Appendix O
Giant Garter Snake Take Assessment

Memorandum

Date:	August 18, 2016
To:	Petrea Marchand, Yolo Habitat Conservancy
From:	Doug Leslie, ICF
Subject:	**Estimating Take of Individual Giant Gartersnakes (*Thamnophis gigas*) Resulting from Implementation of the Yolo HCP/NCCP**

Estimating "take" of giant gartersnakes (the number of individuals killed due to implementation of covered activities under the Yolo HCP/NCCP) is a difficult task and a number of approaches have been taken in the past. The majority of approaches use estimates of density (number of snakes per unit area) in various habitat types and multiply them by the number of acres of each habitat type predicted to be impacted. The accuracy and precision of the estimates of take are dependent on the accuracy of the estimates of density, and ignore differences among broad categories of habitat. It is imperative when estimating density to use estimates that rigorously account for imperfect detection, because giant gartersnakes (GGS) often reside in terrestrial habitats and are thus unavailable for capture. By using estimates that rigorously account for imperfect detection, it becomes unnecessary to produce separate estimates for take due to conversion of aquatic habitats and take due to conversion of associated uplands, unless uplands are impacted without impacting the associated wetland habitats.

We estimated take of GGS by multiplying the number of acres of habitat considered to be permanently impacted (Chapter 5, Table 5-5) by estimates of the density of GGS within that habitat type. We used estimates of GGS abundance (converted to density) that were rigorously estimated by accounting for imperfect detection at the time of trapping. Density estimates derived from trapping in aquatic habitat should account for imperfect detection results and snakes that are not seen or observed because they are either trap shy or not available for capture because they are in terrestrial habitats (including underground estivation sites).

For this analysis we specifically used estimates of abundance from the Natomas Basin Biological Effectiveness Monitoring Program (ICF International 2016) because these estimates are based on the latest estimation and analytical techniques, and provide a range of estimates that accounts for natural variation over time in abundance. They are also based on large sample sizes and are the most current estimates available.

We converted abundance into density by assuming an "area of influence" for each trap of 100 meters, similar to the analysis in Wylie et al (2010). At each trapping site, three transects of 50 traps each were deployed, with traps spaced 10 meters apart. Therefore, the area of influence for each set of three traplines was 15 hectares. Only one of the demographic monitoring sites from the Natomas data set was in rice. We used the highest and lowest estimates from the years 2011 - 2015 to provide a range of estimates for potential take of giant gartersnake in this habitat type. Three of the demographic monitoring sites from Natomas were in created fresh emergent marsh habitats. We used the highest and lowest estimates from these three sites (BKS, Lucich North, and Lucich South sites) over the period 2011 – 2015 to provide a range of estimates for potential take of giant gartersnake in this habitat type.

Because these estimates of take included individuals potentially occurring in adjacent upland terrestrial habitats, we did not produce separate estimates of take for conversion of these habitat categories (i.e. active season upland movement habitat or overwintering habitat, Chapter 5, Table 5-5).

However, we did produce a separate estimate of take for those situations in which upland terrestrial habitats (active season uplands only, because the probability of GGS being beyond this distance - while not zero - is too small to contribute significantly to the estimate of take) would be impacted without impacting the adjacent wetland or aquatic habitat. This estimate was produced by taking the acres of terrestrial habitat predicted to be impacted and multiplying by the density of GGS in adjacent aquatic habitat (i.e marsh or rice), which was then multiplied by the probability of GGS being in adjacent terrestrial habitats during the active season.

We estimated the density of GGS in adjacent uplands by taking the average of the high and low values for marsh and rice. We estimated the probability of GGS being in terrestrial habitats by taking the average of the probability of GGS being in terrestrial habitats for males and females in June, July, August, and September. These four months are the time period in which estimated take may occur because they constitute the official work window in GGS habitat. This time period occurs within the interval when GGS are typically most active (May 1 to October 1). We interpolated these values from Figure 3 in Halstead et al. (2015).

Although "aquatic" habitat is modelled as potential giant gartersnake habitat, conversion of this habitat type is unlikely to result in take of additional giant gartersnakes above the amount of take estimated for the other habitat types (i.e. rice, marsh, and associated uplands) because GGS typically do not occur in riverine or lacustrine habitats. Nevertheless, we produced an estimate of take for this habitat type by multiplying the number of acres to be converted by the density of GGS. We used the density estimate for seasonal wetlands from Wyllie et al (2010) to produce this estimate because this is the lowest density estimate available and density of GGS in aquatic habitat is likely to be very low relative to other habitat types.

These estimates all assume that impacts will occur during the GGS active season.

The estimates of abundance and density used in the analysis of take, as well as the estimates of take resulting from the permanent conversion of rice, fresh emergent marsh, aquatic, and Active Season Upland habitats not associated with conversion of adjacent wetlands habitats under the Yolo County HCP/NCCP, are provided in Table 1.

The resulting estimates should be considered as grossly overestimating the amount of take likely to occur. The density estimates on which the take estimates are based are biased high. Because GGS capture probabilities are so low, trapping is done in areas with the highest density of snakes and the highest probabilities of capture. Therefore, these estimates represent the highest densities of snakes and are not representative of the average density of snakes throughout the areas that will be impacted. In addition, an unknown proportion of the fresh emergent marsh habitat is actually seasonal marsh, meaning it is not flooded during the GGS summer active season. Seasonal wetlands such as these actually have the lowest densities of GGS of any habitat sampled by Wylie et al (2010), yet we used density estimates from permanently flooded emergent wetlands to produce the estimates of take. Depending on the proportion of emergent wetland predicted to be impacted comprised of winter rather than summer flooded marsh, the estimates of take are likely to be grossly overestimated. Finally, the estimates assume that no GGS will escape during construction or disturbance, even though avoidance and minimization measures have been incorporated into the Plan to ensure that take is minimized.

In addition to the high likelihood that potential take is grossly overestimated, there is large variation in the resulting estimates of take. This variation results from high variation in densities across both space and time in abundance. The high point estimate of take is more than double the low estimate. Therefore, these estimates should be considered indicative of the order of magnitude of potential take only.

We did not produce a separate estimate of take likely to result from temporary impacts because only 9 acres of habitat are predicted to be temporarily impacted. The take associated with temporary impacts to 9 acres would not appreciably add to the total estimate of take.

Table 1. Estimates of Abundance, Density, and Take of Giant Gartersnake (± Symmetric Posterior 95% Credible Interval) Resulting from the Permanent Conversion of Rice and Fresh Emergent Marsh Habitats under the Yolo County HCP/NCCP.

Habitat Type	Acres	Abundance	Density (ind/ha)	Take
Rice (Low)	87	16 (8-47)	1 (1-3)	38 (19-110)
Rice (High)	87	44 (28-75)	2 (2-5)	103 (66-176)
Fresh Emergent Marsh (Low)	76	70 (47-123)	5 (3-8)	144 (97-253)
Fresh Emergent Marsh (High)	76	264 (70-508)	18 (5-34)	542 (144-1,043)
Aquatic	109	29 (22-53)	0.83 (0.63-1.5)	37 (28-66)
Active Season Upland (Isolated)	73.8	N/A	6.6 (2.6-12.6)	133 (52-255)
Total (Low)				352 (196-684)
Total (High)				815 (290-1,540)

Literature Cited

Halstead, B. J., Skalos, S. M., Wylie, G. D., & Casazza, M. L. (2015). Terrestrial ecology of semi-aquatic giant gartersnakes (Thamnophis gigas). Herpetological Conservation and Biology, 10(2), 633–644.

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Wylie, G. D., Casazza, M. L., Gregory, C. J., & Halstead, B. J. (2010). Abundance and Sexual Size Dimorphism of the Giant Gartersnake (Thamnophis gigas) in the Sacramento Valley of California. Journal of Herpetology, 44(1), 94–103. http://doi.org/10.1670/08-337.1