Giant Garter Snake

(Thamnophis gigas)

Legal Status
Federal: Threatened.
State: Threatened.

Global and State Conservation Status: G2G3S2S3: Global Rank, G2G3 somewhere between a G2 = Imperiled: At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors, and a G3 = Vulnerable: At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors ; State Rank, S2S3 = Same as global ranks but referring only to the range of taxa within California.

Recovery Plan: Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*) (1999). A final Recovery Plan is anticipated in 2009.

Species Description and Life History

The giant garter snake (*Thamnophis gigas*) is an aquatic snake endemic to the Central Valley of California. Described as among California's most aquatic garter snakes (Fitch 1940), giant garter snakes are associated with low-gradient streams, and valley floor wetlands and marshes; they have adapted successfully to regions of rice agriculture. Giant garter snakes are one of the largest snakes in the genus *Thamnophis*. A sexually dimorphic species, females can reach sizes in excess of 1 m (3.3 ft) and 850 g (1.87 lb), while proportionally smaller males seldom exceed 250 g (0.55 lb). Giant garter snakes possess a dark brown or olive background color separated by light-colored longitudinal stripes. For this species, coloration is geographically and individually variable. Snakes from the San Joaquin Valley region may exhibit a black-checkered pattern along the back and sides, and often lack a distinct dorsal stripe; while snakes from the Sacramento Valley region are typically darker, with a complete dorsal stripe that varies from bright yellow to orange or dull brown. Originally considered a subspecies of *Thamnophis ordinoides* (Fitch 1940), the giant garter snake has undergone a lengthy series of taxonomic revisions, finally being accorded full species status based on morphological and distribution data in the late 1880s (Rossman and Stewart 1987), a classification later confirmed through genetic analyses (Paquin 2001, Paquin *et al.* 2006).

Upon emerging from overwintering sites, male giant garter snakes immediately disperse in search of mates and will continue breeding from March into early May. Female giant

garter snakes brood young internally, giving birth to live young from late July through early September (Hansen and Hansen 1990). Young immediately disperse and seek shelter to absorb their yolk sacs, after which they molt and begin feeding on their own. Brood size ranges from 10 to 46 young, with a mean of 23.1 (n=19) (Hansen and Hansen 1990). Averaging 3 to 5 g (0.11 to 0.18 oz) with a snout-to-vent length of approximately 20.6 cm (8.1 in.), young giant garter snakes will double their size within their first year (Hansen and Hansen 1990, USFWS 1999). Sexual maturity probably averages 3 years in males and 5 years in females (G. Hansen pers. comm., USFWS 1999).

Giant garter snakes are strongly associated with aquatic habitats, typically overwintering in burrows and crevices near active season foraging habitat (Hansen 2004a, Hansen 2004b). Individuals have been noted using burrows as far as 50 m (164 ft) from marsh edges during the active season, and retreating as far as 250 m (820 ft) from the edge of wetland habitats while overwintering, presumably to reach hibernacula above the annual high water mark (Hansen 1986, Wylie et al. 1997, USFWS 1999).

Changing agricultural regimes, development, and other shifts in land use create an ever-changing mosaic of available habitat. Giant garter snakes disperse in response to these changes in order to find suitable sources of food, cover, and prey. Connectivity between regions is therefore extremely important for providing access to available habitat and for genetic interchange. In an agricultural setting, giant garter snakes rely largely upon the interconnected network of canals and ditches that provide irrigation and drainage to provide this connectivity. The canals and ditches within the Plan Area likely serve an important role in giant garter snake movement.

Data based on radiotelemetry studies show that home range varies by location, with median home range estimates varying between 9.2 ha (23 ac) (range 4.2 to 82 ha [10.3 to 203 ac], n=8) in a semi-native perennial marsh system and 53.2 ha (131 ac) (range 1.3 to 1,330 ha [3.2 to 2,792 ac], n=29) in a managed refuge (USFWS 1999).

Habitat Requirements and Ecology

Habitats occupied by giant garter snakes typically contain permanent or seasonal water, mud bottoms, and vegetated dirt banks (Fitch 1940, Hansen and Brode 1980). Prior to reclamation, these wetlands consisted of freshwater marshes and low-gradient streams. In some rice-growing areas, giant garter snakes have adapted to vegetated, artificial waterways and associated rice fields (Hansen and Brode 1993) where velocities fall within tolerable limits (E. Hansen *in litt*. 2009).

This species appears to be mostly absent from permanent waters that support established populations of predatory game fishes; from streams and wetlands with sand, gravel, or rock substrates; and from riparian woodlands lacking suitable basking sites, prey populations, and cover vegetation (Hansen and Brode 1980, Rossman and Stewart 1987, Brode 1988, USFWS 1999). The species may also avoid natural or artificial waterways that undergo routine dredging, mechanical or chemical weed control, or compaction of bank soils (Hansen 1988, Hansen and Brode 1993). Giant garter snakes are associated

with aquatic habitats characterized by the following features: (1) sufficient water during the snake's active season (typically early spring through mid-fall) to supply cover and food such as small fish and amphibians; (2) emergent, herbaceous wetland vegetation, such as cattails (*Typha* spp.) and bulrushes (*Scirpus* spp.), accompanied by vegetated banks to provide basking and foraging habitat and escape cover during the active season; (3) upland habitat (e.g., bankside burrows, holes, and crevices) to provide short-term refuge areas during the active season; and (4) high ground or upland habitat above the annual high water mark to provide cover and refuge from flood waters during the dormant winter period (Hansen and Brode 1980, Hansen 1998).

Survivorship and longevity of giant garter snakes are unknown, with few quantitative studies of survivorship available for the genus as a whole. One proxy comes from data on individual survival rates for a population of valley garter snakes (*Thamnophis sirtalis fitchi*) at a mountain lake in northern California. Snakes from this population exhibited first-year survivorship among neonates ranging from 28.7 to 43.0 percent, with a second-year neonate survivorship of 16.4 percent. Survival of yearling snakes was greater than that of juveniles, at 50.8 percent, while survival of snakes 2 years and older decreased to 32.7 percent (Jayne and Bennett 1990). In a different study, Lind *et al.* (2005) found that survival estimates for female Pacific coast aquatic garter snakes (*Thamnophis atratus*) in northwestern California was higher than that of males, which is consistent with trends reported for giant garter snakes in the Natomas Basin (Jones and Stokes 2007).

Spending cool winter months in dormancy or periods of reduced activity, giant garter snakes typically emerge from late March to early April and remain active through October; the timing of annual activity is subject to varying seasonal weather conditions. Daily activity consists of emerging from burrows after sunrise, basking to warm bodies to active temperatures, and foraging or courting for the remainder of the day (Hansen and Brode 1993). Like others in their genera, giant garter snakes likely rely on chemical cues to determine reproductive status and to locate mates (Shine *et al*. 2003, O'Donnell *et al*. 2004, E. Hansen, pers. obs.). Activity generally peaks during spring emergence and courtship from April into June, whereupon observations of giant garter snakes diminish significantly until a second peak is observed after females give birth during late July into August (Hansen and Brode 1993, Wylie *et al.* 1997, USFWS 1999, Hansen 2004). Giant garter snakes then remain actively foraging and occasionally courting until the onset of cooler fall temperatures.

Giant garter snakes feed on small fishes, tadpoles, and small frogs (Hansen 1980, USFWS 1999), specializing in ambushing prey underwater (Brode 1988). Historically, giant garter snakes preyed on native species such as the thick-tailed chub (*Gila crassicauda*) and California red-legged frog (*Rana aurora draytonii*) (which have been extirpated from the giant garter snake's current range), as well as the pacific treefrog (*Pseudacris regilla*) and Sacramento blackfish (*Orthodox microlepidus*) (Cunningham 1959, Rossman et al. 1996, USFWS 1999). Giant garter snakes now utilize introduced species, such as small bullfrogs (*Rana catesbeiana*) and their larvae, carp (*Cyprinus carpio)*, and mosquitofish (*Gambusia affinis*). While juveniles probably consume insects

and other small invertebrates, giant garter snakes are not known to consume larger terrestrial prey such as small mammals or birds.

Large vertebrates, including raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*), red foxes (*Vulpes vulpes*), gray foxes (*Urocyon cinereoargentius*), river otters (*Lutra canadensis*), opossums (*Didelphis virginiana*), harriers (*Circus cyaneus*), hawks (*Buteo* spp.), herons (*Ardea herodius*, *Nycticorax nyctycorax*), egrets (*Ardea alba*, *Egretta thula*), and American bitterns (*Botaurus lentiginosus*) prey on giant garter snakes (USFWS 1999). In areas near urban development, giant garter snakes may also fall prey to domestic or feral house cats (G. E. Hansen pers. comm.). In permanent waterways, introduced predatory game fishes, such as bass (*Micropterus* spp.), sunfish (*Lepomis* spp.), and channel catfish (*Ictalurus* spp.), prey on giant garter snakes and compete with them for smaller prey (Hansen 1998, USFWS 1993).

Giant garter snakes coexist with the valley garter snake (*Thamnophis sirtalis fitchi*). In limited instances, both may be found together with the mountain garter snake (*Thamnophis elegans elegans*), a subspecies of western terrestrial garter snake, in locations where this species' range extends to the floor of the Central Valley. The extent of competition among these species is unknown but, generally, differences in habitat use and foraging behavior allow their coexistence (Brode 1988, USFWS 1999).

Species Distribution and Population Trends

Distribution

The current known distribution of giant garter snakes is variable, and extends from near Chico in Butte County south to the Mendota Wildlife Area in Fresno County. Occurrences of giant garter snakes are not known from the northern portion of the San Joaquin Valley north to the eastern fringe of the Sacramento-San Joaquin River Delta, where the floodplain of the San Joaquin River is limited to a relatively narrow trough (Hansen and Brode 1980, USFWS 1993). The resulting gap of approximately 100 km (62.3 mi) separates the southern and northern populations, with no giant garter snakes known from the lowland regions of Stanislaus County (CNDDB 2004, Hansen and Brode 1980). Scattered records within the Sacramento-San Joaquin River Delta suggest that giant garter snakes may have occupied this region at one time, but longstanding reclamation of wetlands for intense agricultural applications has eliminated most suitable habitat (CNDDB 2004, Hansen 1986). Recent records within the Sacramento-San Joaquin Delta are haphazard, and repeated surveys have failed to identify any extant population clusters in the region (Hansen 1986, Patterson and Hansen 2002, Patterson 2003). Recent occurrence records indicate that, within this range, garter snakes are distributed in 13 unique population clusters coinciding with historical flood basins, marshes, wetlands, and tributary streams of the Central Valley (Hansen and Brode 1980, Brode and Hansen 1992, USFWS 1999). These populations are isolated, without protected dispersal corridors to other adjacent populations, and are threatened by land use practices and other human activities, including development of wetland and suitable agricultural habitats.

One of these 13 extant giant garter snake populations, the northern Yolo Basin population, is distributed along the northeastern edge of the Yolo Basin near the Sacramento River. Yolo County is well within the Central Valley proper and includes the floodplains of the Sacramento River as well as those of Cache, Willow, and Putah Creeks. Upon receding, these creeks may have provided the wetland habitat and prey utilized by giant garter snakes during the spring and summer active season. The historical distribution of giant garter snakes in Yolo County is unclear; however, with the majority of sightings made only in recent decades (Hansen 1986, CNDDB 2007).

Giant garter snakes are documented in two distinct concentrations along the eastern edge of Yolo County (CNDDB 2007; Hansen *in litt.* 2005, 2006, 2007; Wylie *et al.* 2004, 2005, 2006). The first concentration lies in the northeastern portion of Yolo County, northwest of Knights Landing and in the southern end of the Colusa Basin near Sycamore Slough and the Colusa Basin Drainage Canal. Wylie *et al* (2006) reports a population density in the Colusa Basin Drainage Canal of 20±3 snakes/km during 2006, falling within 2003 and 2004 confidence intervals, noting, however, that local distribution appears to have shifted away from areas formerly in rice production that have either been fallowed or converted to other crop types. The second concentration lies in the east-central portion of Yolo County, with records in the Yolo Bypass east of Conaway Ranch near the Tule Canal, the Willow Slough/ Willow Slough Bypass from Conaway Ranch south to the Yolo Wildlife Area, the Davis Wetlands complex south of Conaway Ranch between the Willow Slough Bypass and the Yolo Bypass, the Yolo Wildlife Area along the east edge of the Yolo Bypass west levee, and the adjacent ricelands west of the Yolo Wildlife Area. Surveys conducted in 2005, 2006, and 2007 resulted in captures of 34, 9, and 1 unique individual(s), respectively, in the Yolo Wildlife Area; 8, 18, and 8 unique individuals, respectively, in the adjacent ricelands; and 36 unique individuals (2007 only) in the Davis Wetlands complex (Hansen *in. litt.* 2006, 2007, 2008). Hansen (2005, 2006, 2007) reports an even distribution within size classes, estimating local populations ranging from 8 ± 2.6877 (95% C.I. = 7 to 20) to 57 ± 9.53 (95% C.I. = 45 to 84) in the Yolo Wildlife Area; 5 ± 0.4932 (95% C.I. = 5 to 5) to 17 ± 5.9655 (95% C.I. = 12 to 39) in the adjacent ricelands; and from 26 ± 21.2829 (95% C.I. = 11 to 120) to 67 ± 59.7094 (95% C.I. = 22 to 322) within the Davis Wetlands Complex (Hansen *in. litt.* 2006, 2007, 2008). Queries of the online databases of the California Academy of Sciences (2008) and Museum of Vertebrate Zoology (2008) yielded one additional occurrence record (CAS 178594) situated within downtown Davis: However, the stated location for this record (a frontage road one mile east of the Yolo Causeway) conflicts with the stated coordinates, leaving the true location unclear.

Population Trends

Prior to listing in 1971, giant garter snakes were known from 16 localities, representing nine distinct populations based on available literature and museum records (Hansen and Brode 1980, USFWS 1993). Range-wide status surveys of the giant garter snake conducted during the mid-1970s and 1980s indicate that they have been extirpated from the San Joaquin Valley south of Mendota in Fresno County, an area comprising as much

as one-third of the snake's former range (Fitch 1940, Hansen and Brode 1980, Rossman and Stewart 1987, Stebbins 2003). Once plentiful in areas such as Mendota, Los Banos, and Volta, giant garter snakes are now known from only a small number of localities in the southern aspect of their range (USFWS 1999, Dickert 2003, Hansen 2007). Giant garter snakes have not been documented from Burrell in Fresno County northward to Stockton since prior to 1980 and now appear to be most abundant in regions of the northern Sacramento Valley that are dominated by rice agriculture (USFWS 1993, 1999; CNDDB 2007).

Evidence that giant garter snakes may once have been distributed throughout the easterly reaches of Yolo County is illustrated by reported sightings in portions of Solano County adjacent to Yolo County, in South Fork Putah Creek near Davis and the Liberty Farms region of the Yolo Basin. Repeated attempts to assess local distribution suggest that both the Liberty Farms and Putah Creek populations are probably extirpated (Hansen 1986, Wylie 2005, D. Kelly, pers. com.).

Genetic analyses of tissue samples collected from giant garter snakes in the Yolo Wildlife Area and adjacent ricelands are ongoing. Engstrom (2007) reports that the Yolo Basin population is genetically very similar to those of the Natomas and Middle American Basins, but that genetic diversity within the Yolo Basin is lacking, which is typical of recently colonized populations. Engstrom reports, however, that there appears to be very little gene flow between the Yolo Basin and neighboring populations, and that ongoing migration into the Yolo Basin is not significant.

Threats to the Species and Other Conservation Issues

Continued loss of wetland or other suitable habitat resulting from agricultural and urban development constitutes the greatest threat to this species' survival. Conversion of Central Valley wetlands for agriculture and urban uses has resulted in the loss of as much as 95 percent of historical habitat for the giant garter snake (Wylie *et al.* 1997). In areas where the giant garter snake has adapted to agriculture, maintenance activities such as vegetation and rodent control, bankside grading or dredging, and discharge of contaminates, threaten their survival (Hansen and Brode 1980, Brode and Hansen 1982, Hansen and Brode 1993, USFWS 1999, Wylie *et al.* 2004). Within agricultural areas, giant garter snakes are also threatened by fluctuations in the amount and locations of rice production, and by the conversion of rice-lands to other crop types. Giant garter snakes are subject to mortality through loss or degradation of habitat; predation of juvenile giant garter snakes by introduced predators; elimination of giant garter snakes or prey species by pesticides and other toxins; road mortality; maintenance and modification of agricultural ditches, drains, and flood control systems; and flooding (Hansen 1986, USFWS 1999). Snakes remaining in rice fields are subject to threats from mechanical harvesting, including disrupted foraging, thermoregulating, or direct mortality; the extent of these threats is unknown (USFWS 2006). For many snake species, chemoreseptivity plays an integral role in habitat (Clark 2004) and mate selection (Shine *et al*. 2003, O'Donnell *et al*. 2004in snakes ability to navigate through their habitat, find overwintering sites, and locate mates. In developed areas, threats of vehicular mortality

also are increased. Paved roads likely have a higher rate of mortalities than dirt or gravel roads due to increased traffic and traveling speeds, and as many as 31 giant garter snake traffic mortalities have been reported during a 4-year period in the Natomas Basin (Hansen and Brode 1993).

The loss of wetland habitat is compounded by elimination or compaction of adjacent upland and associated bankside vegetative cover, as well as water fouling; these conditions are often associated with cattle grazing (Thelander 1994). While cattle grazing and irrigated pastures may provide the summer water that giant garter snakes require, high stocking rates may degrade habitat by removing protective plant cover and underground and aquatic retreats such as rodent and crayfish burrows (Hansen 1986, USFWS 1999). Studies of wandering garter snakes (*Thamnophis elegans vagrans*) in northern California have shown population numbers to be much higher in areas where grazing was excluded (Szaro *et al.* 1985). Radiotelemetry studies in perennial wetlands where grazing was differentially excluded show that giant garter snakes avoid areas where grazing is frequent (Hansen 2002). Cattle grazing may, however, provide an important function in controlling invasive vegetation that can compromise the overall value of wetland habitat (Hansen 2002).

Giant garter snakes are also threatened by the introduction of exotic species. Examinations of gut contents confirm that introduced bullfrogs (*Rana catesbeiana*) prey on juvenile giant garter snakes throughout their range (Treanor 1983, Dickert 2003, Wylie *et al.* 2003). While the extent of this predation and its effect on population recruitment is poorly understood, estimates based on preliminary data from a study conducted at Colusa National Wildlife Refuge suggests that 22 percent of neonate (newborn) giant garter snakes succumb to bullfrog predation (Wylie *et al.* 2003). Other studies of bullfrog predation on snakes have documented bullfrogs ingesting other species of garter snakes up to 80 cm (31.5 in) long, resulting in a depletion of this size-class within the population (Bury and Wheelan 1984). Introduced predatory game fishes, such as black bass (*Micropterus* spp.), sunfish (*Lepomis* spp.), and channel catfish (*Ictalurus* spp.), prey on giant garter snakes and compete with them for smaller prey (Hansen 1988, USFWS 1993).

Selenium contamination and impaired water quality have been identified as a threat to giant garter snakes, particularly in the southern portion of their range (USFWS 1999). While little data are available regarding the effects of specific contaminants, the bioaccumulative properties of selenium in the food web has been well documented in the Kesterson National Wildlife Refuge area (Saiki and Lowe 1981, Ohlendorf *et al.* 1988, Saiki and May 1988, Saiki *et al.* 1991, USFWS 1999).

Recent findings demonstrate that giant garter snakes are extant within Yolo County (CNDDB 2007; Hansen *in litt*. 2006, 2007, 2008; Wylie *et al.* 2003, 2004, 2006). However, little is known of their regional distribution or their population status throughout the remainder of Yolo County. While some estimates are available (e.g., Hansen and Brode 1993, Wylie et al. 2004), giant garter snake population sizes and densities are not well known throughout their range. Differential dispersal and home

range patterns between males and larger females who spend the majority of the active season gestating young are not reported. Lifetime dispersal patterns of both neonates and adults of this species are unknown.

Until uncertainties regarding population structure, population dynamics, and the strength, frequency, and direction of environmental fluctuations and edge effects are resolved, it is impossible to establish population numbers as a delisting criterion for this species (USFWS 1999). Current criteria for assessing the species' status include the quality and distribution of available habitat and the presence of both young and adults, indicating a stable population structure within known populations (USFWS 1993, 1999).

Throughout the Central Valley, Geographic Information Systems (GIS) modeling has been used to analyze microhabitat characteristics and suitability of aquatic and upland habitats for the giant garter snake (Hansen 2003b). Modeling includes the use of 23 distinct habitat variables correlated with giant garter snake life history and ecological requirements. Data are maintained within a comprehensive database, which is updated in response to changes in land use or habitat management. Coverage currently includes all navigable waterways within California Department of Boating and Waterways Aquatic Weed Control Division's Water Hyacinth and *Egeria densa* Control Program service areas, spanning the Central Valley from the Port of Sacramento in Sacramento County south to the Mendota Pool area in Fresno and Madera Counties, and in select areas within Sacramento, Sutter, and Yuba Counties.

In the Central Valley, rice fields have become important habitat for giant garter snakes. Irrigation water typically enters the rice lands during April along canals and ditches. Giant garter snakes use these canals and their banks as permanent habitat for both spring and summer active behavior and winter aestivation. Where these canals are not regularly maintained, lush aquatic, emergent, and streamside vegetation develops prior to the spring emergence of giant garter snakes. This vegetation, in combination with cracks and holes in the soil, provides much needed shelter and cover during spring emergence and throughout the remainder of the summer active period.

Rice is planted during spring, after the winter fallow fields have been cultivated and flooded with several inches of standing water. In some cases, giant garter snakes move from the canals and ditches into these rice fields soon after the rice plants emerge above the water's surface, and they continue to use the fields until the water is drained during late summer or fall (Hansen and Brode 1993). It appears that the majority of giant garter snakes move back into the canals and ditches as the rice fields are drained; although a few may overwinter in the fallow fields, where they hibernate within burrows in the small berms separating the rice checks (Hansen 1998).

While within the rice fields, the snakes forage in the shallow warm water for small fish and the tadpoles of bullfrogs and treefrogs. For shelter and basking sites, giant garter snakes utilize the rice plants, vegetated berms dividing the rice checks, and vegetated field margins. Gravid (pregnant) females may be observed within the rice fields during summer, and at least some giant garter snakes are born there (Hansen and Brode 1993,

Hansen 1998). Suitability of rice fields for giant garter snakes may vary by crop type. Wild rice species (e.g., *Zizania* spp.) may reach five to six feet in height, obscuring sunshine and limiting opportunities for snakes to thermoregulate. White or brown rice species are shorter in stature, providing superior basking opportunities.

Water is drained from the fields during late summer or fall by a network of drainage ditches. These ditches are sometimes routed alongside irrigation canals and are often separated from the irrigation canals by narrow vegetated berms that may provide additional shelter. Drainage typically occurs one month prior to harvest for white or brown rice and two to three weeks prior to harvest for wild rice crops (D. Sills pers. comm.). Remnants of old sloughs also may remain within rice-growing regions, where they serve as drains or irrigation canals. Giant garter snakes may use vegetated portions along any of these waterways as permanent habitat. Studies indicate that despite the presence of ditches or drains, giant garter snakes will generally abandon aquatic habitat that is not accompanied by adjacent shallow-water wetlands (Hansen 2008, Jones and Stokes 2008, Wylie *et al.* 2006), underscoring the important role that this crop plays in this species' life history.

Central Valley wetland conservation occurs through a combination of both public and privately managed refuges, mitigation banks, and duck clubs, creating a large network of wetland preserves throughout the historical range of the giant garter snake. A large percentage of these wetland conservation efforts, however, are geared toward waterfowl management, often placing greater emphasis on winter water rather than the summer water upon which giant garter snakes depend (G. Hansen pers. comm., USFWS 1999). With proper consideration given to design, location, and management, these efforts might also significantly benefit the giant garter snake and other wetland-dependent species (USFWS 1999).

Under the 1999 *Draft Recovery Plan for the Giant Garter Snake (Thamnophis gigas)*, initiation of the delisting process is anticipated by 2028, given that defined recovery criteria are adequately met. A revised final Recovery Plan providing refined recovery criteria is anticipated for 2009 (D. Kelley pers. comm.). To accomplish the recovery of this species, the USFWS emphasizes: habitat protection; public participation, outreach, and education; habitat management and restoration; surveying and monitoring; and continued research (USFWS 1993).

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