Graham's Beardtongue (*Penstemon grahamii*) Monitoring in the White River Field Office - 2018 Summary

Graham's beardtongue in flower in the Raven Ridge ACEC. Photo: Phil Krening

Produced by:

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Summary

Monitoring of Graham's beardtongue (*Penstemon grahamii*) was completed in June of 2018. This marked the tenth year of monitoring during a fourteen-year period (2005-2018) at the singular study site in Colorado located within the Raven Ridge ACEC. The population trend at the site was stable to increasing between 2017 and 2018. Following a livestock trailing event in 2013, that significantly reduced the number of plants at the site, the population has shown signs of recovery. This year we documented the highest rosette density in the previous five years (0.15 plants/m^2). Overall, we have observed a significant decrease in mean rosette density at the site since the current monitoring study was established in 2005 (t(14) = 2.66, p < 0.05). We continue to evaluate historical occurrences and potential habitat in Colorado for populations that may be suitable for sampling, with the intent of adding to the representation of occupied sites to our study system. To date, we have been unable to identify other populations of Graham's beardtongue in Colorado that meet the criteria for sampling.

1. Introduction –

The Mormon Gap population of Graham's Penstemon (*Penstemon grahamii*) at Raven Ridge has been the focus of various monitoring efforts since 1986. The population is the most studied population of *P. grahamii* in Colorado due to its relatively large size and accessibility.

The Mormon Gap population occupies characteristic *P. grahamii* habitat consisting of exposed Parachute Creek member Green River Formation near the eastern extent of the species known global range of distribution (Figure 1). Raven Ridge contains the majority of *P. grahamii* habitat on public land in Colorado. The entirety of the ridge is contained in the 4,980 acre Raven Ridge Area of Critical Environmental Concern (ACEC) which was established in 1985 and subsequently expanded in 1997.

2. Monitoring History –

Monitoring was initially established by the Bureau of Land Management (BLM) at the Mormon Gap *P. grahamii* population in 1986. Monitoring was completed as part of a multi-species monitoring effort focused on seven sensitive plant species found in the area. The original study design consisted of three gridded macroplots of varying sizes located at distinct *P. grahamii* occurrences on Raven Ridge. Plants were tagged and census counts were taken of each plot to determine mean density. Monitoring was completed annually from 1986 through 1990 when it was discontinued.

In 2005 the BLM reinitiated long-term monitoring at Plot 5 (North Unit South at Mormon Gap) - hereafter referred to as the Raven Ridge / Mormon Gap population - from the original study that concluded in 1990. The 2005 BLM study consisted of the original 20m x 35m (700m²) macroplot.

A census of the plot was taken in 2005 and 2008. All plants were tagged and their x/y coordinates recorded.

In 2009 the macroplot was divided into 20 1m x 35m transects and power analysis was performed in order to obtain statistical meaningful sampling results. Sampling has occurred annually since 2009 with the exception of 2013. Current methodology follows:

3. Methods –

The demographic monitoring methods summarized here were adapted from the BLM technical references *Measuring and Monitoring Plant Populations* (Elzinga et al., 1998) and the *Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems* (Herrick et al., 2005). Methods were selected to efficiently provide robust data. Monitoring is designed to determine if populations are increasing, decreasing, or stable by comparing differences in mean density. Understanding the demography and trend of these populations can then be used to inform land management decisions aimed at reducing or eliminating threats to the species and minimize the likelihood of, and need for, listing under the ESA (BLM, 2008).

3.1 Monitoring Objectives:

Management Objective: Maintain stable or increasing population density of *Penstemon grahamii* at the Raven Ridge / Mormon Gap population for a 20-year period (2005 – 2025).

Sampling Objective: We aim to be 90% confident that *Penstemon grahamii* density estimates are ± 20% of the true value.

3.2 Sample Design:

Permanent sample units are preferred in monitoring long-lived perennial species especially when plants may exhibit unknown levels of dormancy (Elzinga et al., 1998; McCaffrey, 2014). Permanent sampling units should be used whenever possible due to their advantage in requiring fewer samples than temporary sampling units and being much more statistically robust when conducting analysis. This thereby increases the power of the data and increases monitoring efficiency.

3.3 Field Establishment and Data Collection Procedure:

Permanent sampling units were established within macroplot in 2009. In order to limit observer bias, transect locations were selected within the plot using a restricted random method (Elzinga et al., 1998). Ten inch steel stakes are placed in the middle and at both ends of each transect. When transect length exceeds 25 meters quarter points were established to ensure the accuracy of data collection. In order to accurately detect and document important recruitment and disturbance events monitoring is conducted on a yearly basis.

All plants within each 1 meter transect belt are tagged with an 8" nail and numbered aluminum tag in order to relocate individuals from year to year. X / Y coordinates are recorded in order to assist with relocation. All plants within each 1 meter transect belt are counted to determine mean density. Population trend is determined by calculating changes in mean density between and across years.

In order to address questions related to the life history of the species demographic metrics are recorded on an annual basis for each marked plant. Demographic metrics include but are not limited to: reproduction, recruitment, and longevity of individuals. All plants falling within transects are counted and the number of vegetative and reproductive rosettes per plant documented. Other demographic metrics may be recorded including: number of inflorescences per plant/stem, flowers per inflorescence. The total diameter of rosettes may be recorded in addition to notes indicating evidence of browsing or herbivory and general condition of the plant.

3.4 Power Analysis:

Two years of data are required in order to preform sample size calculations. The number of sampling units within the macroplot will be adjusted during the third year of monitoring to accommodate the necessary number of samples required to obtain statistically meaningful results. The calculation used to determine the necessary number of samples to detect a specified amount of change in plant density between two time periods using permanent sample units is:

$$n = \frac{(s)^2 (Z_\alpha + Z_\beta)^2}{(MDC)^2}$$

Where n is the necessary number of transects needed to detect a specified amount of change between two samples according to a specified power (Elzinga et al., 1998). Calculations are performed to meet a sampling objective that maximizes statistical power (≥ 0.8) of detecting at least a 20% absolute change in mean plant density, while maintaining the possibility of committing either a type 1 or 2 error at $\leq 20\%$.

A finite population correction factor (FPC) is applied when sampling > 5% of the within-plot population:

$$n' = \frac{n}{\left(1 + \left(\frac{n}{N}\right)\right)}$$

3.6 Statistical Analysis:

Sampling results, once compiled, are compared from year to year using a two-tailed paired t-test analysis to determine the significance ($p \leq 0.05$) of changes in mean density over time. As with determining sample size, if more that 5% of a population has been sampled you must apply the FPC to the results of the significance test (Elzinga et al., 1998).

All statistical transformations were completed using Microsoft Excel.

4. Results –

4.1 Trend monitoring –

Due to methodological differences, our ability to make direct comparisons between the original monitoring study (1986 – 1990) and the more recent data (2005 – 2018) is limited.

Based on the best available data, the Raven Ridge / Mormon Gap population of *P. grahamii* exhibited a stable to increasing population trend between 1986 and 2012. Between 1986 and 1990 there were an average of 159 rosettes per monitoring year compared to an average of 185 rosettes during the five monitoring years that occurred between 2005 and 2012. While interannual variability in the number of rosettes is evident during this timeframe it appears that the population remained relatively stable during this 26 year period.

Between 2012 and 2014 (monitoring did not occur in 2013) the population experienced a significant decrease $t(14) = 9.16$, $p < 0.01$ in mean rosette density. This dramatic decrease was attributed to a large number of sheep trailing through the population. Evidence of the disturbance was documented upon visitation to the site for monitoring in 2014.

Following the near extirpation of the population in 2013 we have documented a significant increase $t(14) = 5.87$, $p < 0.01$ in rosette density at the site between 2014 and 2018. Despite signs of recovery, population density remains below historic levels.
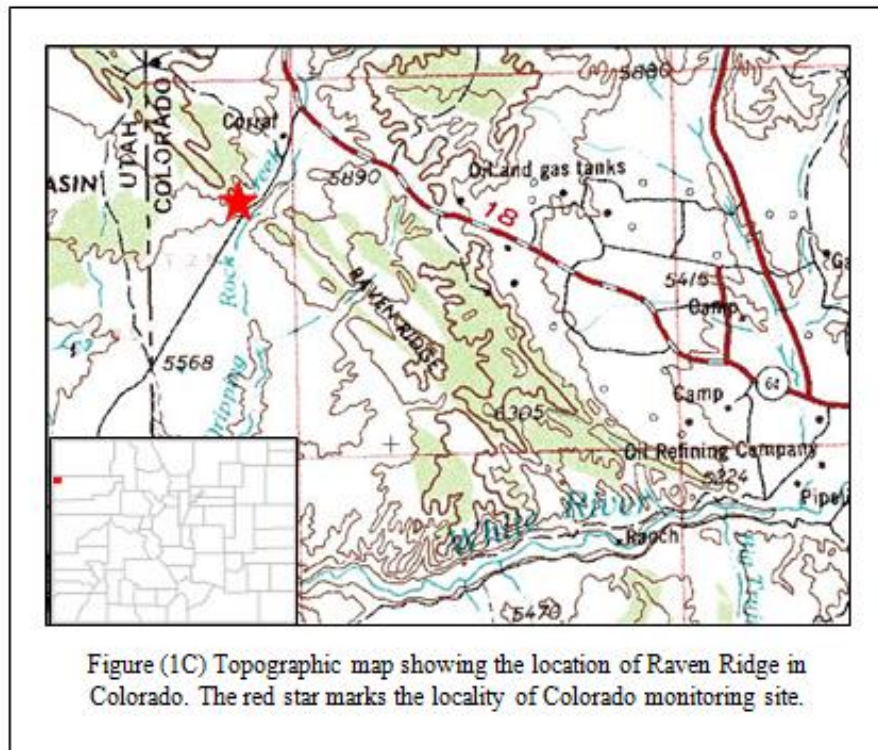

Figure (1C) Topographic map showing the location of Raven Ridge in Colorado. The red star marks the locality of Colorado monitoring site.
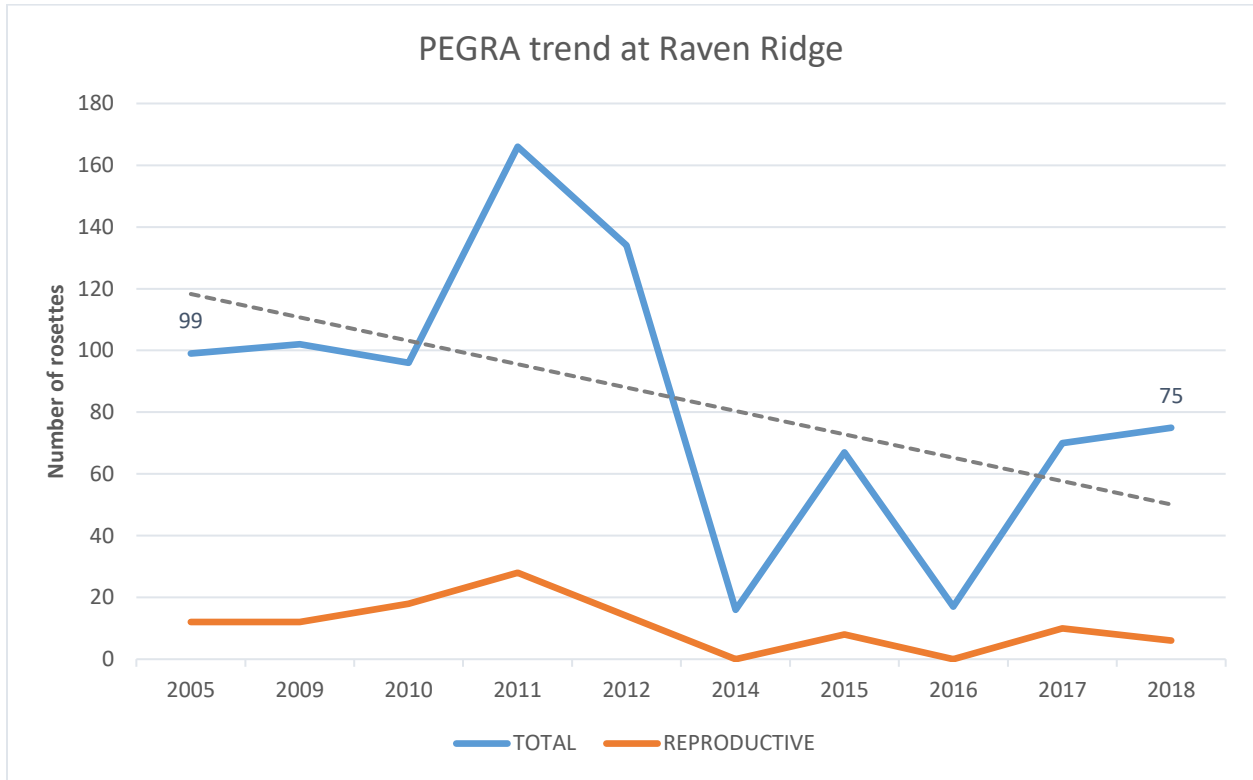
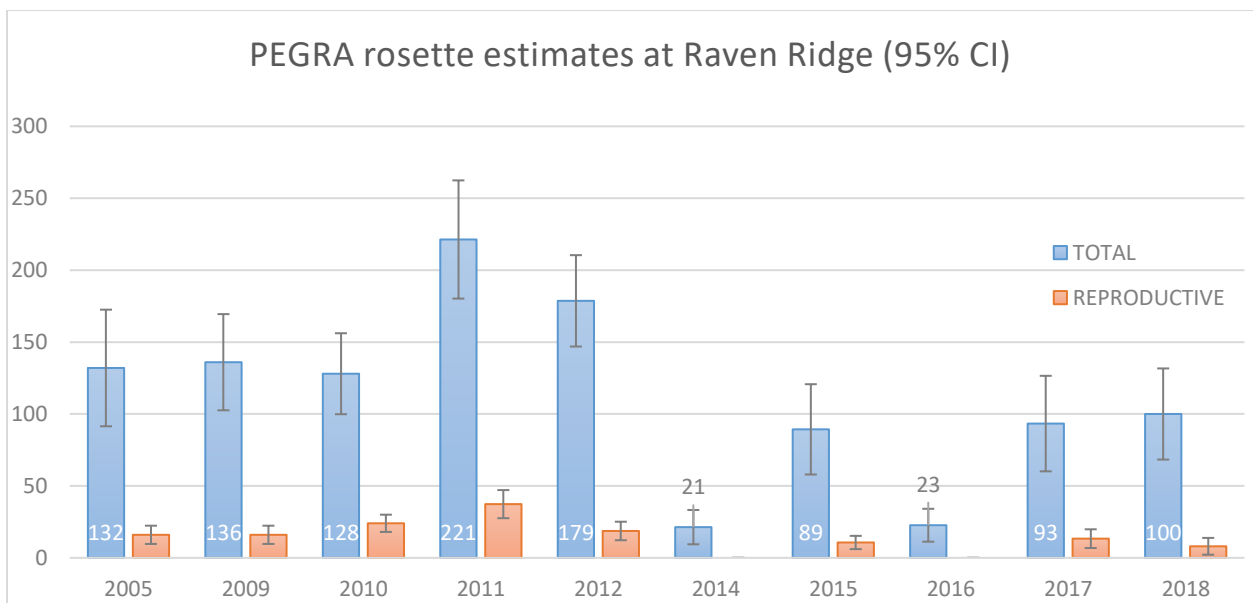**Figure 1.** PENGRA trend at the Raven Ridge study site

Figure 2. Estimated PENGRA population values at the Raven Ridge study site with 95% CI
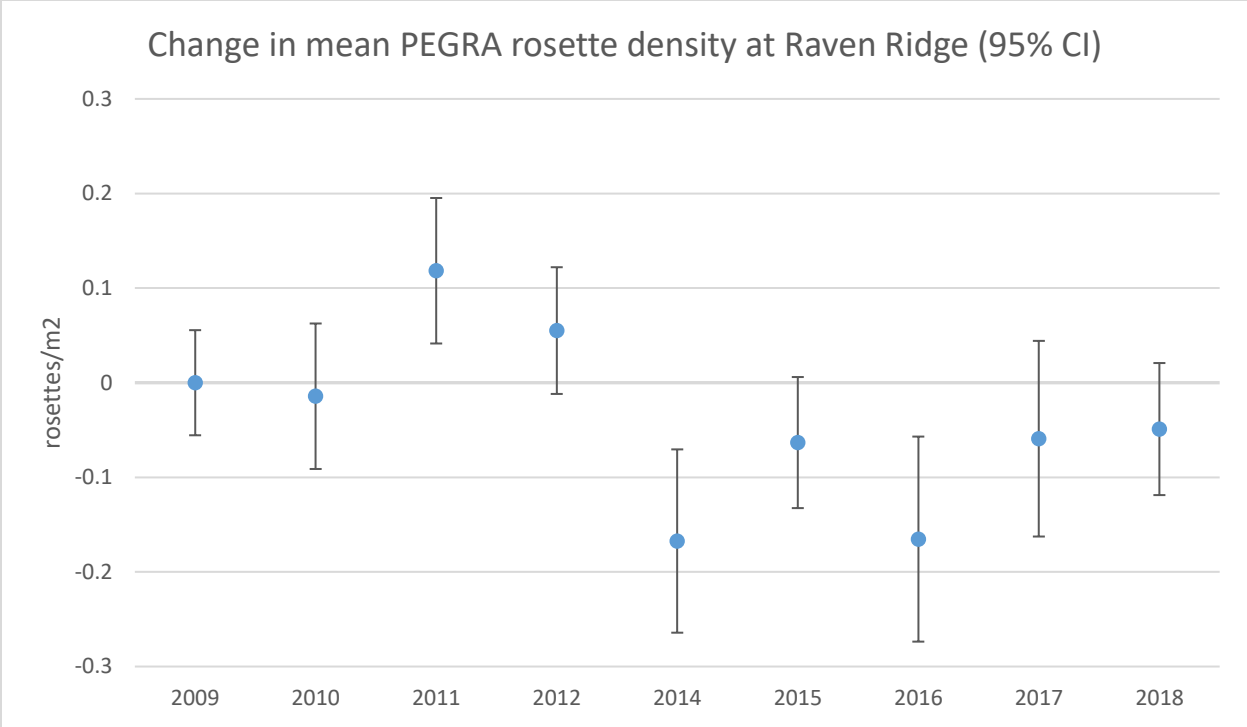
Figure 3. Change in mean PENGRA rosette density at the Raven Ridge study site with 95% CI