

# 2020 Giant Gartersnake (*Thamnophis gigas*) Surveys Horseshoe Lake Restoration

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## EXECUTIVE SUMMARY

This project assessed the presence, distribution, and abundance of giant gartersnakes (*Thamnophis gigas*) on Horseshoe Lake and its tributaries on the Cosumnes River Preserve. During the 2020 sampling year, trapping was conducted at the Cosumnes River Preserve during 1 60-day survey period between June 22 and August 22 to evaluate the status of GGS under post-restoration conditions on Horseshoe Lake. No giant gartersnakes were encountered in the preserve during the 2020 survey period. However, 21 valley garter snakes (*Thamnophis sirtalis fitchi*) were captured, demonstrating habitat use by other gartersnake species. Survey efforts included periodically measuring water chemistry and cataloguing prey items (by-catch) collected in traps. Of those measured reliably, water chemistry metrics obtained in 2020 fell within the ranges believed to be tolerable for giant gartersnake prey species, and the composition and abundance of prey species collected in traps was comparable to that observed at other occupied sites.

## INTRODUCTION

The Badger Creek population of the State- and Federal-threatened giant gartersnake (GGS) is located on the Cosumnes River Preserve (Preserve) in Sacramento County, California. While it is credited as the most genetically diverse population among those studied (Engstrom 2010, Paquin et al. 2006, Wood et al. 2015), it has experienced an apparent range contraction contemporaneous with changes in regional hydrology and habitat quality. On this site, the species has also experienced a recent reduction in population density and putative, subsequent reduction in genetic diversity because of California's recent drought (Hansen and Scherer 2017). Though documented within the North Fork of Badger Creek in the 1980's the persistence of GGS east of State Route 99 remains unclear. While recent genetic testing through newly-developed environmental DNA (eDNA) methods suggests the species persists here (Blankenship and Schumer 2017), species presence has not been directly verified. To improve conditions and water persistence on the east side of State Route 99, the Horseshoe Lake Restoration project restored habitat on the Horseshoe Marsh unit of the Preserve. Population surveys were conducted in 2018 to document baseline conditions and in 2020 to measure the preliminary response of GGS to restoration efforts.

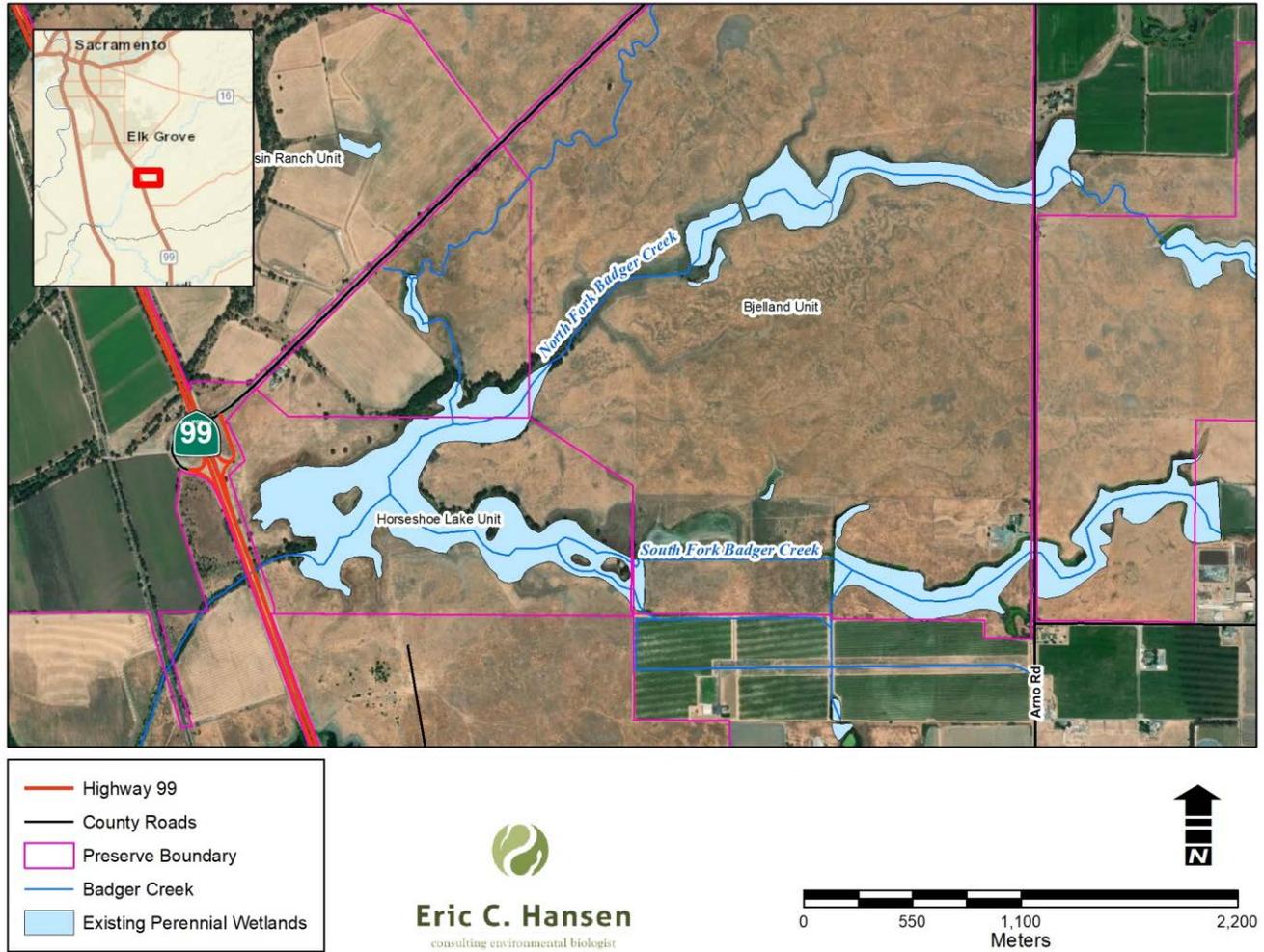
This project provides GGS presence/absence data that can be used to assess the response to restoration of Horseshoe Marsh and its tributaries (North Fork Badger Creek and South Fork Badger Creek) on the Preserve for GGS by:

1. Rigorously trapping within Horseshoe Marsh and its tributaries to assess presence, and distribution of GGS on the project site and within the project area;
2. Using capture-mark-recapture data to assess abundance in areas where captures are sufficient to provide estimates, and to use resulting data to compare abundance at site before and after restoration.

**Project Location**

The project location encompasses both the north and south fork of Badger Creek, which lies east of SR 99 and contains the Horseshoe Lake, Valensin, and Bjelland units of the Preserve in in Sacramento County, California (Figure 1).

Figure 1. Project location



## Methods

### *Giant Garter Snake Surveys*

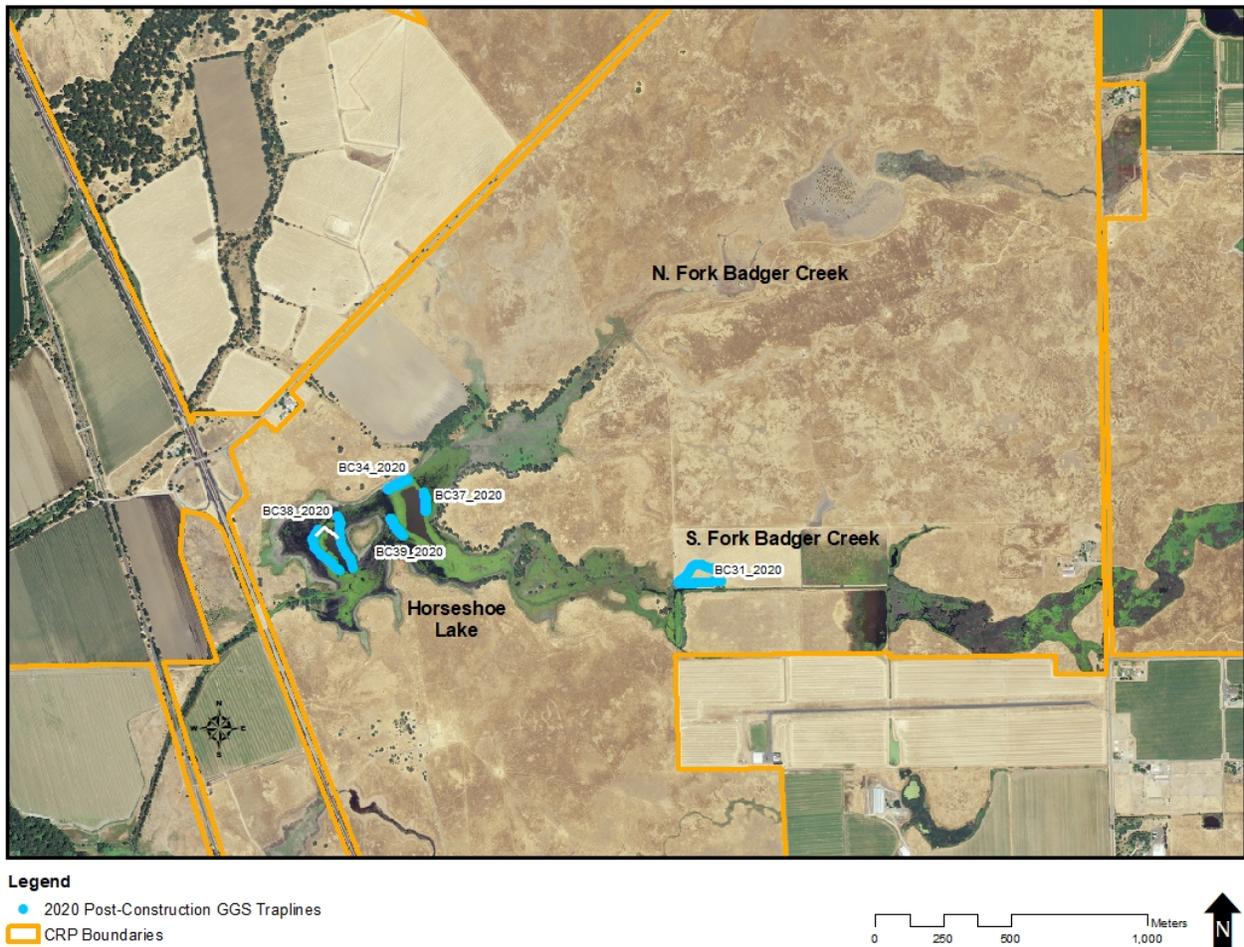
Sampling for GGS entailed a combination of aquatic trapping and visual encounter surveys (VES). Both trapping and VES were conducted between June 22<sup>nd</sup> and August 22<sup>nd</sup> over one 60-day period during the GGS active season.

The GGS is a secretive and elusive species that occurs at low density in many locations. Investigations into current distribution must, therefore, use survey and analytical methods (e.g. Halstead et al. 2011) that can accommodate low expected detection probabilities to produce robust inferences. Species are rarely detected with certainty in studies of spatial distributions (Gu and Swihart 2003), and as we noted above, detecting GGS at locations where they occur can be particularly challenging. Accounting for imperfect detection, therefore, is an essential component of the sampling design and analytical approach. Trapping methods were implemented to increase detection probability by increasing encounter rates and decreasing escape rates. Where a clear terrestrial interface or foraging pathway is lacking (e.g., within perennial marsh), drift fences with traps modified to maximize surface contact were used to increase encounter rates (e.g. Hansen et al. 2010). Additionally, flexible screen mesh covers extending below the waterline were used on the aperture of each trap funnel to reduce escape rates (Hansen, unpublished data).

Trapping entailed the placement and daily monitoring of 200 floating aquatic traps divided into 50-trap transects over one 60-day period. Due to limited water availability, 50 traps were deployed on the Bjelland Unit on the south fork during the first 30 days, and 150 traps were deployed at Horseshoe Lake. After 30-days in the Bjelland Unit the water had dropped significantly and the traps were moved to Horseshoe Lake and remained there for the last 30 days, bringing the total number of traps in Horseshoe Lake to 200. The resulting distribution of trapping locations is depicted in Figure 2. Survey period and trapping effort can be found in Appendix A, Table 1. For all trapped areas, habitat covariates (vegetation height, density, species composition, water depth, substrate, slope, aspect, and distance to upland refugia) and water persistence were recorded to detail habitat suitability, providing an option to model covariates associated with occupancy, and to assess the likelihood of colonization in restored habitats, if desired at a future date. Data recorded for each trap location included UTM coordinates and environmental characteristics, (e.g., vegetation and substrate types).

Surveys were conducted in full accordance with the terms and conditions of US FISH AND WILDLIFE SERVICE RECOVERY PERMIT 10(a)-(1)-(A) ESA TE-018177-7.2 and DEPARTMENT OF FISH AND GAME SCIENTIFIC COLLECTING PERMIT 003881 with its associated MOU.

Figure 2. Cosumnes River Preserve 2020 Trapping Locations



### **Water Quality Metrics**

Water chemistry metrics, including electrical conductivity (EC) (mS/cm), and temperature, were measured at each trapping location (where sufficient water was present) at the end of each survey period using a portable YSI 556 Multi-Probe unit. Fluctuations in water surface levels were also noted. While water quality measurements are not a requirement for GGS monitoring at the Preserve, these data are collected to help interpret observed GGS and aquatic prey distributions.

## **Prey Samples**

Although traps were not purposely baited, frogs, tadpoles, and fish were frequently caught in the traps and likely served as attractants for GGS. Wherever traps remained in place without interference, organisms within the traps were identified and counted as by-catch at the end of each survey period in order to compare prey composition and densities between trapping quadrats within the Preserve and between the Preserve and other study sites throughout the Sacramento Valley.

## **RESULTS**

### ***Giant Garter Snake Surveys***

Trapping surveys resulted in the accrual of 10,454 trap-days all located in freshwater marsh habitat on the Preserve. Valley garter snakes (*Thamnophis sirtalis fitchi*) were observed at both the Bjelland unit and the western section of Horseshoe Lake, however no GGS were encountered either visually or through trapping. Drying of potential habitats at all upper reaches of Badger Creek was rapid, suggesting a lack persistent spring and summer wetlands at all but Horseshoe Lake.

### ***Water Quality***

#### ***Badger Creek – South Fork (Bjelland Unit)***

Where sufficient water was present, water chemistry metrics including electrical conductivity (EC) (mS/cm) and temperature (°C) were measured at each trap site. The electrical conductivity (EC) (mS/cm) was 1.01. The average water temperature during daytime trap checks was 26.14°C.

#### ***Horseshoe Lake***

Where sufficient water was present, water chemistry metrics including electrical conductivity (EC) (mS/cm) and temperature (°C) were measured at each trap site. The mean electrical conductivity (EC) (mS/cm) was 0.678. The average water temperature during daytime trap checks was 24.73°C.

## **Prey Samples**

#### ***Badger Creek – South Fork (Bjelland Unit)***

Detected prey species consisted of both adult and larval American bullfrogs (*Lithobates catesbeianus* [= *Rana catesbeiana*]), mosquitofish (*Gambusia affinis*), and Centrarchids, excluding bass (*Lepomis* spp.). Centrarchids fish were the most abundant prey species detected (n=178), followed by mosquitofish (n=17), larval American bullfrogs (n=16), and adult American bullfrogs (n=2). Although

not considered prey for GGS, 4 red swamp crayfish (*Procambarus clarkii*), and 305 water beetles (*Hydrophilidae* spp.) were also captured in traps during 2020. Raw counts and CPUE of prey items at each trapping location are provided in Appendix A, Table 2. Appendix B includes photographs of the trap lines set during surveys in 2020.

### *Horseshoe Lake*

Detected prey species consisted of adult American bullfrogs (*Lithobates catesbeianus* [= *Rana catesbeiana*]), mosquitofish (*Gambusia affinis*), bass (*Micropterus* spp.), other Centrarchids (*Lepomis* spp.), carp (*Cyprinus carpio*), golden shiner (*Notemigonus crysoleucas*), and bullhead catfish (*Ameiurus* spp.). Centrarchids were the most abundant prey species detected (n=233), followed by golden shiner (n=136), mosquitofish (n=78), bass (n=44), American bullfrog adults (n=36), carp (n=25), and catfish (n=5). Although not considered prey for GGS, 509 red swamp crayfish (*Procambarus clarkii*), 63 water beetles (*Hydrophilidae* spp.), and 7 freshwater shrimp (*Crangon franciscorum*) were also captured in traps during 2020. Raw counts and CPUE of prey items at each trapping location are provided in Appendix A and Table 3. Appendix B includes photographs of the trap lines set during surveys in 2020.

## **DISCUSSION**

Results of surveys conducted on the Reserve's Horseshoe Unit in 2020 are consistent with those conducted east of State Route 99 since 2001, suggesting either absence or else presence at densities undetectable by rigorous trapping techniques. With the exception of poor water persistence in prior years the reasons for this remain unclear.

The diversity and abundance of prey species found in aquatic traps was low relative to other sites occupied by GGS (E. Hansen, unpublished data), but not to an extent that would be considered limiting. Water metrics were generally consistent with those recorded at occupied sites supporting a rich abundance of prey species elsewhere in the Central Valley. While information regarding suitable EC ranges for GGS prey species is generally lacking, a cursory review of the scientific literature indicates that most juvenile freshwater fishes can tolerate EC values up to 3 mS/cm without adverse effects (adults can generally tolerate EC values up to 13 mS/cm) (James et al. 2003). Salinity levels above 4.5 parts per thousand (approximately 7.03 mS/cm EC) are considered unsuitable for the California red-legged frog (*Rana draytonii*) (Jennings and Hayes 1994); tolerable salinity ranges for other Ranid frogs (i.e., bullfrogs) are likely similar. The EC values recorded for this project were well within tolerable ranges, suggesting potential for continued development of the GGS prey base over time.

While trapping surveys may fail to detect GGS in low densities, protocol-level surveys still provide valuable information regarding GGS densities compared with other occupied sites throughout their range. For example, while densities were low, GGS were still detected during trapping surveys on the CRP west of SR-99 in 2017 (Hansen *et al.* 2017). The fact that GGS were not detected using identical methods east of SR-99 in 2018 and 2020 suggests that if GGS do persist here, they do so in very low densities. While such densities are of dubious benefit to population persistence over time, the

maturation of restored habitat at Horseshoe Lake, subsequent increases in water persistence, hydraulic connectivity to a known population west of State Route 99, and detection of environmental DNA in the region in 2017 (Blankenship and Schumer 2017) provide potential for increased colonization of Horseshoe Lake over time.

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## Appendix A. Tables

**Table 1: 2020 GGS survey period and trapping effort**

Permanent Transect ID	General Habitat Type	Start Date	End Date	Number of Traps	Total Days	Total Trap Days (Theoretical)	Total Lost Trap Days	Total Trap Days (Actual)	Total GGS Captures
BC31	Freshwater marsh	6/22/2020	8/22/2020	50	30	1500	2	1498	0
BC34	Freshwater marsh	6/23/2020	8/22/2020	50	60	3000	0	3000 <sup>1</sup>	0
BC37	Freshwater marsh	6/23/2020	8/22/2020	50	60	3000	0	3000	0
BC38	Freshwater marsh	6/23/2020	8/22/2020	50	60	3000	15	2985	0
BC39	Freshwater marsh	7/22/2020	8/21/2020	50	30	1500	31	1469	0

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<sup>1</sup> Theoretical total traps days are being used for lines BC34 and BC37. These do not account for occasional uncapping of traps during brief periods of low water.

## Appendix A. Tables

**Table 2: 2020 prey catch by unit effort (CPUE) – South Fork Badger Creek (Bjelland Unit)**

Quadrat ID	Trap Days	Ranid Adult		Ranid Larvae		<i>Centrarchid</i> Species		Mosquitofish		Combined Prey	
		Count	CPUE	Count	CPUE	Count	CPUE	Count	CPUE	Count	CPUE
BC31	1498	2	0.001	16	.011	178	0.119	17	0.011	213	0.142

**Table 3: 2020 prey catch per unit effort (CPUE) – Horseshoe Lake**

Quadrat ID	Trap Days	Ranid Adult		Catfish		<i>Centrarchid</i> Species		Bass		Carp		Mosquitofish		Golden Shiner		Combined Prey	
		Count	CPUE	Count	CPUE	Count	CPUE	Count	CPUE	Count	CPUE	Count	CPUE	Count	CPUE	Count	CPUE
BC34	3000 <sup>2</sup>	7	0.002	0	0.000	29	0.010	0	0.000	6	0.002	6	0.002	0	0.000	48	0.016
BC37	3000	11	0.004	0	0.000	16	0.005	4	0.001	7	0.002	4	0.001	21	0.007	63	0.021
BC38	2985	16	0.005	5	0.002	77	0.006	38	0.013	12	0.004	59	0.020	115	0.039	322	0.108
BC39	1469	2	0.001	0	0.000	111	0.076	2	0.001	9	0.006	6	0.004	0	0.000	130	0.088
<b>Total</b>	10454	36	0.003	14	0.001	233	0.022	44	0.004	25	0.002	78	0.007	136	0.013	563	0.054

<sup>2</sup> Theoretical total traps days are being used for lines BC34 and BC37 until we finish data entry. Actual totals will be reported in final report. The numbers in red will be recalculated once total trap days is determined.

## Appendix B: Photographs



**BC Quadrat 31 - facing west**



**BC Quadrat 34 – facing west**



**BC Quadrat 37 – facing south**



**BC Quadrat 38 – facing southeast**



**BC Quadrat 39 – facing northeast**