisco Peninsula Watershed south of Highway 92 (Service 2020a, p. 30). At the time of the 2020 Species Status Assessment, the species had been observed within the complex during recent surveys, but no trapping surveys or population estimates were available for the population complex. Since 2020, four random encounters with adult San Francisco garter snakes have been documented within the population complex (C. Rando, San Francisco Public Utilities Commission Water Enterprise, in litt. 2025; Rando and Dudek 2025, unpublished data).

La Honda
The La Honda population complex encompasses ranches on two private properties that have censused San Francisco garter snake populations. One of the ranches has not been surveyed since 1988 (McGinnis 1988, pp. 16–19; Service 2020a, p. 30). The other ranch, Mindego Ranch, is a 424-hectare former cattle operation that is part of the Russian Ridge Open Space Preserve owned and managed by the Midpeninsula Regional Open Space District (MidPen). From 2014–2017, mark-recapture population estimates at Mindego Ranch indicated a stable population fluctuating from 97–195 individuals, with additional variation based on modeling methods (open versus closed models) (Kim et al. 2018, pp. 30–34, 76; Service 2020a, p. 31). Notably, Wood et al. (2020, p. 19) found the Mindego population to be isolated and to have a high inbreeding coefficient. In 2024, the Geological Survey carried out mark-recapture surveys at Mindego Ranch resulting in a population estimate of 92 individuals (63–158 95% credible interval) (B. Halstead pers comm. 2025a). Captured San Francisco garter snakes were well distributed across age classes and a slightly female-biased sex ratio of 0.47 males/female (0.14–1.93 95% credible interval) was found (B. Halstead pers comm. 2025a; Starr et al. 2025, p. 22). Also in 2024 at Mindego Ranch, San Francisco garter snake density was found to be highest near wetlands with density declining as distance from wetlands increases (B. Halstead pers comm. 2025a; Starr et al. 2025, p. 22).

In addition, MidPen continues to maintain and opportunistically monitor cover boards at the Russian Ridge and La Honda Creek Open Space Preserves; cover boards at Tunitas Creek Open Space Preserve were also maintained and monitored by MidPen through 2022 (Tokatlian et al. 2020, pp. 9–10; Starr et al. 2022, pp. 8–10; Starr et al. 2023, pp. 8–11; Starr et al. 2025, pp. 7–8). San Francisco garter snakes have not been detected at La Honda Creek or Tunitas Creek Open Space Preserves, and no individuals have been found under the coverboards at Mindego Ranch in recent years.

Pescadero

Several kilometers south of Pescadero, Cloverdale Coastal Ranch (Cloverdale Ranch) occupies 213 hectares of former pasture, including several wetlands and ponds as well as grasslands. Cloverdale Ranch changed ownership from the Peninsula Open Space Trust to MidPen in 2023. Trapping at Cloverdale Ranch in 2018 resulted in a population estimate of 73 individuals (61–88 95% Highest Posterior Density Interval) (Wood et al. 2020, p. 10). Continued trapping by the Geological Survey in 2022, 2023, and 2024 resulted in 114 captures of 73 individuals, 122 captures of 80 individuals, and 135 captures of 91 individuals, respectively (Halstead 2023, p. 6; Halstead 2024, pp. 4–6; B. Halstead pers comm. 2025a). In 2022, 28 gravid females were captured ranging in size from 507–778 millimeters (mm) snout-vent length (Halstead 2023, p. 6). A portable ultrasound device was used to count the embryos in the gravid females; embryo counts ranged from 7 to 27 (Halstead 2023, p. 6). In 2023, San Francisco garter snakes were detected at four previously unsurveyed water bodies at Cloverdale Ranch indicating that the species is utilizing additional habitat on the property and is more widely distributed across the property then previously understood (Halstead 2024, p. 6). The 2024 trapping resulted in a population estimate of 149 individuals (121–191 95% credible interval) (B. Halstead pers comm. 2025a). Also in 2024, trapping found a good distribution in size classes and an even sex ratio of 1.02 males/females (0.73–1.42 95% credible interval) (B. Halstead pers comm. 2025a). Halstead suggests that population estimates for Cloverdale Ranch likely underestimate abundance as the sampled area where trapping is conducted is small in comparison to the available habitat on the property (B. Halstead pers comm. 2025a). Overall, the population at Cloverdale Ranch is considered to be abundant with all age classes represented and large reproducing females that are fecund.

Año Nuevo

This complex includes Año Nuevo State Park and the private Cascade Ranch property. In 2018 the population abundance at Año Nuevo State Park using the trapping data for two sites (visitor center pond and BART mitigation site) combined was estimated to be 123 individuals (93–161 95% Highest Posterior Density Interval) (Wood et al. 2020, p. 10). In 2023, the Geological Survey completed funnel trapping surveillance at the Green Oaks Restoration Project site in Año Nuevo State Park (see **Conservation and research** for additional information on the Green Oaks Restoration Project; Halstead 2024, p. 5). Two San Francisco garter snakes were captured in funnel traps and two others were captured during visual encounter surveys and cover board monitoring around the site (Halstead 2024, p. 7). In 2024, six individuals were captured a total of eight times, and four additional snakes were known to occur on the site resulting in a population estimate of 20 individuals (9–47 95% credible interval) (B. Halstead pers comm. 2025a). Preliminary information from the 2025 survey effort indicates that a greater number of individuals were captured than in previous years, and the first between year recaptures occurred at the Green Oaks Restoration Project site indicating that the species is establishing and

surviving in the restored habitat. As trapping locations at Año Nuevo State Park changed in 2023 to focus on the Green Oaks Restoration Project, recent capture rates and population estimates are not directly comparable to those from 2018. However, the presence of multiple San Francisco garter snakes at newly constructed ponds in an area that previously did not provide suitable habitat for the species is encouraging.

Threats:
The 1967 listing rule for the San Francisco garter snake (Department of Interior 1967, entire) did not identify specific threats to the species. The 1985 recovery plan identified alteration and isolation of habitats resulting from urbanization as the primary reason for the decline of the San Francisco garter snake (Service 1985, p. 13). Habitat loss and the degradation of remaining habitat continued to be the primary threats to the San Francisco garter snake at the time of the 2006 status review (Service 2006, p. 15). Threats to San Francisco garter snake identified in the 2020 Species Status Assessment and status review include fragmentation and urbanization; changes to aquatic habitat, including saltwater intrusion, drought, and water management activities; seral succession; illegal collection; predation by non-native invasive bullfrogs and fish; disease, specifically the emergent threat of snake fungal disease; the effects of small population size; and climate change (Service 2020a, pp. 33–41; Service 2020b, p. 2). The 2020 Species Status Assessment provides an in-depth assessment of these threats and discusses how these threats may affect the species through 2100 (see Service 2020a, pp. 33–78). Since the 2020 Species Status Assessment and status review, snake fungal disease has been detected in San Francisco garter snakes at the West-of-Bayshore property (see further discussion of *Snake fungal disease* below) and there has been further research on the effects of bullfrogs on the species (see further discussion of *Competition with non-native invasive bullfrogs* below). The other identified threats continue to be present, and their effects on the species remain similar to as described in the 2020 Species Status Assessment and status review.

Snake fungal disease
As stated in the 2020 Species Status Assessment, snake fungal disease is a disease that was first detected in the state of California in 2019 (Service 2020a, p. 41). The disease is caused by a fungus, *Ophidiomyces ophiodiicola*, that lives in soil and can be transmitted to snakes through skin abrasions or through direct contact with other infected snakes. Cases may be mild to life-threatening, and visible signs may include scabs, skin ulcers or nodules, crusted scales, discolored scales, cloudy eyes and a swollen or disfigured face. The infection may cause the upper layer of infected skin to shed repeatedly. Affected snakes are often emaciated, possibly due to decreased ability to capture prey, and often rest in open, unprotected areas where they are exposed to adverse weather and predators.

Following the 2019 detections of the disease in a California kingsnake (*Lampropeltis californiae*) in Amador County and a non-native Florida water snake (*Nerodia fasciata pictiventris*) in Sacramento County, the Department received an award from the Service for a 5-year statewide disease surveillance effort (Department 2023, unpaginated). Between 2020–2024, skin swabs were collected from a total of 554 individual snakes, both free-ranging and in wildlife rehabilitation centers (Patterson et al. 2021, p. 2; Elander et al. 2022, p. 2; Elander et al. 2023, p. 2; Patterson and Clifford 2024, p. 2). As a result of this surveillance effort, snake fungal disease was detected in seven additional species within 10 counties in the Sacramento Valley, San Francisco Bay area, and San Diego area (Department 2023, unpaginated). In 2022, as part of the

Department's disease surveillance effort, skin swabs were collected from 14 snakes captured at the West-of-Bayshore property including seven San Francisco garter snakes (Elander et al. 2022, p. 9; Swaim 2022, p. 6; A. Park, San Francisco International Airport, in litt. 2025). Samples from two of the San Francisco garter snakes and three western yellow-bellied racers (*Coluber constrictor mormon*) from the West-of-Bayshore property were positive for snake fungal disease (Elander et al. 2023, p. 6; SFIA and ESA 2023, p. 47; A. Park, San Francisco International Airport, in litt. 2025). Additionally, one of the San Francisco garter snakes that tested positive for the disease was noted upon capture to have a swollen throat, which is a clinical sign of snake fungal disease (SFIA and ESA 2023, p. 47). San Francisco garter snakes and other more widespread snake species were also swabbed for disease testing at Mori Point and Cloverdale Ranch in 2022; all samples from these areas were negative for the disease (MidPen 2024, p. 82; B. Halstead pers comm. 2025b). Snake fungal disease may cause severe symptoms and mortality in snakes; however, the effect of the disease on the survival and reproduction of San Francisco garter snakes remains unknown.

Competition with non-native invasive bullfrogs

Kim et al. (2021, entire) investigated the diet and seasonal prey dynamics of San Francisco garter snake populations co-occurring with non-native, invasive American bullfrogs (*Lithobates catesbeianus*) to assess intraguild predation between these taxa. Analysis of fecal DNA and the contents of voluntary regurgitate from San Francisco garter snakes found that both juveniles and adults predominantly preyed on native anurans (Sierran tree frogs (*Hyliola* [=*Pseudacris*] *sierra*) and California red-legged frogs (*Rana draytonii*) rather than American bullfrogs, with this pattern peaking during the spring, which is a critical time for San Francisco garter snakes to forage after emerging from brumation (Kim et al. 2021, pp. 4–5). The stomach contents of adult American bullfrogs showed that they also foraged heavily on native anurans and similar to the snakes, bullfrogs consumed Sierran treefrogs to a greater extent earlier in the year, between March and May (Kim et al. 2021, p. 5). Only low occurrence of predation on San Francisco garter snake (<2% of the prey in bullfrog stomachs) by bullfrogs was found (Kim et al. 2021, p. 5). These diet patterns suggest that American bullfrogs negatively impact San Francisco garter snakes primarily through seasonal competitive interactions, namely competition for limited prey in the spring, rather than through direct predation (Kim et al. 2021, p. 7). Furthermore, Kim et al. (2021) found that removal of American bullfrogs at one site resulted in improved recruitment of both San Francisco garter snake and native anurans, further supporting the idea that eradication of American bullfrogs can enhance the viability of San Francisco garter snakes by alleviating predation pressures on their common amphibian prey (Kim et al. 2021, p. 10).

Conservation and research:

Conservation actions conducted since the 2020 Species Status Assessment and status review include growth and survival modeling, demographic modeling to compare reintroduction strategies, a reintroduction site suitability assessment, initiation of a pilot head-starting program, formation of a recovery working group, and habitat restoration.

Growth and survival modeling

Rose et al. (2022 pp. 4, 7) used long-term capture-mark-recapture data of the San Francisco garter snake to inform a growth-survival model for the species . The capture-mark-recapture data comprises a total of 1,090 captures across five study sites (Pacifica, Crystal Springs and Skyline, Mindego, Pescadero, and Año Nuevo), including 163 individuals that were captured and

measured multiple times and were used to inform a growth-survival model (Rose et al. 2022, p. 7). Most recaptured snakes (154 out of 163) were greater than 300 mm snout-vent length at first capture, so minimal data were available to estimate growth of neonates. Growth of females was found to plateau at a greater snout-vent length than males. Growth rates were similar between sexes until two years of age, after which growth rates diverged with growth of males plateauing at 4–5 years of age whereas females plateaued at 7–8 years of age. Overall, more variation in growth rates was found among sites than between years (Rose et al. 2022, p. 10).

Capture-mark-recapture data from two sites (Pescadero and Mindego) were used to estimate the annual apparent survival, capture probability, and recapture probability and relation to size (Rose et al. 2022, p. 5). Overall, snake size was found to affect annual survival and was positively related to recapture probability and availability on-site for capture (Rose et al. 2022, p. 11). Capture probability was found to be positively related to air temperature and negatively related to relative humidity and day of the year with lower capture probability if there was precipitation 24 hours prior to trap-checks (Rose et al. 2022, p. 8). Recapture probability was positively related to snake snout-vent length up to around 500 mm. Survival rates fluctuated from year to year. At Pescadero, mean annual survival was higher for females (0.660) than males (0.521) (Rose et al. 2022, p. 9); whereas at Mindego, the mean annual survival of females (0.523) was lower than males (0.677). There was uncertainty in annual survival for the smallest (< 300 mm snout-vent length) and largest snakes (> 700 mm snout-vent length) due to small sample sizes; however, there was a pattern of nearly equal survival rates for snakes between 300 and 550 mm snout-vent length, and a decrease in survival for female snakes as snout-vent length increased from 550 mm to 700 mm. Decreased survival of larger females may be attributed to aging or costs associated with reproduction (Rose et al. 2022, p. 9).

Demographic modeling of reintroduction strategies

Rose et al. (2023, entire) used simulations of demographic models to compare the effectiveness of various reintroduction strategies for the San Francisco garter snake. Growth, survival, and reproduction functions were incorporated into an integrated projection model to simulate the dynamics of reintroduced and donor populations over a 30-year period (Rose et al. 2023, pp. 4, 8). The four reintroduction strategies considered were: 1) release of neonates shortly after birth; 2) release of head-started juvenile snakes reared in captivity and released at one year of age; 3) translocation of adults directly from donor population to reintroduced population; and 4) release of a mix of different age classes including neonates, juveniles, and adults (Rose et al. 2023, p. 8). Each reintroduction strategy was modeled with snake releases occurring annually for different periods of time including 1, 5, 10, 15, and 20 years of the 30-year period. Furthermore, all reintroduction strategies were simulated using 3, 5, or 10 adult females to produce the release cohorts, and uncertainty in neonate survival was captured by modeling all reintroduction strategies with four different neonate survival rates (0.10, 0.20, 0.30, and 0.40). In total, 240 simulated reintroduction scenarios were modeled. Releasing head-started juveniles over 15 years was found to be the most viable reintroduction strategy that also minimized potential impacts to donor populations due to the lower number of adult females that are required to be removed from donor populations (Rose et al. 2023, p. 13).

La Honda Creek reintroduction suitability assessment

Rose et al. (2025, entire) assessed the suitability of La Honda Creek Open Space Preserve (La Honda Creek), a 2,515-hectare preserve in San Mateo County managed by MidPen, as a

potential reintroduction site for the San Francisco garter snake based on historical presence, climate, habitat, and prey availability. They found that the San Francisco garter snake likely occurred historically within La Honda Creek and may have been extirpated due incompatible land use (Rose et al. 2025, p. 8). Natural recolonization of La Honda Creek is considered unlikely due to barriers to dispersal between the closest populations at Cloverdale Ranch and Russian Ridge (Mindego Ranch) Open Space Preserves (Rose et al. 2025, pp. 16, 20). Climatic conditions at La Honda Creek were found to be favorable for San Francisco garter snake, closely matching those of nearby extant populations; however, climate change could affect the suitability of the site through increased frequency of drought, wildfire, and extreme precipitation events. The presence of over 25 wetlands, many improved for native amphibian habitats and supporting breeding populations of native prey, indicate there is adequate aquatic habitat to support San Francisco garter snakes (Rose et al. 2025, pp. 8, 9). However, many of the wetlands lack emergent wetland vegetation and adjacent riparian woodland and coastal scrub that is needed to provide connectivity between foraging and upland habitats for the San Francisco garter snake (Rose et al. 2025, pp. 9, 15). Sufficient burrows and other upland refuges are also thought to be present at La Honda Creek (Rose et al. 2025, p. 8). Overall, habitat at La Honda Creek was determined to be suitable for reintroduction of San Francisco garter snakes, but exclusion of cattle from the vicinity of wetlands at which snakes are reintroduced would allow for the growth of emergent wetland vegetation and adjacent scrub and would benefit the San Francisco garter snake (Rose et al. 2025, p. 21). Additionally, Rose et al. (2025, p. 6) modeled the probability of extirpation resulting from different reintroduction strategies that involved annual releases of 36 head-started juveniles of each sex within 1–6 subpopulations (or individual wetlands) at La Honda Creek for 5, 10, 15, and 20 years. The probability of extirpation was minimized when reintroductions occurred within a single subpopulation and continued annually for a greater number of years (Rose et al. 2025, p. 16).

Population enhancement

In 2024, a Population Enhancement Plan for Mori Point/Sharp Park and Mindego Ranch (Enhancement Plan; Anderson et al. 2024, entire) was drafted by MidPen, Golden Gate National Recreation Area, Geological Survey, and San Francisco Zoo. The population enhancement plan was informed by the studies described above including growth and survival modeling (Rose et al. 2022, entire), modeling of reintroduction strategies (Rose et al. 2023, entire), reintroduction site suitability (Rose et al. 2025, entire), and post-release monitoring of head-started giant garter snakes (Nguyen et al. 2023, entire). The Plan includes five long-term goals: 1) Increase the population size and genetic diversity of the Mori Point/Sharp Park population; 2) Increase the genetic diversity of the Mindego Ranch population; 3) Increase the genetic diversity of the Año Nuevo and Cloverdale Ranch populations; 4) Establish a new population at La Honda Creek; and 5) Include other populations and partners as feasible (Anderson et al. 2024, p. 4). The first phase of the Enhancement Plan involves collection of gravid females from Cloverdale Ranch, captive-rearing of offspring from these females at the San Francisco Zoo, and release of captive-reared juveniles to Mori Point and Mindego Ranch (Anderson et al. 2024, pp. 6–7). At the time of development of the Enhancement Plan, both the Golden Gate National Recreation Area and MidPen had secured funding to support two years of collections and releases to Mori Point and Mindego Ranch (Anderson et al. 2024, p. 6).

In May 2025, 11 gravid females were captured at Cloverdale Ranch and transported to the San Francisco Zoo (B. Halstead, Geological Survey, and R. Stiles, San Francisco Zoo, pers comm.

2025). Following parturition, or birth, the gravid females will be returned to their collection locations at Cloverdale Ranch to minimize impacts to the donor population (Anderson et al. 2024, p. 7). Each gravid female is expected to have 12–15 offspring which will be reared in captivity for approximately a year until they reach 300 mm snout-vent length. Two thirds of the one-year-old juveniles will then be released to Mori Point and Mindego Ranch, and the remaining third of the one-year-old juveniles will also be released back to the Cloverdale Ranch to further minimize impacts to the donor population. The Geological Survey plans to carry out post-release population monitoring using the same methods as the baseline population monitoring to estimate abundance and survival rates of released snakes each year following augmentation (Anderson et al. 2024, p. 9). The Geological Survey will also complete genetic monitoring at the donor and recipient populations and genotyping of all snakes used in the head-starting program (Anderson et al. 2024, pp. 9–10).

Recovery working group

A recovery working group for the San Francisco garter snake convened in May 2024 and continues to meet twice annually. The San Mateo Resource Conservation District has organized the working group meetings which have included, among other participants, MidPen, Peninsula Open Space Trust, San Francisco Zoo, Stanford University, San Francisco Public Utilities Commission, San Francisco Recreation and Parks Department, California State Parks, Department, Geological Survey, Golden Gate National Recreation Area (National Park Service), and the Service. The recovery working group strives to collaboratively identify and advance actions necessary for the recovery of San Francisco garter snake across the species' range.

Land management

In June of 2023, MidPen purchased 2,064 hectares of Cloverdale Ranch from the Peninsula Open Space Trust (Trust), creating the Cloverdale Ranch Open Space Preserve. MidPen also entered into a management agreement with the Trust for the remaining 405 hectares of Cloverdale Ranch. In January of 2024, MidPen completed the San Francisco Garter snake Habitat Management Plan for the Cloverdale Ranch Open Space Preserve (Management Plan; MidPen 2024, entire). The primary purpose of the Management Plan is to contribute to the recovery of special status species at Cloverdale through protecting and improving habitat for both California red-legged frogs and San Francisco garter snakes (MidPen 2024, p. 6). Preventing the expansion of bullfrogs, limiting population sizes of other invasive species, and maintaining open water and emergent vegetation are identified as needs to further improve habitat conditions for San Francisco garter snakes at Cloverdale Ranch. The Management Plan identifies specific actions to be carried out over the 5-year term of the plan to address these needs (MidPen 2024, pp. 105–106). The Management Plan also outlines minimization and avoidance measures to protect aquatic features and adjacent uplands and implementation of decontamination protocols to prevent the spread of snake fungal disease. Additionally, the Management Plan identifies goals for monitoring the San Francisco garter snake including continuation of annual mark-recapture surveys, addition of funnel trap arrays in unsurveyed areas, addition of camera trap arrays to monitor snake activity throughout the year, and monitoring the response of populations to management actions to inform adaptive management (MidPen 2024, pp. 100–103).

Habitat restoration

Habitat restoration and conservation activities in areas occupied by the San Francisco garter snake include creation and restoration of aquatic and upland habitat for the species and their

prey. Within the Pacifica population complex, non-native plant control has been carried out in upland areas at Mori Point by the National Park Service and in both aquatic and upland areas at Sharp Park by the San Francisco Recreation and Parks Department (Potter 2025, pp. 5–6, 8; Anderson et al. 2024, p. 3). At Mori Point, over 3,000 invasive signal crayfish (*Pacifastacus leniusculus*) were removed from a California red-legged frog breeding pond in 2024 (D. Fong, National Park Service, Golden Gate National Recreation Area, pers comm. 2025). Also in 2024 at Mori Point, asphalt and concrete slabs were removed from around a created pond and partially buried onsite to provide hibernaculum; wildlife cameras have been installed to capture observations of use of the hibernaculum by San Francisco garter snakes or other wildlife (D. Fong pers comm. 2025).

At the West-of-Bayshore population complex, habitat improvement actions completed since 2020 include removal of non-native upland vegetation and removal of overgrown aquatic vegetation and accumulated sediment to enhance open-water foraging habitat for the San Francisco garter snake and breeding habitat for the California red-legged frog (SFIA and ESA 2025, p. 8). At Mindego Ranch within the La Honda Population Complex, restoration work involving enhancement of 4 hectares of pond, wetland, and upland habitat for the San Francisco garter snake and California red-legged frog was carried out in 2020 as mitigation for the Cordilleras Health System Replacement Project (Service 2023, pp. 17–21; Tokatlian et al. 2021, p. 18). Two ponds, Knuedler Lake and Upper Springs, were excavated to remove accumulated sediment and vegetation to increase the hydro-period of the ponds and ultimately increase the amount of open-water habitat available to both San Francisco garter snakes and California red-legged frog, especially in late fall (Tokatlian et al. 2021, p. 18). Following pond restoration, California red-legged frog egg masses were observed at Knuedler Lake in 2022, 2023, and 2024 (Starr et al. 2023, p. 18). California red-legged frog eggs and metamorphs were detected at Upper Springs in 2021 and 2022 but by 2024 Upper Springs had become overly vegetated again which may be inhibiting California red-legged frog breeding activity (Starr et al. 2025, p. 17). Even so, one young San Francisco garter snake was observed adjacent to the enhanced area at Upper Springs in March 2024.

At Cloverdale Ranch within the Pescadero population complex, the Butano Farms San Francisco Garter snake Habitat Enhancement Project was completed in 2021 (San Mateo Resource Conservation District 2024, p. 1). The project provided mitigation for biological impacts associated with Pacific Gas & Electric Company (PG&E) Line 101 Inline Inspection and Upgrade, and Lomita Park Station Rebuild Project in the City of Millbrae, San Mateo County. The project focused on enhancing a 0.4-hectare pond and surrounding vegetation to improve aquatic and upland habitat for San Francisco garter snakes and California red-legged frogs. Surveys in 2024 found the pond is holding water throughout the year and contains suitable California red-legged frog breeding habitat (San Mateo Resource Conservation District 2024, p. 13). However, the American bullfrog population grew at the site following the wet winters of 2022–2023 and 2023–2024; bullfrog control is ongoing at the site (San Mateo Resource Conservation District 2024, p. 13).

At Año Nuevo State Park, restoration projects in the Quiroste Valley and Green Oaks Property have improved habitat for the San Francisco garter snake. Grasslands in the Quiroste Valley have undergone extensive habitat succession due to encroachment of closed-canopy, woody vegetation, primarily Douglas fir forest and coastal scrub (Halbert 2025, p. 1). A multi-year

restoration project was initiated in 2018 to reduce woody vegetation and limit shrub cover to 25–33% across the 47-hectare project area. Upon completion, the project will restore the shrub-grassland matrix, which is the preferred terrestrial habitat of the San Francisco garter snake, to the Quiroste Valley (Halbert 2025, p. 1; Service 2020a, p. 16). In 2022, Año Nuevo State Park initiated the Green Oaks Restoration Project to protect and enhance habitat for the San Francisco garter snake, California red-legged frog, and Pacific tree frog on the 95-hectare Green Oaks Property (formerly known as the BART Mitigation Property; Halbert 2025, pp. 17–26). The Green Oaks Property has a long history of farming and, when acquired by State Parks, contained significant agricultural infrastructure constructed to rapidly transport water off the site. The overarching goals of the restoration project were to restore natural surface and subsurface hydrologic processes to support a mosaic of coastal wetland and prairie habitats (Halbert 2025, p. 19). While the project focused on restoring hydrologic processes, it was specifically designed to enhance aquatic habitat for the San Francisco garter snake and their prey. The bulk of the construction work was completed in 2022 with adaptive management completed in 2023. Post-restoration monitoring by the Geological Survey has found increasing numbers of San Francisco garter snakes at the Green Oaks Restoration Project site (see *Año Nuevo* subsection in **Abundance**; B. Halstead pers comm. 2025a).

Habitat Conservation Plans

Currently, there are three Habitat Conservation Plans that include the San Francisco garter snake as a covered species: PG&E Bay Area Operations and Maintenance Habitat Conservation Plan (ICF International, Inc. 2017, entire), San Bruno Habitat Conservation Plan under its fifth amendment (TRA Environmental Sciences, Inc. 2008, entire), and Stanford University Habitat Conservation Plan (Service 2013, entire). Since the 2020 Species Status Assessment and status review, 0.63 acre of San Francisco garter snake core habitat and 0.53 acre of dispersal habitat have been temporarily disturbed by activities covered under the PG&E Bay Area Habitat Conservation Plan (PG&E 2025, Table 3-3a). As of 2024, a total of 2.45 acres of San Francisco garter snake core habitat and 1.78 acres of dispersal habitat have been temporarily disturbed and 0.06 acre of dispersal habitat has been permanently lost under the PG&E Habitat Conservation Plan (PG&E 2025, Table 3-3a). PG&E is well ahead of the amount of mitigation that must be acquired for the San Francisco garter snake with the preservation/restoration of 57.75 acres of habitat through 2024 (PG&E 2025, Table 3-4a).

Recovery criteria:

The recovery plan for the San Francisco garter snake describes downlisting and delisting criteria for the species (Service 1985, pp. 18–20). The criteria focus on the protection of six populations identified as critical to the long-term survival of the species and the establishment and protection of four additional populations. The six significant populations and the entities managing the land where those populations occur include: the West-of-Bayshore property at San Francisco International Airport (City and County of San Francisco), San Francisco State Fish and Game Refuge property (San Francisco Public Utilities Commission), Laguna Salada (City and County of San Francisco), Pescadero Marsh and Año Nuevo State Reserve properties (California State Parks), and the Cascade Ranch property (private landowner). Specifically, the downlisting criteria call for 200 or more San Francisco garter snakes maintained at a 1:1 sex ratio at each of the six significant populations for five consecutive years. The delisting criteria call for maintaining these abundance numbers and sex ratios at the six significant populations and at four additional populations at undefined sites for at least 15 years.

Progress towards the recovery criteria remain as described in the 2020 Species Status Assessment and status review (Service 2020a, p. 23; Service 2020b, p. 2). There is currently only one population, West-of-Bayshore, with over 200 individuals and populations with the smallest abundance estimates may have shifted sex ratios. Thus, the downlisting and delisting criteria for the San Francisco garter snake are not met.

Conclusion:
After reviewing the best available scientific information, we conclude that the San Francisco garter snake remains an endangered species. The evaluation of threats affecting the species under the factors in 4(a)(1) of the Endangered Species Act and analyses of the status of the species in the 2020 Species Status Assessment (Service 2020a, entire) and 2020 5-year status review (Service 2020b, entire) remain an accurate reflection of the species' current status.

RECOMMENDATIONS FOR FUTURE ACTIONS

Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the San Francisco garter snake. Some of these recommendations have already been discussed in previous recovery documents (Service 2020b, pp. 3–4) and remain valid.

- *Continue demographic and genetic monitoring of the species*: Continue trapping surveys for populations with estimated abundance and genetic diversity to assist with assessing status and trends for the species. Additionally, the effectiveness of camera trapping and other noninvasive survey techniques that reduce the risk of transmission of snake fungal disease should be investigated.

- *Continue disease surveillance for snake fungal disease:* Monitor the spread and prevalence of snake fungal disease throughout the range of the San Francisco garter snake. Investigate the impact of the disease on individuals and populations.

- *Prioritize biosecurity during field activities to reduce transmission of snake fungal disease*: Handling should be minimized and, when snakes are handled, hands should be disinfected using an alcohol-based hand sanitizer between individuals, or disposable nitrile gloves should be used and changed between animals. Mud and debris should be removed from footwear and field gear, and snake processing tools that come into contact with snakes or their environment should be disinfected between snakes or sites. The Department recommends disinfecting field gear using a 10 percent bleach solution with a minimum exposure time of five minutes to effectively kill the fungus (Department 2023, unpaginated).

- *Encourage conservation among private landowners*: Conservation by private landowners should be encouraged. In addition to including public entities in conservation and recovery efforts, participation by private landowners from both agricultural and urban settings is needed to recover the San Francisco garter snake. This is especially important in locations where substantial quantities of suitable habitat persist. In order to accomplish this, ongoing efforts to conduct outreach meetings to educate the public as to the needs of the species should be fully supported by the Service and its partners. The Service and

partners can explore the possibility of working with private and non-federal property owners to develop Conservation Benefit Agreements (CBAs), voluntary agreements which contribute to the recovery of species listed as endangered or threatened under the Endangered Species Act.

- *Conduct habitat assessments and surveys for population complexes with unknown conditions or in suitable habitat without known populations*: Recent trapping surveys of San Francisco garter snake populations have focused on known populations with high quality habitat, many (but not all) of them on public lands. Habitat assessments and trapping surveys in the central part of the species range where conditions are largely unknown is necessary to evaluate the current and future condition of the species in those areas. Surveys on private lands, with landowner support, can help encourage private landowners to participate in conservation and recovery efforts.

- *Continue head-starting efforts informed by recent research and adaptive management*: Complete a genetic management plan for translocations and introductions/reintroductions, and conduct restoration for donor and recipient populations as appropriate. Investigate the efficacy of gradual acclimation strategies, such as "soft releases" that temporarily confine snakes in suitable enclosures prior to full release, to improve survival rates. Careful consideration should be given to the impact of adult removals on existing populations used as donors for reintroduction, ensuring their long-term viability is not compromised. These efforts should be monitored, their effectiveness assessed , and then managed adaptively.

- *Focus on habitat restoration to restore connectivity within and between populations*: Reinstating connectivity can increase genetic diversity and enhance representation for the species.

Acting Field Supervisor, Sacramento Fish and Wildlife Office

Approve AMBER AGUILERA Digitally signed by AMBER AGUILERA Date: 2025.08.08 10:06:33 -07'00' **Date** _____

Literature Cited

Anderson, J., D. Fong, B. Halstead, J. Rose, R. Stiles, D. Wood. 2024. Draft San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia)* Population Enhancement Plan for Mori Point/Sharp Park and Mindego Ranch, San Mateo County-Phase I. Dated July 2024. 11 pp.

Barry, S. J. 1978. Status of the San Francisco garter snake. California Department of Fish and Game, Inland Fisheries Endangered Species Program, Special Publication 78-2. October 1978. 21 pp.

Barry, S. J. 1996. The San Francisco Garter Snake and the San Francisco Watershed. Unpublished technical report of 5 year study. 145 pp.

Barry, S. 1994. The Distribution, Habitat, and Evolution of the San Francisco Garter Snake, *Thamnophis sirtalis tetrataenia*. Master's thesis, University of California, Davis. 140 pp.

Cover, J.F., Jr., and D.M. Boyer. 1988. Captive reproduction of the San Francisco garter snake *Thamnophis sirtalis tetrataenia*. Herpetological review 19: 29–33.

[Department] California Department of Fish and Wildlife. 2023. CDFW Research Confirms New Detections of Snake Fungal Disease. Available online at https://wildlife.ca.gov/News/Archive/new-detections-of-snake-fungal-disease#:~:text=Since%202008%2C%20SFD%20has%20been,without%20showing%20signs%20of%20infection. Accessed March 20, 2025.

Department of the Interior. 1967. Native Fish and Wildlife; Endangered Species. Federal Register 32: 4001.

[Diversity Database] California Natural Diversity Database. 2025a. Rare Find 5 [Version 5.3.0] [Internet]. Occurrence Report for *Thamnophis sirtalis tetrataenia* (Accessed January 3, 2025). California Department of Fish and Wildlife, Sacramento, California. 69 pp.

[Diversity Database] California Natural Diversity Database. 2025b. California Natural Diversity Database unprocessed data for *Thamnophis sirtalis tetrataenia* submitted via online field survey forms [geospatial data]. California Department of Fish and Wildlife, Sacramento, California. Data provided on January 3, 2025.

Elander, R., L. Patterson, and D. Clifford. 2022. Annual Performance Report: Detection of *Ophidiomyces Ophidiicola* and Snake Fungal Disease in California. California Department of Fish and Wildlife. 14 pp.

Elander, R., L. Patterson, and D. Clifford. 2023. Annual Performance Report: Detection of *Ophidiomyces Ophidiicola* and Snake Fungal Disease in California. California Department of Fish and Wildlife. 16 pp.

Fitch, H.S. 1980. *Thamnophis sirtalis*. Catalogue of American Amphibians and Reptiles. 270 pp.

Fong, D., and R. Townsend. 2025. San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*) Visual Encounter and Coverboard Surveys at Golden Gate National Recreation Area, CY2024: Permit #TE-036499-9. Report prepared for Sacramento Fish and Wildlife Office, U.S. Fish and Wildlife Service, Sacramento, California and Natural Resources Management and Science Division, Golden Gate National Recreation Area, San Francisco, California. 18 pp.

Fox, W. 1951. The status of the gartersnake, *Thamnophis sirtalis tetrataenia*. Copeia 1951: 257−267.

Halbert, P. 2024. Annual Reports for San Francisco Garter Snake; Santa Cruz and San Mateo Counties; California State Parks; 2019–2023; Portia Halbert 161496. 30 pp.

ICF International, Inc. 2017. Bay Area Habitat Conservation Plan operations & maintenance. Final plan prepared for Pacific Gas & Electric Company, Environmental Policy. September 2017. 548 pp.

Kim, R., B. J. Halstead, G. D. Wylie, and M. L. Casazza. 2018, Distribution and demography of San Francisco gartersnakes (Thamnophis sirtalis tetrataenia) at Mindego Ranch, Russian Ridge Open Space Preserve, San Mateo County, California: U.S. Geological Survey Open-File Report 2018-1063. 80 pp.

McGinnis, S.M. 1987. The distribution and feeding habitat requirements of the San Francisco garter snake (*Thamnophis sirtalis tetrataenia*). Final report prepared for the California Department of Fish and Game Interagency Agreements C-673 and C-1376. 39 pp.

McGinnis, S.M., P. Keel, and E. Burko. 1987. The use of upland habitats by snake species at Ano Nuevo State Reserve. Report to California Department of Fish and Game. December 30, 1987. 13 pp.

McGinnis, S. 1988. Life history of the San Francisco garter snake (*Thamnophis sirtalis tetrataenia*). Final Report for the California Department of Fish and Game Interagency Agreement-2045 (FY 87–88). 47 pp.

[MidPen] Midpeninsula Regional Open Space District. 2024. San Francisco Gartersnake (*Thamnophis sirtalis tetrataenia*) Habitat Management Plan, Cloverdale Ranch, San Mateo County, California. 116 pp.

Nguyen, A.M., B.D. Todd, and B.J. Halstead. 2023. Survival and establishment of captive-reared and translocated giant gartersnakes after release. Journal of Wildlife Management 87:e22374. https://doi.org/10.1002/jwmg.22374. 17 pp.

Patterson, L., and D. Clifford. 2024. Annual Performance Report: Detection of *Ophidiomyces Ophidiicola* and Snake Fungal Disease in California. California Department of Fish and Wildlife. 8 pp.

Patterson, L., D. Clifford, and R. Elander. 2021. Annual Performance Report: Detection of *Ophidiomyces Ophidiicola* and Snake Fungal Disease in California. California Department of Fish and Wildlife. 5 pp.

Pacific Gas & Electric (PG&E). 2025. Pacific Gas and Electric Company, Bay Area Operation and Maintenance Habitat Conservation Plan 2024 Annual Report. March 2025. 31 pp.

Potter, S. 2025. 2024 San Francisco Recreation and Park Department Annual Report for USFWS Recovery Permit TE-54728-2. Unpublished report to the U.S. Fish and Wildlife Service, Sacramento, California. 66 pp.

Rose, J.P., R. Kim, E.J. Schoenig, P.C. Lien, and B.J. Halstead. 2022. Integrating growth and survival models for flexible estimation of size-dependent survival in a cryptic, endangered snake. Ecology and Evolution 12:e8799.

Rose, J.P., R. Kim, E.J. Schoenig, P.C. Lien, and B.J. Halstead. 2023. Comparing reintroduction strategies for the endangered San Francisco gartersnake (*Thamnophis sirtalis tetrataenia*) using demographic models. PLoS ONE 18(10): e0292379. https://doi.org/10.1371/journal.pone.0292379.

Rose, J.P., E.J. Schoenig, R. Kim, A.M. Nguyen, and B.J. Halstead. 2025. Assessing the feasibility of reintroducing San Francisco gartersnakes (*Thamnophis sirtalis tetrataenia*) to La Honda Creek Open Space Preserve, San Mateo County, California: U.S. Geological Survey Open-File Report 2024–1073. https://doi.org/ 10.3133/ ofr20241073. 25 pp.

San Mateo Resource Conservation District. 2024. 2024 Post Implementation Annual Monitoring Report for the Butano Farms San Francisco Garter Snake Habitat Enhancement Project San Mateo County, California. Report prepared for: Pacific Gas and Electric Company. Report prepared by: San Mateo Resource Conservation District, 80 Stone Pine Road, Suite 100, Half Moon Bay, CA 94019. 24 pp.

[Service] U.S. Fish and Wildlife Service. 1985. Recovery Plan for the San Francisco Gartersnake *Thamnophis sirtalis tetrataenia*. U. S. Fish and Wildlife Service, Endangered Species Program, Portland, Oregon. 77 pp.

[Service] U.S. Fish and Wildlife Service. 2006. San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento, California. 42 pp.

[Service] U.S. Fish and Wildlife Service. 2013. Stanford University Habitat Conservation Plan. Revised March 2013. 152 pp.

[Service] U.S. Fish and Wildlife Service. 2020a. Species Status Assessment for the San Francisco gartersnake (*Thamnophis sirtalis tetrataenia*), Version 1.0. May 2020. Sacramento, California. 95 pp.

[Service] U.S. Fish and Wildlife Service. 2020b. San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento, California. 5 pp.

[Service] U.S. Fish and Wildlife Service. 2023. Biological Opinion on the Reinitiation of Formal Consultation on the Cordilleras Health System Replacement Project in San Mateo County, California (U.S. Army Corps of Engineers (Corps) file number 2016-00140S). Dated August 23, 2023. U.S. Fish and Wildlife Service file number 2023-0003337. Sacramento Fish and Wildlife Office, Sacramento, California. 36 pp.

[Service] U.S. Fish and Wildlife Service. 2024. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews for 59 Pacific Southwest Species. Federal Register 89: 83510–83514.

[SFIA and ESA] San Francisco International Airport and Environmental Science Associates. 2023. San Francisco Garter Snake Monitoring Report; 2007–2022 Mark-Recapture Survey Results. 2019–2029 San Francisco Garter Snake Recovery Action Plan; West of Bayshore Property, San Francisco International Airport, San Francisco California; U.S. Fish and Wildlife Service Recovery Permit No. TE-176209-3 and California Department of Fish and Wildlife Agreement 1600-2020-0216-R3. Data Collection by: Swaim Biological, Inc and LSA Associates. 56 pp.

[SFIA and ESA] San Francisco International Airport and Environmental Science Associates. 2024. Recovery Action Plan for the San Francisco Garter Snake: Annual Report 2023. West of Bayshore Property, San Francisco International Airport, San Francisco California; U.S. Fish and Wildlife Service Recovery Permit No. TE-176209-3 and Biological Opinion 2023-0015982-S7-001. 50 pp.

[SFIA and ESA] San Francisco International Airport and Environmental Science Associates. 2025. Recovery Action Plan for the San Francisco Garter Snake: Annual Report 2024. West of Bayshore Property, San Francisco International Airport, San Francisco California; U.S. Fish and Wildlife Service Recovery Permit No. TE-176209-3 and Biological Opinion 2023-0015982-S7-001. 36 pp.

[SFIA and LSA] San Francisco International Airport and LSA. 2021. Recovery Action Plan for the San Francisco Garter Snake: 2020 Annual Progress Report. West-of-Bayshore Property, San Francisco International Airport, San Francisco California; U.S. Fish and Wildlife Service Recovery Permit No. TE-176209-3 and California Department of Fish and Wildlife Agreement 1600-2014-0161-R3. 30 pp.

[SFIA and LSA] San Francisco International Airport and LSA. 2022. Recovery Action Plan for the San Francisco Garter Snake: 2021 Annual Progress Report. West-of-Bayshore Property, San Francisco International Airport, San Francisco California; U.S. Fish and Wildlife Service Recovery Permit No. TE-176209-3 and California Department of Fish and Wildlife Agreement 1600-2014-0161-R3. 26 pp.

Starr, A., K. Tokatlian, M. Sharp-Chaney, K. Kammerer, and S. Reinhart. 2025. 2024 Biological monitoring report: California red-legged frog (*Rana draytonii*) and San Francisco garter

snake (*Thamnophis sirtalis tetrataenia*) in La Honda Creek, Russian Ridge, and Cloverdale Ranch Open Space Preserves. Midpeninsula Regional Open Space District. 29 pp.

Starr, A., M. Sharp-Chaney, K. Tokatlian, and J. Andersen. 2022. 2021 Biological monitoring report: California red-legged frog (*Rana draytonii*) and San Francisco garter snake (*Thamnophis sirtalis tetrataenia*): Russian Ridge, Tunitas Creek, and La Honda Creek Open Space Preserves. Midpeninsula Regional Open Space District. 26 pp.

Stebbins, R.C. 1985. A field guide to western reptiles and amphibians. Houghton Mifflin Company, Boston, Massachusetts and New York, New York. 335 pp.

Swaim Biological, Incorporated. 2018. San Francisco garter snake monitoring report 2007-2017 mark-recapture survey results. Unpublished report prepared for San Francisco International Airport Bureau of Planning and Environmental Affairs. 67 pp.

Swaim, K.E. 2022. Results of 2022 Surveys for the San Francisco Gartersnake (*Thamnophis sirtalis tetrataenia*) at the San Francisco International Airport West of Bayshore Study Area – 4th RAP Population Survey. "45 Day" Interim Trapping Survey Report for Recovery Permit TW 815537. Report prepared for and submitted to the Service on December 7, 2022. 22 pp.

TRA Environmental Sciences, Inc. 2008. San Bruno Mountain Habitat Management Plan 2007. Prepared for the County of San Mateo Parks Department, Redwood City, California. Available at: https://www.smcgov.org/parks/san-bruno-mountain-habitat-management-approach-projects-documents. 178 pp.

Tokatlian, K., M. Sharp-Chaney, E. Wolff, and J.K. Andersen. 2020. 2019 Biological monitoring report: California red-legged frog (*Rana draytonii*) and San Francisco garter snake (*Thamnophis sirtalis tetrataenia*): Mindego Ranch, Toto Ranch, and La Honda Creek Open Space Preserve. Midpeninsula Regional Open Space District. 24 pp.

Tokatlian, K., M. Sharp-Chaney, A. Starr, and J.K. Andersen. 2021. 2020 Biological monitoring report: California red-legged frog (*Rana draytonii*) and San Francisco garter snake (*Thamnophis sirtalis tetrataenia*): Mindego Ranch, Toto Ranch, and La Honda Creek Open Space Preserve. Midpeninsula Regional Open Space District. 27 pp.

***In litteris* references**

Acord, Brian. 2019. California Natural Diversity Database. California Department of Fish and Wildlife. E-mail to Karen Swaim, Swaim Biological, dated October 28, 2019. Subject: RE: RE CNDDB "SFGS" Occurrence #35 Fwd: Fwd: SFGS pic (not).

Chang, Annie. 2024. California Natural Diversity Database. California Department of Fish and Wildlife. E-mail to Kate Bocskor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated December 20, 2024. Subject: RE: San Francisco gartersnake 5-year review and unprocessed records.

Park, Audrey. 2025. Bureau of Planning & Environmental Affairs, San Francisco International Airport. E-mail to Kate Bocskor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated April 28, 2025. Subject: RE: SFGS 5-year review.

Swaim, Karen. 2007. Swaim Biological. E-mail to Sean Barry, University of California, Davis, dated May 1, 2007. Subject: Re: SFGS pic.

Personal communications

Fong, Darren. 2025. Personal communication from the National Park Service, Golden Gate National Recreation Area during the May 13, 2023, San Francisco gartersnake Working Group Meeting.

Halstead, Brian. 2025a. Personal communication from U.S. Geological Survey during the May 13, 2025, San Francisco Gartersnake Working Group Meeting.

Halstead, Brian. 2025b. Personal communication from U.S. Geological Survey during the May 21, 2025, USGS-USFWS quarterly coordination meeting.

Halstead, Brian, and Rochelle Stiles. 2025. Personal communication from Brian Halstead of the U.S. Geological Survey and Rochelle Stiles of the San Francisco Zoo during the May 21, 2025, Check-in with USGS re: San Francisco gartersnake head-start meeting.