MONITORING *PENSTEMON GIBBENSII* (GIBBENS' BEARDTONGUE)

IN SOUTH-CENTRAL WYOMING – 2016-2021

Prepared for the Bureau of Land Management
Wyoming State Office and Rawlins Field Office

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ABSTRACT

This project is a final report on *Penstemon gibbensii* (Gibbens' beardtongue) monitoring in Wyoming. It marks the culmination of monitoring in 2016-2021 to update the long-standing monitoring of the Cherokee Basin population started by BLM in 1985, and to compare results with those of a nearby population, the Sand Creek population. The 2021 monitoring results demonstrate that population numbers remain low in the Cherokee Basin transects and remain high in the Sand Creek transects. The two populations have essentially the same climate and so differences in trend between the two populations are attributed to habitat differences. The original 1985 question whether the species could be protected from extinction at Cherokee Basin when this was the only known location has become a broader set of questions that no longer have the same urgency but at least as great a need for information reviews and an opportunity for interstate coordination.

Report citation:

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Front cover: . Note that all photographs in this report are by the author.

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ACKNOWLEDGEMENTS

This monitoring reflects the initiative and labor of Bureau of Land Management (BLM) and Wyoming Natural Diversity Database (WYNDD). BLM range specialists designed the exclosure and initiated monitoring of *Penstemon gibbensii* in 1985 at Cherokee Basin, the earliest of maintained plant monitoring programs by Bureau of Land Management in Wyoming. Walter Fertig (WYNDD) initiated monitoring of *P. gibbensii* in 1995 at Flat Top Mountain. The two different monitoring studies were pursued jointly by BLM and WYNDD starting in 2007 and expanded to include Sand Creek in 2011. Monitoring in 2011 took place with the help of Andy Warren, Frank Blomquist, Susan Chambers and Emma Stewart (BLM). More recently, it took place in 2020 with the help of Frank Blomquist and Aimee Huff (BLM Little Snake Field Office), and in 2021 with the help of Frank Blomquist and Hannah Gurrieri (WYNDD). The 2016 monitoring study was funded under Cooperative Agreement No. L12AC20036. Subsequent support for *Penstemon gibbensii* monitoring was under Cooperative Agreement No. L16AC00389 as coordinated by Chris Keefe, Brad Jost and Frank Blomquist.

INTRODUCTION

The purpose of this monitoring work is to document *Penstemon gibbensii* population trends in Wyoming. It compares trends of the Cherokee Basin and Sand Creek populations, building on earlier monitoring work (Warren 1992). It is the final in a series of interim monitoring reports for the two populations (Heidel 2017, 2018, 2019, 2020, 2021a), augmenting the most current status information in which:

> " Prolonged drought appears to be responsible for the population declines in the state, as documented at two monitored sites and estimated at a third. Population declines exceed an order of magnitude at Cherokee Basin, where this appear to be associated with extreme erosion" (Heidel 2009).

This is a monitoring study that is best explained in background information about the evolving state of knowledge over time.

BACKGROUND

Penstemon gibbensii was first recognized as a species when it was described by Robert Dorn (Dorn 1982) based on his collections of it in 1981 at Cherokee Basin (BLM Rawlins Field Office in Sweetwater County). This location is the type locality. The species was designated as a Category 2 candidate for listing under the Endangered Species Act by the U.S. Fish and Wildlife Service (USFWS) in 1983. At that time, the only known population was the type locality at Cherokee Basin. Under Bureau of Land Management (BLM) Manual 6840, the BLM is directed to manage USFWS candidate species in such a manner that ensures these species and their habitats are conserved and that agency actions do not contribute to the need to list these species as Threatened or Endangered (Willoughby et al. 1992). To protect the plant and prevent the need for listing it, plans were developed for constructing an exclosure, discussed in the Divide Grazing EIS (1983) in the BLM Rawlins Field Office. The exclosure was constructed in 1985.

The Bureau of Land Management (BLM) initiated monitoring of Penstemon gibbensii in 1985 upon completing construction of the Cherokee Basin exclosure to test species' response to excluding livestock, and excluding both livestock and big game, as compared to its trends in unfenced habitat as the control. Mark Andrew (Andy) Warren and BLM colleagues replicated monitoring of P. gibbensii in 1988 and 1991, and the first monitoring/evaluation report was prepared in 1992 reporting a threefold increase in total population numbers between 1985-1991, and with similar trends in both treatments and the control (Warren 1992). Monitoring was later replicated in 1997, 2001, 2004 and 2007 by Warren and BLM colleagues, i.e., at 3-6 year intervals with results stored in manual agency files. The original purpose for monitoring *Penstemon gibbensii* at Cherokee Basin was to evaluate its management response. Over time, it became a gauge of species' trend under natural conditions.

A complete review of *Penstemon gibbensii* documentation and agency designation through 2008 was reported in Heidel (2009), bringing the total number of Wyoming populations to six, and out-of-state population numbers reported as three (Figure 1). Since then, a new Colorado population was discovered by D. G. Malone in 2017 (Malone et al. 2018). It is the only

Colorado population that is located close to Wyoming populations, and it is located about 5 miles south of the Cherokee Basin population (south of the southwesternmost Wyoming point in Figure 1). The new Colorado population is at Powder Wash overlooking the Little Snake River. It is the only one that is located close to Wyoming populations, only about 5 miles south of Cherokee Basin (Malone et al. 2018). Though it is slightly lower than the nearby Wyoming populations, at about 6250 ft, it is located on a ridgetop rather than midslope or toeslope positions like Cherokee Basin and Sand Creek, respectively.

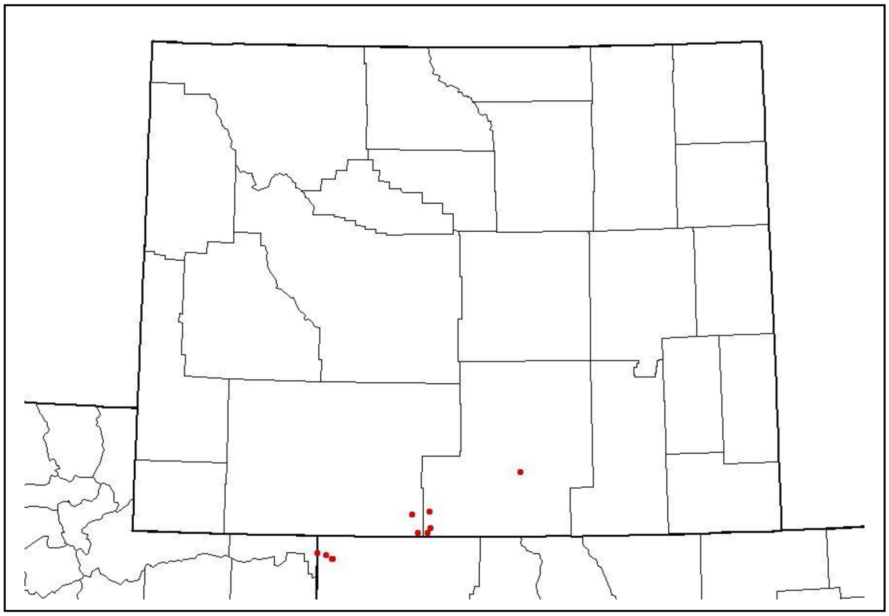


Figure 1. Nine populations of *Penstemon gibbensii* as reported in Heidel (2009).

The 2009 report mentioned that *Penstemon gibbensii* was included among a list of 206 species that was petitioned for listing in 2008 under the Endangered Species Act. A determination was made that the listing of *P. gibbensii* was not warranted on June 9, 2011 (USDI Fish and Wildlife Service 2001). [Federal Register 76(111):33924-33965].

Penstemon gibbensii is designated as a sensitive species by BLM state offices throughout its distribution. Colorado and Utah populations of *P. gibbensii* are not monitored, and though there have been revisits, different segments have been covered by different people with different objectives, complicating interpretation. There might be slight decline in one Colorado population area in the past, and stability in another (Jill Handwerk, pers. commun. 2017), but no reports of major declines in other states as evident in the Cherokee Basin population and possibly other Wyoming populations.

STUDY AREA

Penstemon gibbensii study sites are in the Washakie Basin in Sweetwater County and immediately adjoining Carbon County (Figure 2). The Sand Creek population is more extensive than the Cherokee Basin one, straddling Sand Creek, at slightly lower elevations (6260-6360 ft vs 6500-6600 ft,), and with transects that are six miles east of the Cherokee Basin transects.

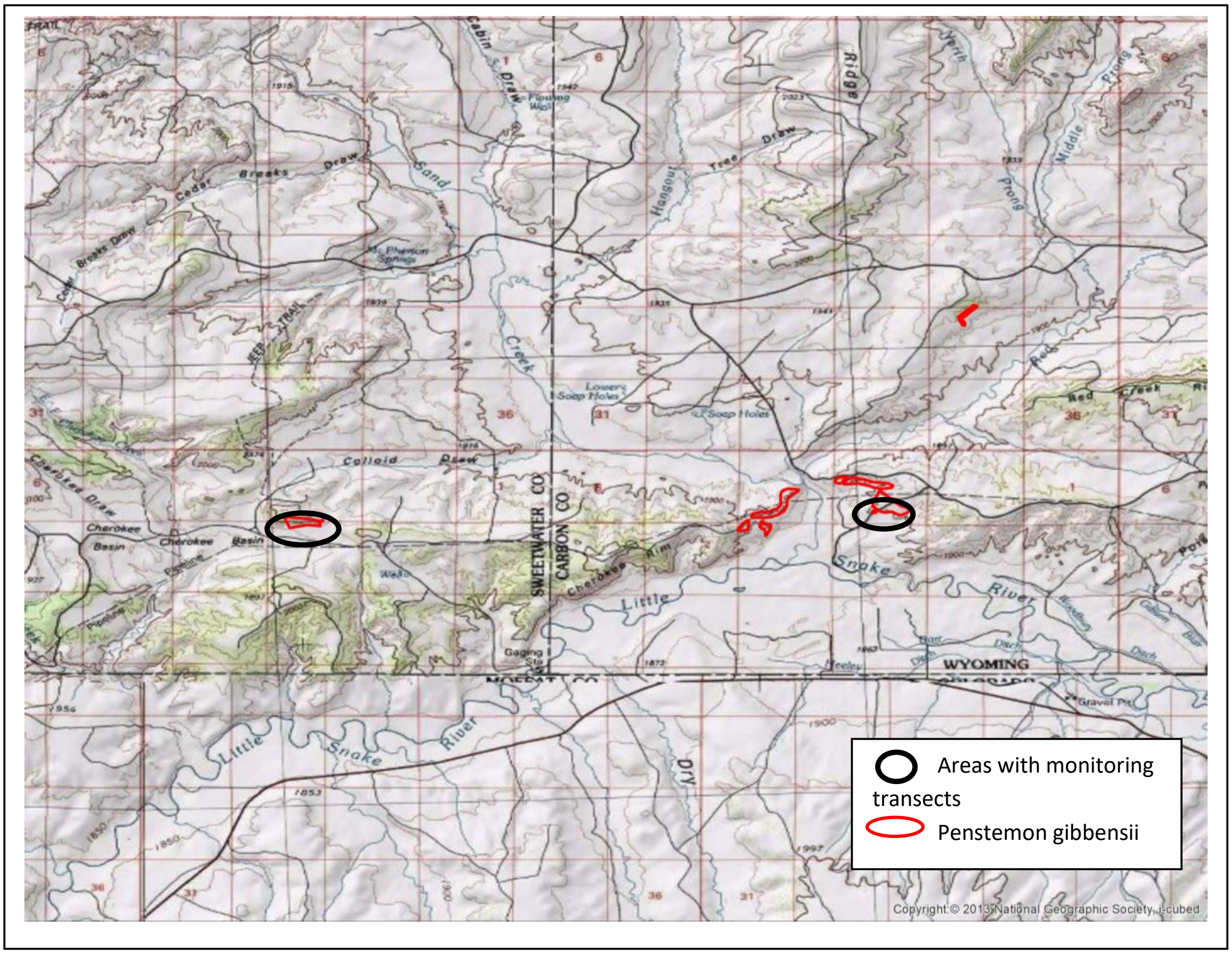


Figure 2. *Penstemon gibbensii* populations at Cherokee Basin (left) and at Sand Creek (right)

The species grows on exposed slopes with limited soil development. The Cherokee Basin population occupies steep slopes that are highly erodible. The Sand Creek population is also on south-facing slopes but the slopes are in a toeslope position of less than 5° and less vulnerable to erosion. Their soils have high volcanic ash content, which limits soil development (Heidel 2009).

A third monitored population at Flat Top is also referenced but it is less-suited for comparison because it has a much smaller sample area, its location is distant at a higher elevation and topographic position, and the sampling was set up differently. The monitoring location and design information for all three are detailed in Appendix A (Heidel 2019) and accompanied by aerial imagery, mapping, schematic monitoring diagrams, and record of data collected for all three monitoring locations. Overviews of the monitoring designs are presented in Table 1.

METHODS

The study design for *Penstemon gibbensii* monitoring in Wyoming is the belt transect, a permanently marked elongate sample area through high density population segments, in keeping with the population trend approaches discussed by Lesica (1987). However, it differs from the recommended design in that it runs perpendicular to the slopes rather than in homogeneous habitat parallel to the slope along the same contour. The latter may not have been an option if the pattern of individual *P. gibbensii* plants ran down slopes rather than across them.

The Cherokee Basin *Penstemon gibbensii* monitoring was set up in 1985 in five transects; three in a tall exclosure (8 ft tall), one in a contiguous medium exclosure, and one outside the exclosures. The contiguous exclosures total about 10 ac. It was designed to address species' management response to different grazing regimes (ungrazed, grazed by native ungulates only, and open to all grazing). The tall exclosures enclosed over 80% of the occupied habitat of *P. gibbensii* at the Cherokee Basin site, preventing entry by big game and livestock. A smaller, 3-strand barbed wire exclosure covered 15% of the habitat, preventing entry by livestock. The remaining 5% of occupied habitat was unfenced, located outside the exclosures. There are no exclosures at the other two monitored populations, which are within large livestock grazing allotments that were previously sheep grazing allotments.

The Cherokee Basin transects are marked by fence stakes 110 feet apart. A 150 ft measuring tape is extended between the stakes (bottom to top) in which the sample area is 100 ft long x 1 chain (5 ft) wide, and with a 5 ft interval at upper and lower ends that is not read. The sample area is to the right (east) of the tape (facing uphill, standing at the fence stake). Data have been recorded in 5 ft x 10 ft subsample areas, including the tally of *Penstemon gibbensii* by category (mature/seedling as later changed to big/small), and the tally of every other species present. These density and frequency data are recorded on a BLM Range Trend Plot Data Worksheet and the upper half of the worksheet is used to record *Penstemon gibbensii* coordinates. Each worksheet is labelled by the transect number.

In 2011, monitoring of *Penstemon gibbensii* at the Sand Creek population was started to provide trend comparison with the nearby population at Cherokee Basin population. These populations have essentially the same climate but the habitats differ, providing an initial way to evaluate whether or not the population trends at Cherokee Basin represent species' rangewide trends. It followed the same sampling design, except that the Sand Creek population is not in an exclosure like the Cherokee Basin population. It also differed in that there are only two transects, and they are read on both sides of the tape (a: west side, and b: east side).

The presence of more than one transect also allows for the possibility of detecting differences between locales and associated habitat variation. For purposes of simplified analysis, this report shows the pooled datasets without referring to separate transect data, except that the transects at Cherokee Basin are grouped by exclosure categories (high exclosure, medium-height exclosure, and outside of exclosures).

We have used only half of the Sand Creek dataset because in 2017, only the west side of Sand Creek transects were read. Each worksheet is labelled not only by transect number, but whether whether it is the first or second of sample areas within a 5 ft x 10 ft sample area (lower vs upper, recorded as a vs b).

Table 1. *Penstemon gibbensii* monitoring design overview

Population/ EO#	**No. of transects**	**Establishment year**	**Management variable(s)**	**Total transect length and belt area monitored**	**Plant categories (original)**	**Veg. composition**
Cherokee Basin/ #001	5	1985	Exclosure (high, med, outside)	5- 100 ft x 5ft transects = 2500 ft² (232.25 m²)	Mature, Seedling	Yes
Sand Creek/ #002	2	2011	None	2- 100 ft x 10 ft transects = 2000 ft² (185.8 m²)	Big, Small, Seedling	Yes
Flat Top/ #003	3	1995	None	55 m x 0.5 m within 3 variable length transects = 148 ft² (13.75 m²)	Veg., Reprod., Seedling	Yes - Added in 2016

Penstemon gibbensii monitoring was replicated at both Cherokee Basin and Sand Creek in 2016. The original monitoring at Cherokee Basin was set to be re-read every 3-6 years, based on the premise that *P. gibbensii* is a short-lived perennial and that an intermittent monitoring frequency could provide the most substantive population trend results for the time invested. We increased the frequency of monitoring at Sand Creek to every year to detect finer-scale differences between years. Revisits were judiciously made to Cherokee Basin to replicate census (2019-2021).

A record of *Penstemon gibbensii* monitoring is presented in Table 2.

Table 2. *Penstemon gibbensii* monitoring log in Wyoming

Investigators\ Population (Occur. No.)	**Cherokee Basin (#001)**	**Flat Top (#003)**	**Sand Creek (#002)**
Warren, Nelson	1985-08-02	-	-
Warren, Greenquist	1988-07-29	-	-
Warren, Fradl	1991-08-01	-	-
Fertig, Struttmann	-	1995-08-05	-
Warren, Blomquist	1997	-	-
Warren, Blomquist	2001-07-26	-	-
Warren, Blomquist	2005-08-06	-	-
Warren, Blomquist, Heidel, Biasotti, Wade	2007-07-16	-	-
Blomquist, Heidel, Larson	-	2008-07-16	-
Warren, Blomquist, Heidel, Chambers, Stewart	2011-08-04	-	2011-08-05
Warren, Blomquist, Heidel, Tyree	2016-08-01	2016-08-02	-
Blomquist, Heidel, Battisti, Donahue	2017-07-28[1]	-	2017-07-29
Blomquist, Heidel		-	2018-08-2 and 3
Blomquist, Heidel, Wolken, Weldon, Zelman	2019-08-06	-	2019-08-1 and -2
Blomquist, Heidel, Huff	2020-08-01	-	2020-07-30
Blomquist, Heidel, Gurrieri	2021-07-29		2021-07-27 and 28

Note: The Flat Top site was also considered for comparison but is erodible, its original sample area is much smaller (less than 14 m^2) and it is at a greater distance and different elevation from Cherokee Basin and Sand Creek and with a slightly different design (metric units, different categories of species' information, frame placement at alternate intervals along the transects rather than continuous ones). The three Wyoming monitoring sites represent half of known populations in the state and a wide range of settings.

Complete census of the Cherokee Basin population was not part of study design due to the steep, erodible slopes (Warren 1992). Instead, there has been a practice of walking throughout the exclosure on the contours after the transects are read, to come up with a minimum tally that has been called the "walk count." It was described as only 33-50% of actual numbers in early years.

Plants were originally tallied in the Cherokee Basin in one of two categories: "mature" or "seedling" (Warren 1992) analogous to flowering and nonflowering. To the best of our understanding, true seedlings were never observed at Cherokee Basin between 1985-2019 – until 2020. In 2020, a total of eight seedlings showed up in three transects. By contrast, seedlings have been found at Sand Creek in low numbers for the past three years.

[1] A visit to seek seedlings was conducted in 2017. No seedlings were found, and no established plants were found in the transects. It was not conducted with the same level of scrutiny and not incorporated in monitoring results.

The original Cherokee Basin monitoring design also recorded every vascular plant species present and a tally of them to document composition over time. This same practice was added to Sand Creek population monitoring and to the Flat Top population monitoring.

MONITORING RESULTS

Monitoring results at Cherokee Basin show less difference between treatments (tall exclosure, medium-height exclosure, and the control outside exclosures) than between years (Figure 3). Major decline took place in all treatment settings by 2004. In 2019, *Penstemon gibbensii* was almost absent from monitoring transects in all three treatments (Heidel 2020). But the next year, true seedlings were reported for the first time (Heidel 2021a).

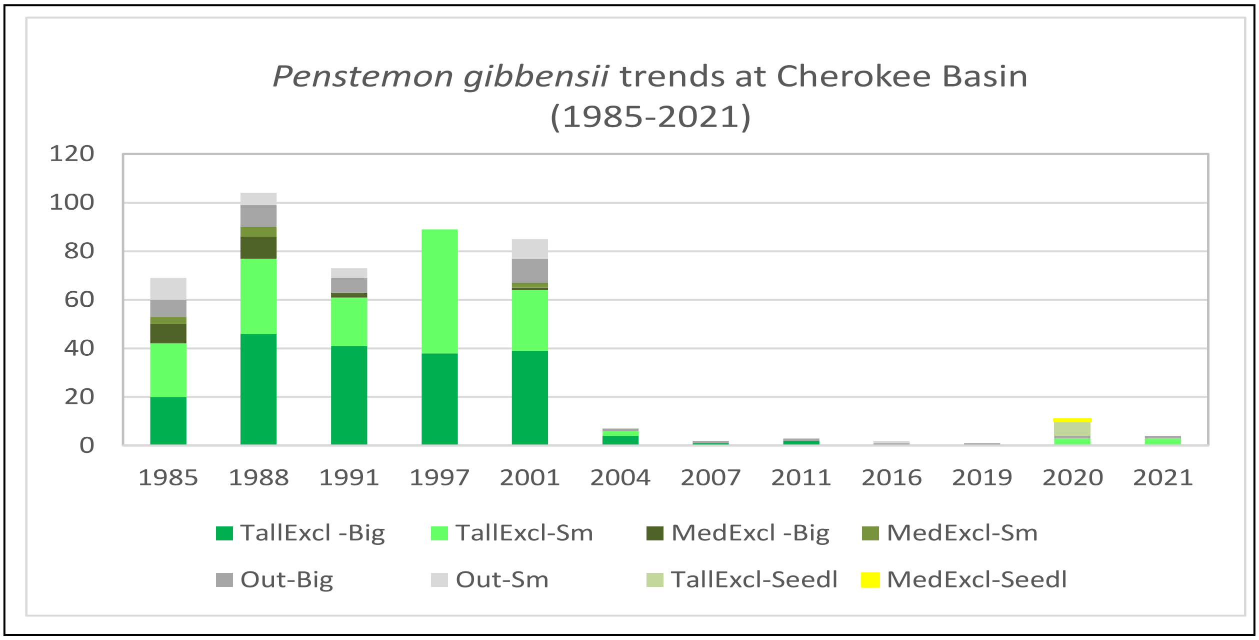


Figure 3. *Penstemon gibbensii* trends at Cherokee Basin (1985-2021) – showing trends by size class and by exclosure category[2]

Complete census of Cherokee Basin population size was not part of study design due to the steep, erodible slopes (Warren 1992). Instead, there has been a practice of walking throughout the exclosure on the contours after the transects are read, to come up with a minimum tally that has been called the "walk count." It was described as only 33-50% of actual numbers in early monitoring years, but has taken on greater proportions as numbers decline. In 2021, the walk count was 19 plants, down from 27 plants in 2019 as highest in recent years.

[2] Tall Excl is the 8 ft tall high exclosure that excludes both big game and livestock. Med Excl is the 3 ft tall medium exclosure that excludes livestock. Outside Excl is directly adjoining but outside exclosures. Note: 1997 had the highest tally of plants in the High Exclosure of any monitoring year but transects were not read that year in the Medium Exclosure or Outside the Exclosures.

By comparison, monitoring results at Sand Creek show stable or increasing trends between 2011-2021 (Figure 4), with peak numbers in 2021, and the presence of seedlings in most monitoring years.

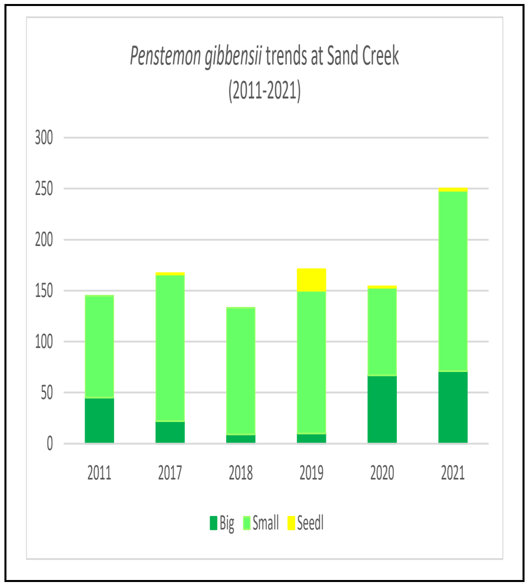
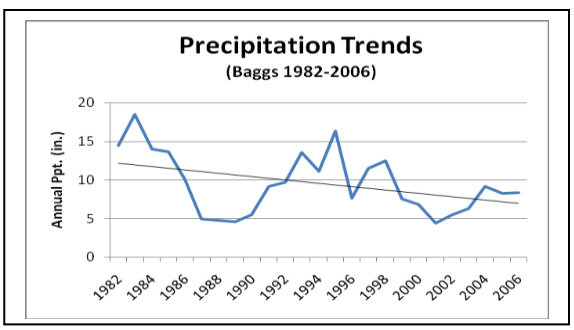


Figure 4. *Penstemon gibbensii* trends at Sand Creek (2011-2021) – showing trends by size class[3]

EVALUATING CLIMATE CONDITIONS

Climate at the two monitoring sites (Cherokee Basin, Sand Creek) is similar, with only 6 miles distance between them. Climate data is available from three sources. The nearest NOAA monitoring station was in Baggs, WY (USDI NOAA 2006), but data collecting was discontinued after 2006. Average annual precipitation in NOAA data is reported as 10.72 in (based on 1979-2006), and mean annual temperature is reported as 42.8 °F (based on 1979-2006). Superimposing a linear regression line on NOAA data (1982-2006) suggests overall decreases in precipitation and a stable or slightly increasing temperature. Though annual precipitation was low during the years when population numbers dropped, the precipitation was lower at the time the exclosure was established and annual temperature differences were minor (Figure 5).



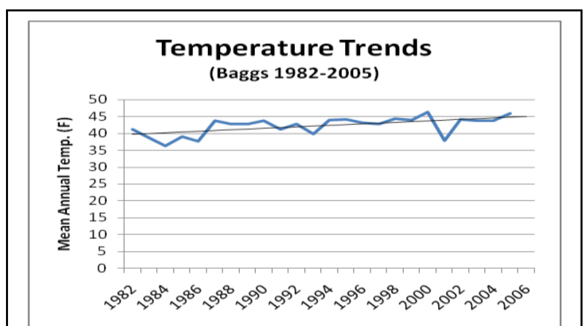


Figure 5. NOAA annual precipitation and mean temperature in Baggs, WY (1982-2006)[4]

[3] In 2017, only one side of the Sand Creek transects was read, so that that prior and subsequent results are edited to show the identical sample area over time, and represent just half of the sample area in Table 2.

[4] NOAA data from 2004-2006 includes more than one month in which data are missing for most of the month.

Warren (1992) reported rain gauge measurements from two BLM rain gauges 2.5 and 3 miles from the Cherokee Basin population as having 8.3 in. and 8.9 in. annual average over a 25 year period, and with variability between 1981-1991 that ranged from +49% above average to -50% below average. Even though the last four years of that rain gauge data (1988-1991) were all below average, at a time when *Penstemon gibbensii* numbers increased, it was hypothesized that "Warm season species like *P. gibbensii* could take advantage of summer thunderstorms after other species had stopped growing or completed their life cycles." The rain gauge results mirror the NOAA results for the 1980s (Figure 5).

A third approach to representing climate at *Penstemon gibbensii* locations was developed using PRISM data as a modeled, interpolation of climate data. The PRISM dataset represents year-round data from Cherokee Basin going back to 1950, sought to evaluate both precipitation and temperature trends (minimum, mean and maximum) on a seasonal basis. They indicate that conditions are much more arid than in Baggs. The 70-year average annual precipitation for the Cherokee Basin area was 3.36 in., with minimum/maximum values of 1.84 in-5.31 in. PRISM data was also set up in quarterly periods (Winter=Jan-Mar; Spring=Apr-June; Summer=July-Sept, and Fall=Oct-Dec) for exploratory data purposes to highlight seasonality of trends and flag major changes (Figure 6). Three trends stood out: increases in Winter Precipitation, increases in Winter Temperature Minimums, and increases in Summer Temperature Means.

Tilini et al. (2016) used PRISM data to focus on that portion of precipitation that arrives during the dormancy months of the year (November thru March) for an average over a 30-year period (1980-2010) (Table 3) for the three populations where *P. gibbensii* seeds were collected. Winter precipitation has importance for Intermountain *Penstemon* species. The three populations studied by Tilini et al. (2016) span the range in elevation for the species from the lowest elevation (Brown's Park, UT) to one at upper elevation values (Flat Top, WY). The Sand Creek climate conditions correspond to those nearby at Cherokee Basin.

Climate of three *Penstemon gibbensii* locations addressed in seed ecology research (from Tilini et al. 2016)

Population location	**Elevation (m)**	**Setting**	**Nov-Mar ppt (mean, mm)**	**Nov-Mar temperature (mean, °C)**
Brown's Park, UT	1700	Unknown	59	-1.1
Sand Creek, WY	1900	Toe slope	116	-3.3
Flat Top, WY	2320	Upper slope	189	-2.6

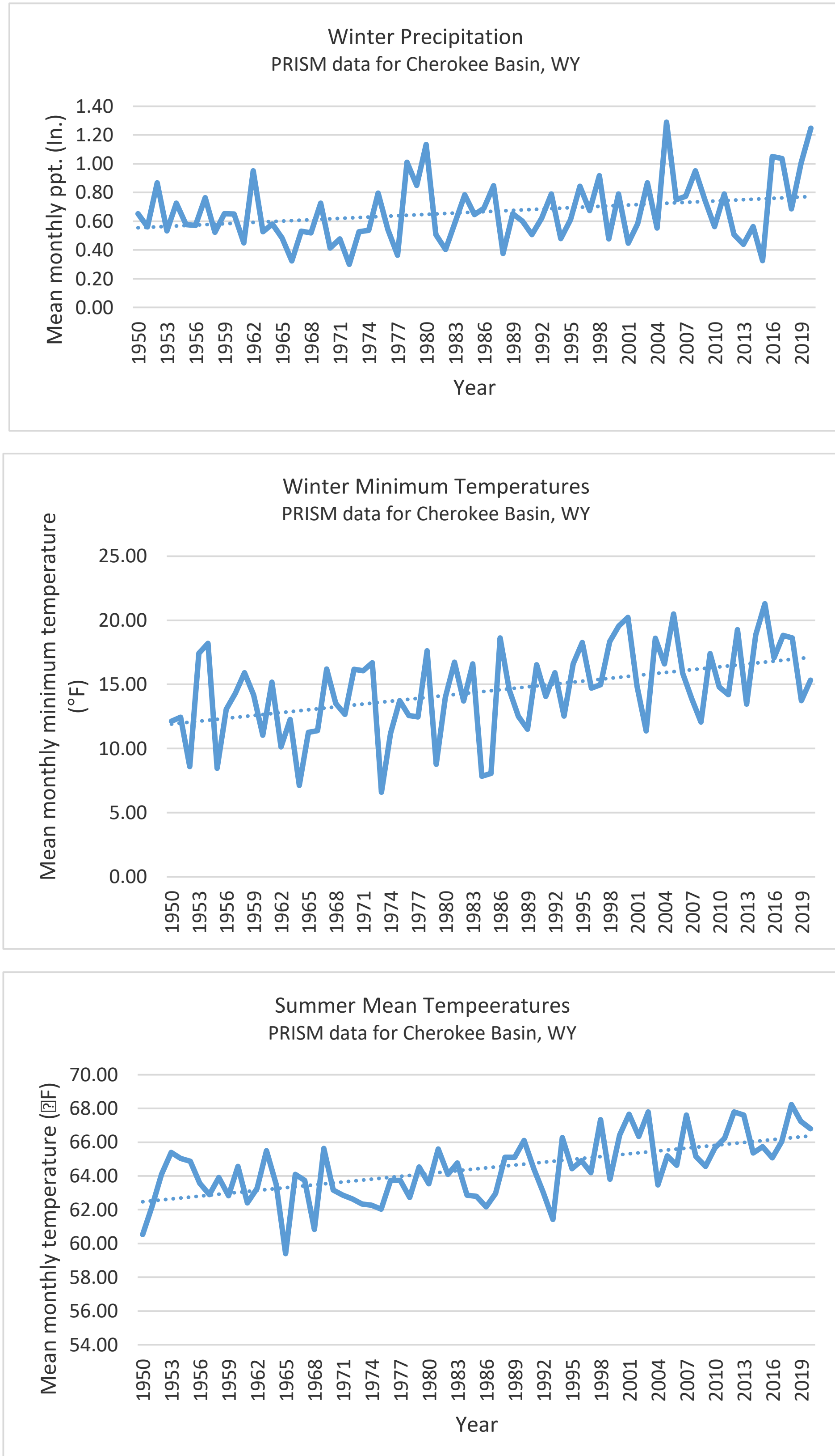


Figure 6. PRISM data for Cherokee Basin area showing change (1950-2020), including:

A. Winter precipitation

B. Winter minimum temperatures, and

C. Summer mean temperatures

EVALUATING SOILS CONDITIONS

Soil conditions differ between the Wyoming population settings (Table 4; from Heidel 2009) showing that soils at Cherokee Basin are much more finely-textured than at Sand Creek.

Table 4. Soils analysis for *Penstemon gibbensii* sites in Wyoming[5]

	SAND	SILT	CLAY	CACO3 EQ	COLOR	COLOR
	%	%	%	%	DRY	WET
CHEROKEE BASIN	27	40	33	5.45	2.5 Y 7/3	2.5 Y 5/2
SAND CREEK	77	13	10	0.71	2.5 Y 6/4	2.5 Y 6/4
FLAT TOP	45	43	12	0.14	2.5 Y 7/3	2.5 Y 4/3
SHEEP ROCK	82	10	8	4.82	2.5 Y 7/3	2.5 Y 4/3
WILLOW CREEK	35	43	22	0.46	2.5 Y 6/6	2.5 Y 4/4
RED CREEK	85	3	12	0.18	2.5 Y 7/3	2.5 Y 6/3

Soil samples at *Penstemon gibbensii* sites in Wyoming were run through x-ray diffraction. Results indicated that either clinoptilolite (Na,K,Ca)2-3 Al3(Al,Si)13 O36 – 12H2O, a zeolite mineral; or anothorite Ca (Al2Si2O8), a feldspar mineral are present (Table 5). Both sites have high quartz content but Cherokee Basin also has high Anorthite. They are consistent with zeolites that form from volcanic ash deposits in a marine environment. They are generally characterized by their ability to lose and absorb water without damage to their crystal structures. Clinoptilolite in particular is like a natural molecular sieve having a large amount of pore space, high resistance to extreme temperatures, and a chemically neutral basic structure. It forms as a result of devitrification of volcanic glass in tuff.

Table 5. Mineralogy of *Penstemon gibbensii* soil samples[6]

	Analcime (a zeolite) %	**Anorthite (a feldspar) %**	**Calcite %**	**Clinoptilolite (a zeolite) %**	**Gypsum %**	**Microcline (a feldspar) %**	**Quartz %**
Cherokee Basin		45.2?	4.6	X			50.2
Sand Creek				X			100
Flat Top Mountain				X			X
T84N R18W		88.7?		X			11.3
Willow Creek	5.5			X	14.8		79.7
Red Creek		28.9?		X		56.9	14.1

sis of Cherokee Basin soil, provided by BLM Lab (Worland)

[5] Table 4 Soils analyses were conducted at University of Wyoming Soils Testing Lab. From Heidel (2009)

[6] Xray diffraction analysis of soils were provided by BLM Lab (Worland)

The soils at Cherokee Basin are sterile, and the chemistry of volcanic ash is associated with unconsolidated soil structure and little or no profile development.

Figure 8. Photo records from Cherokee Basin showing water erosion in 2011

A. Soil erosion features at the Cherokee Basin site included rill and gullying patterns, observed at their extreme in 2011 (Transect 1)

B. A *Penstemon gibbensii* vegetative plant at Cherokee Basin in 2011.

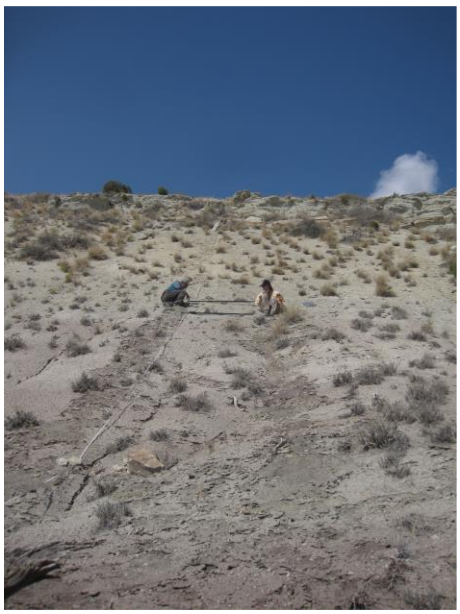


Figure 9. Soils in occupied habitat at Cherokee Basin are powdery and highly friable. Foot traffic is kept outside of the belt transect area as viewed in 2021 (Transect 1, same as Figure 8A).

Climate and soils interact. For example, in 2011 visits to Cherokee Basin, pronounced rill erosion was noted. It may be that persistence of the seedbank and survival of plants is changed not just by annual, seasonal or monthly conditions but also by short-term events, whether they are heavy rains, extreme heat, low snowcover or other conditions. It is also likely that the steep south-facing slopes of Cherokee Basin have much less percolation than the gentle south-facing slopes of Sand Creek (Figures 8-9).

Another observation of note was the 2021 documentation of *Penstemon gibbensii* in flower on 30 October, as photographed by Russell Duncan (Duncan pers. commun.), consultant at Sand Creek. It is possible that the "tails" of the growing season, in early spring and late fall, may be as important if not more so in seed production, survival and mortality.

UNEXPECTED INFORMATION

In 2020, surveys for a rare rockcress (*Boechera crandallii*) at Poison Buttes by WYNDD instead turned up small numbers of *Penstemon gibbensii* plants on the five biggest knolls. Also in 2020, consultants surveyed for TES plant species along a proposed transmission line route and located it about 0.2 mi (0.3 km) north of the Cherokee Basin exclosure on a north-facing slope. This new site was visited by BLM and WYNDD at the time of 2021 monitoring where it was relocated in fruit. We walked the nearest ridge to the north without finding it and did not extend surveys for it in nonflowering condition.

The Poison Buttes are sandstone parent material and may not have been considered in earlier surveys. Likewise, north-facing slopes may not have been considered in earlier surveys. These discoveries are evidence that habitat affinities are not fully characterized. We did not visit in time to initiate surveys in 2021.

The *Penstemon gibbensii* negative survey extent is shown in Figure 10, showing additional unsurveyed potential habitat to the north of Cherokee Basin and to the north of Poison Buttes. The Andersen et al. (2016) potential distribution model for *P. gibbensii* was the one used by consultants in 2020. One of the two new locations may be far enough from other populations to treat as separate populations, but intervening habitat has not been surveyed.

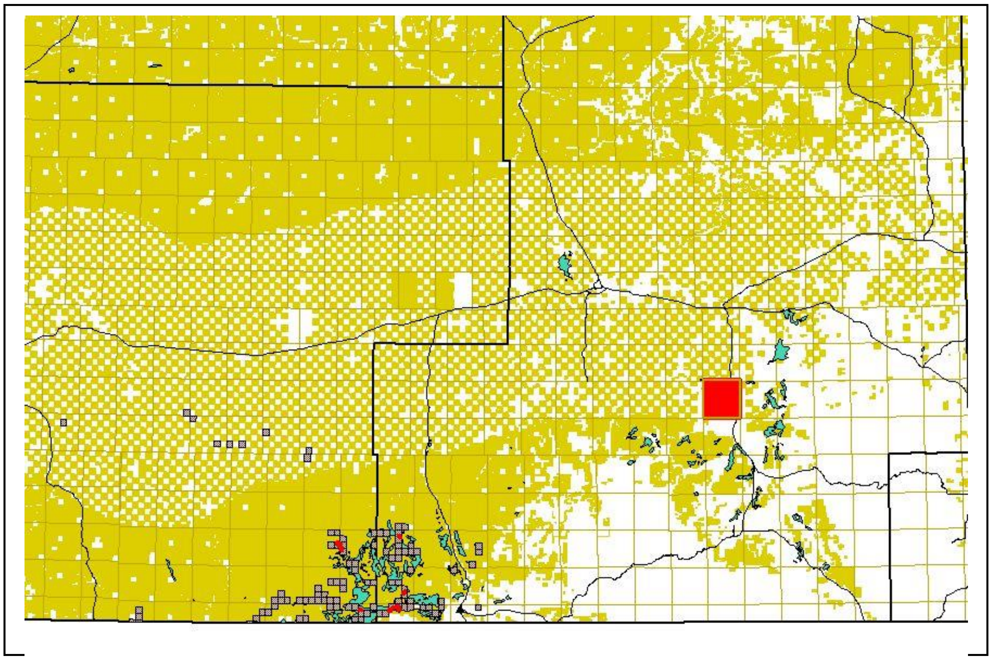


Figure 10. Current and potential distribution of *Penstemon gibbensii*, superimposed with negative survey results (Heidel 2009)

DISCUSSION

The number of *Penstemon gibbensii* plants at Cherokee Basin remains low, in sharp contrast to its high numbers at Sand Creek. It is postulated that this represents site-specific conditions reflecting seed bank depletion on the steep erodible slopes. In all years since 2001, flowering plants were in the minority compared to vegetative plants. The highest number of flowering plants recorded in the exclosure over the past three years is only 13, so that seed production limits the capacity for rebound.

Two of the other Wyoming populations have been reported as having declining numbers, including Flat Top population and the population in T18N R84W. The latter was regarded as the largest Wyoming population, estimated at 4500-5000 plants by Walter Fertig in 1999, but with numbers estimated at 500-1000 plants in 2008 by the author, and very much lower in a 2012 fieldtrip visit during a drought year. If the Cherokee Basin monitoring results are mirrored at these other two sites, then half of Wyoming populations have depressed numbers.

<u>Importance of seedlings</u>

Penstemon gibbensii is a short-lived perennial reliant on seeds to reproduce. During the course of Sand Creek monitoring in 2011, true seedlings were observed for the first time in all the years of monitoring. They were shorter than 2 cm and with cotyledons attached (Figure 11). What were originally called seedlings at Cherokee Basin were small vegetative plants. Seed production, seed germination and recruitment are life history bottlenecks in maintaining population numbers at Cherokee Basin.

Seeds of *Penstemon gibbensii* have strong primary dormancy and greatest sensitivity to environmental cues when imbibed rather than dry (Tilini et al. 2016). Conditions with extended below-normal precipitation have been hypothesized to account for no seedlings, as noted in 1995 on the heels of summer drought conditions (Fertig and Neighbours 1996). Another explanation is reflected in statements by Dorn (1989) who noted that the species appears to have limited reproductive success in most years because of dry conditions. Dorn made this statement when three more populations were known in addition to the Cherokee Basin one.

Figure 11. True seedling of *Penstemon gibbensii*, at Sand Creek in 2011. Note: Red stem, thickish in-rolled glabrous leaf, opposite leaves

Recruitment on steep slopes may be doubly-difficult because unconsolidated soils that are prone to erosion which can wash out seeds from suitable habitat. It appears that Cherokee Basin may be far more vulnerable to erosion as exacerbated by drought and storm cell events than the other five population settings in Wyoming. During 2011 monitoring, signs of rill erosion were noted (Figure 8).

Scenarios at Cherokee Basin

The exclosure is intact, and the original ladder to access it was replaced in 2018. More information comparing the habitat conditions inside the exclosure to the nearby location north of the exclosure would contribute habitat information if not a direct contribution to the study. The only seed material of the species ever collected for conservation was from a Colorado population in 1992, and deposited at a Center for Plant Conservation repository (Denver Botanical Garden; Jennifer Ramp O'Neale pers. commun.). Augmentation is not an appropriate activity at Cherokee Basin.

More complete survey of 2020 location immediately north of the exclosure is to be sought to determine its contribution to the population overall, and make at least a one-time characterization of flowering levels.

Monitoring recommendations

Monitoring of the Cherokee Basin population is recommended at least once every three years if the Gateway South Transmission line is constructed immediately west of the exclosure. This would include the new location immediately north of the exclosure. Monitoring records within the exclosure provide information on the paucity of *Bromus tectorum* (cheatgrass) and almost complete absence of *Halogeton glomeratus* (halogeton) in the transects for future monitoring reference. If further decline is documented at Cherokee Basin, then replication of Sand Creek monitoring is to be sought for context.

Not addressed

This project did not try to produce climate correlations. It is a little surprising that the annual NOAA precipitation values from Baggs were 3X greater than the annual PRISM precipitation values from Cherokee Basin only 16 miles away.

This project did not analyze vegetation data collected as part of species monitoring to determine if the dominant species or other segments of vegetation composition showed changes that paralleled *Penstemon gibbensii* patterns.

This project did not try to construct life history transition matrices for individual *Penstemon gibbensii* plants from one year to the next to quantify longevity.

This project did not replicate Flat Top monitoring because it has environmental conditions and sampling design that differ from both Cherokee Basin and Sand Creek.

Summary

This report will be distributed to BLM offices in other states for reference. A project file of Cherokee Basin monitoring records and design is appropriate to keep in BLM Rawlins FO and at WYNDD. We continue to learn more about the species itself, and a census at the two populations that might also be in decline is warranted. It is recommended that the length of Red Creek Rim be surveyed as well as sections to the immediate north of Cherokee Basin. Depending on outcome, a new status report or an update to the old one may be appropriate, especially if it brought together all data from the 3-state area into a single document.

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