Peer Review of USFWS delisting proposal for *Trichostema austomontanum* ssp. *compactum*

On January 5, 2017, the U.S. Fish and Wildlife Service (FWS) has proposed delisting of *Trichostema austomontanum* ssp. *compactum*, Hidden Lake Blue Curls. Based on my experience with plant conservation biology and extensive work with threaten and endangered plants, I have provided a review of the merits of this proposal.

In the original listing, FWS identified the primary threats to *Trichostema austomontanum* ssp. *compactum* as 1) habitat disturbance, primarily in the form of trampling, and 2) small population size, with 3) climate change added as a threat in 5 year reviews. I will address each threat individually:

1) Habitat Disturbance – It is clear from the available data and various FWS documents that habitat disturbance, primarily in the form of trampling, has been the major threat to *Trichostema austomontanum* ssp. *compactum.* Since listing, this threat has been adequately addressed by the land owner, California Department of Parks and Recreation (CDPR), through the temporary closing of the entire range of *Trichostema austomontanum* ssp. *compactum* to visitation, fencing along nearby trails, changing the conservation status of the habitat, and monitoring disturbances. In the delisting proposal, current and future actions taken by CDPR are clearly outlined, along with adaptive triggers to change management. These include, closing of the habitat to livestock, limitation of future visitation to Hidden Lake, and developing a new access trail to the area that visitors can only access with supervision. Based on these actions I feel that the habitat disturbance threat has been adequately addressed and is no longer a concern. It is possible that disturbance effects could increase in the future, but the 13 year monitoring plan and the CDPR long term habitat plan should prevent this for the foreseeable future.
2) Small populations - *Trichostema austomontanum* ssp. *compactum* is incredibly rare, occurring in a total range of 0.8 hectares. Although the reduced range and small population size is certainly a concern, all available information on this species biology suggests that it is adapted to exist in small populations. The adaptations include self pollination, a robust seed bank, and non-synchronous germination of seeds. Given that there are no direct threats reducing population size and the range is so limited that there is no isolation among population/sub-populations, the small population threat has been adequately addressed by protection of the habitat and limiting disturbance (see 2 above). As an added hedge against stochastic loss of small populations, *Trichostema austomontanum* ssp. *compactum* has been targeted and sampled for seed banking. The actual details of the number of individuals collected and number of seeds stored are somewhat vague, but there is mention that collections followed CPC guidelines, which clearly outline necessary numbers to preserve theoretical diversity.
3) Climate Change – Although climate change is a concern for all organisms, there is no available data to indicate how *Trichostema austomontanum* ssp. *compactum* will respond to changing climate. I view this threat as theoretical and non-actionable, and that FWS has provided a reasonable justification to support this view. There is no data

to suggest that *Trichostema austomontanum* ssp. *compactum* will be negatively impacted by climate change, so this threat has been adequately addressed.

Based on my review of the delisting proposal and the Post-Delisting Monitoring Plan (PDM), and my knowledge of plant biology, I cannot identify any additional threats to *Trichostema austomontanum* ssp. *compactum.* I would however recommend that specific targets for number of plants sampled and seeds stored for *ex situ* conservation be established. The wide variability in number of plants per year and population level seed production, suggests that different genotypes may be represented in different years. Without collecting genetic diversity data it is difficult to confirm this suggestion, but *ex situ* seed collections should target multiple years, including years with both small and large population sizes, to ensure that a range of genotypes are represented. There is information in the delisting proposal and PDM that indicates that *ex situ* collections of *Trichostema austomontanum* ssp. *compactum* were conducted over multiple years, but there are not any details about how those specific years related to population size, specific ecological variables, or number of seeds collected.

Related to the PDM, I have three concerns. First, given the variable population sizes of *Trichostema austomontanum* ssp. *compactum*, will the proposed 13 year monitoring result in the appropriate data to assess if the species is successfully recovered. Specifically, will monitoring every 3 years provide enough information about population trends? Although it is impossible to predict, I could envision a scenario where the monitoring years all fall when the population is small, not giving an accurate representation of actual population trends. For instance, based on the data included in the PDM, monitoring in 2007 (245 plants), 2010 (no data), and 2013 (5100 plants) for an average population of 2672.5 plants, would lead to very different trend estimates than 2008 (27,000 plants), 2011 (no data), and 2014 (4612 plants) for an average population of 15,806 plants. Based on this potential bias, I would recommend conducting monitoring at a more regular frequency (annual or biennial) or doing paired years of monitoring (e.g. years 1,2,3,4,7,8, etc.). Second, and more importantly, what is the trigger for relisting that will be confirmed or rejected via monitoring? The PDM clearly outlines potential outcomes of monitoring, but not how you end up at any of the four listed outcomes. What is an average 13 year population size or area inhabited or other factor that will allow FWS to determine *Trichostema austomontanum* ssp. *compactum* has continued to be secure? In order for the monitoring and recovery to be successful, I recommend that more specific guidelines be established. Third, two monitoring protocols are recommended in Appendix C of the PDM. Although both protocols are theoretically sound for many taxa, I am concerned about two aspects of this approach. In my opinion, only a single approach should be used if the data from multiple years is to be comparable; a macro plot sub-sampling (method 2) will result in different numbers and confidence than a complete census (method 1). Additionally, no information was provided related to whether method 2, which has previously been used, has enough statistical power to detect population trend changes using the sample size calculation formula of Elzinga et al. (2001). I also have concerns about randomly placing the transects each year in method 2, where having macro plots may be a better approach. Monitoring population trends in annual plants is notoriously difficult, and that difficulty will only be increased in a species with such

large fluctuations in population size. Based on these concerns my recommendations is to employ an entire population census approach, similar to method 1.

Overall, I feel that FWS has reasonably justified the proposal for delisting of *Trichostema austomontanum* ssp. *compactum*, and that there are currently no clear unaddressed threats to this species.

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