STATUS REPORT ON *PENSTEMON ACAULIS* (STEMLESS BEARDTONGUE) AND *PENSTEMON YAMPAENSIS* (YAMPA BEARDTONGUE) IN COLORADO, UTAH AND WYOMING

Prepared for Western Lands Conservation Initiative,
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ABSTRACT

Stemless beardtongue (*Penstemon acaulis*) is a regional endemic known from Daggett and Uintah Counties, northeastern Utah, and adjacent Sweetwater County, Wyoming. The distribution of the Yampa beardtongue (*Penstemon yampaensis*), also a regional endemic taxon, is centered in western Moffat County, Colorado with additional distribution in Uintah County and eastern Daggett County, Utah, and a recently documented specimen from Sweetwater County, Wyoming. Surveys were conducted for the stemless beardtongue in Utah in 1991 and Wyoming in 2000 and more recently by the author in 2006-2011. *P. acaulis* is known from about 4,950 acres (4,350 acres in Utah, 600 acres in Wyoming) with population numbers estimated at hundreds of thousands in Utah and about 44,000 in Wyoming. Surveys for *P. yampaensis* have been limited to documenting the presence of this taxon in areas proposed for special protection in Colorado. There is no known survey of this taxon in Utah or Wyoming.

Quarrying, mining, land disturbance by all-terrain recreational vehicles and spray irrigation are of potential concern for habitat of *Penstemon acaulis* on public land. Additionally, cattle grazing on public land, as well as on private land, can be extremely detrimental to the survival of the taxon in areas where the animals congregate. The author has observed serious, local, negative impacts due to animal trampling. While *Penstemon yampaensis* is potentially exposed to the same impacts, three areas containing populations of this taxon have been designated Colorado Natural Areas thereby providing some protection. Populations on other public land areas in Colorado receive no protection. No protection is afforded to the Yampa beardtongue in Utah or Wyoming.

ACKNOWLEDGEMENTS

This report is an update that reflects and builds upon earlier reports on stemless beardtongue prepared by M.A. “Ben” Franklin for the state of Utah, 1992, and Walter Fertig and Laura Welp for Wyoming, 2001. I would like to thank Sherel Goodrich (Ashley National Forest) for the collegiality he has extended me, the free exchange of views and data and the occasional visits in the field. I also wish to thank Michael Menefee (Colorado Natural Heritage Program, CNHP) for data provided on *Penstemon yampaensis*. I am particularly grateful to Bonnie Heidel (Wyoming Natural Diversity Database, WYNDD) for first providing moral support to my field surveys and later offering material support in the form of maps and data and the opportunity of a contract to assist me in writing up the results from my field work of part of five summers in southwestern Wyoming, Utah and Colorado. The preparation of this report was supported by the Western Lands Conservation Initiative, Bureau of Land Management – Rock Springs Field Office, and U.S. Forest Service, in collaboration with Wyoming Natural Diversity Database.

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Cover Photograph: Color variation in *Penstemon acaulis* by Marcel R. Jouseau

I. INTRODUCTION

Penstemon acaulis (stemless beardtongue) and *Penstemon yampaensis* (Yampa beardtongue) are regional endemics of southwestern Wyoming, northeastern Utah and northwestern Colorado. However, to this date, *P. acaulis* has not been reported for Colorado. The status of *P. acaulis* was previously described in a status report of the taxon in Wyoming (Fertig and Welp 2001) and in Ashley National Forest (Franklin 1992). No regional status report has ever been produced for *P. yampaensis*. Colorado Natural Heritage Program has conducted a number of investigations for areas containing the taxon for the purpose of delineating potential conservation areas (Menefee personal communication 2012).

The interest of the author in modeling plant distributions led him to undertake independent field surveys for several years to collect *Penstemon acaulis* location data. During these surveys new populations of *P. acaulis* were discovered in Wyoming and Utah and the first specimen of *P. yampaensis* was recorded for Wyoming. Wyoming Natural Diversity Database (WYNDD) staff realized the significance of the new collections and supporting data, and asked if he would be willing to write about the information collected on *P. acaulis* and *P. yampaensis*.

II. METHODS

The primary purpose of the data collection undertaken by the author during the years 2006-2011 was to support the author's interest in developing a species distribution model for *Penstemon acaulis* and not to define the extent and ecology of extant or new populations of the taxon. Therefore the data collection focused on the presence/absence of the species, obtaining geographic coordinates of the presence/absence points and noting general landscape features that might confirm information available on geologic maps and soil maps or such other geographic information system (GIS) data. However, in 2011, areas mapped in 2009 and 2010 were re-visited to briefly record plant communities associated with *P. acaulis*, as well as make some estimate of plant distribution densities for the taxon. The author never prepared any of the traditional rare plant survey forms customarily prepared by botanists of the Wyoming Natural Diversity Database or of the Utah Natural Heritage Program.

At the start of the original project, information on labels of specimens of *Penstemon acaulis* and *Penstemon yampaensis* was requested from various herbaria (NYB, RM, BRY, USU, COLO, CS). Information on 56 vouchers of the stemless beardtongue and 47 vouchers of the Yampa beardtongue was collected from the various herbaria and collated. The status reports on *P. acaulis* prepared by Ben Franklin (Franklin 1992) and Walter Fertig and Laura Welp (Fertig and Welp 2001) were studied and large amounts of information were gleaned from these two reports. In 2005 and 2006, as a side trip to a mapping survey of the distribution of *Aquilegia jonesii*, various known populations of the stemless beardtongue were visited in order for the author to familiarize himself with the taxon and the environment. The author also spent a day at the Rocky Mountain Herbarium (RM) to study specimens on file.

In 2009, 2010, 2011 the author studied aerial photographs and USGS 7 1/2 minutes topographic maps of southern Sweetwater County, Wyoming and Daggett County, Utah to identify areas similar in character to areas of extant populations of *Penstemon acaulis*. During the periods of May 27 to June 2, 2009, June 4 to June 9, 2010 and June 9 to June 14, 2011 field surveys were undertaken. These dates corresponded with early to peak blooming period for the taxon to facilitate the surveys. Areas selected were surveyed on foot and presence/absence points of the taxon were recorded with a global positioning system (GPS) receiver Magellan Meridian Gold

model. The GPS unit was loaded with topographic maps showing not only elevation contour lines but also all roads, including forest roads, streams and other features allowing the surveyor to assess one's location relative to the landscape seen. Besides presence/absence records, notes including dates, points recorded, whether taxon present or absent, brief observations about the terrain and soils were recorded in a field notebook. The GPS unit recorded at all time the route hiked by the surveyor by recording every 10 meters the location of the surveyor, thus providing a detailed electronic trace of the areas actually surveyed. The presence/absence point files and track files were saved in the field on a digital flash drive. The name of each file was also recorded in the field book. Each evening, the data collected during the day were copied onto a laptop to provide a second copy and visualized with ArcView 3.3, a GIS software, on aerial photo to determine the quality of the data and extent of the area surveyed. Voucher specimens of *P. acaulis* and *Penstemon. yampaensis* were collected in areas believed to be unknown populations at that time. All specimens for Wyoming and Utah have been deposited at the Rocky Mountain Herbarium (RM) and Brigham Young University Herbarium (BRY), respectively. Information on all voucher specimens collected by this author and information collated from labels on herbarium specimens by other collectors are shown in Appendix A.

In 2006, the author collected a composite soil sample at each of six sites from points within extant populations of the stemless beardtongue. For each site three soil samples were collected, then mixed together and this mixed sample was re-sampled to extract one sample for the chemical analyses. Chemical analyses included: extractable phosphorus (Olsen-P), total nitrogen, calcium, magnesium, potassium, sodium, iron, manganese, zinc, copper, lead, nickel, cadmium and chromium. Staff of the Research Analytical Laboratory, Department of Soil, Water and Climate, University of Minnesota performed the soil analyses. Location of sampled points and results of the analyses are presented in Table 4.

In 2010 and 2011, limited excursions were made into Moffat County, Colorado for the purpose of surveying for *Penstemon yampaensis*. The methods for work on this taxon were exactly as described above for *Penstemon acaulis*. They included survey of herbaria for existing records, correspondence with staff from the Natural Heritage Programs and field survey. Departure from the methods associated with the work on *P. acaulis* included: accepting records for the Yampa beardtongue from knowledgeable members of the American Penstemon Society who could provide photographic evidence of the plant associated with GPS coordinates. No soil samples were collected from occupied habitat of *P. yampaensis*. Additionally, no voucher specimens were collected for this taxon in Colorado or Utah.

III. RESULTS- SPECIES INFORMATION

A. Classification

Since C.W.T. Penland described *Penstemon yampaensis* as a newly discovered species (Penland 1958), botanists have offered differing views regarding the classification of *Penstemon acaulis* and *P. yampaensis*. Dorn (2001) in his Vascular Plants of Wyoming treats *P. acaulis* at the species level. Cronquist et al. (1984) in volume 4 of the Intermountain Flora list both *P. acaulis* and *P. yampaensis* at the species level. Weber and Wittmann (2001), in their Colorado Flora: Western Slope, treat the Yampa beardtongue at the variety level as *P. acaulis* var. *yampaensis*. Welsh et al. (2008) treat both taxa at the varietal level such as *P. acaulis* var. *acaulis* and *P. acaulis* var. *yampaensis*. Botanists in the state of Utah have ranked the Yampa beardtongue at the varietal level as *P. acaulis* var. *yampaensis* following E. Neese publication of a New Taxa and Nomenclatural Changes in Utah *Penstemon* (Neese 1986). The author of the

popular book on Penstemons (Nold 1999) also treats the two taxa at the varietal levels. Herbaria outside Utah, authors of scientific papers (Broderick et al. 2011; Wolfe et al. 2006), the conservation organization NatureServe, and the American Penstemon Society continue to refer to the two taxa at the species levels. For expediency, in this report, the two taxa will be referred to at the species level.

***Penstemon acaulis* L.O.Williams**

1. Scientific name: *Penstemon acaulis* L.O. Williams (Williams 1934).
2. Synonyms: *Penstemon acaulis* (Williams) var. *acaulis* Neese, (Neese 1986).
3. Common name: stemless beardtongue.
4. Family: Plantaginaceae (Scrophulariaceae)
5. Size of genus: The genus *Penstemon* is the largest genus endemic to North America. It consists of over 270 species distributed throughout the United States and various regions of Canada, Mexico and Guatemala (Nold 1999, Wolfe et al. 2006). The accepted taxonomy is based primarily on the shape of the anthers and the dehiscence pattern. The genus is currently divided into 6 subgenera, 12 sections and 23 subsections (American Penstemon Society 2012). Over the years various revisions to sections or subsections have been suggested and implemented (Gray 1878, Pennell 1920, Keck 1937,1938,1945; Straw 1966, Holmgren 1979, to cite just a few).

   Very early on, calls for reclassification of *Penstemon acaulis* and, later, it and *Penstemon yampaensis* were made. Penland (1958) compared pubescence and venation of leaves and morphology of the flowers of these two taxa and concluded that they should be moved to section *Cristati* (*Aurator*). Recent phylogenic and genomic research has shown the need for changes to parts of the classification now in use (Wolfe et al. 2006, Broderick et al. 2011).

6. Phylogenic relationships: L.O. Williams placed *Penstemon acaulis* in the section *Caespitosi* (Williams 1934). Keck in his studies of Penstemons (Keck 1937) modified the classification of the genus but maintained *P. acaulis* in the *Caespitosi*; however, he downgraded that section to a subsection of the section *Ericopsis*. Differences in pubescence and venation of leaves, in addition to the fact that the morphology of the corolla of *P. acaulis,* as well as that of *P. yampaensis*, does not fit the typical plicate character of the corolla of other taxa in the Caespitosi subsection, lead Penland (1958) to conclude that these two taxa should be placed in the section *Cristati* (*Aurator*). Nevertheless, currently the stemless beardtongue belongs to the subgenus *Penstemon*, section *Ericopsis*, subsection *Caespitosi.* Recently, researchers at Ohio State University were awarded a small grant from the American Penstemon Society to "study the relationships and taxonomic affinities among members of the genus *Penstemon* subsection *Caespitosi*"(Lewis 2011). This study will include both *P. acaulis* and *P. yampaensis.* This author will procure specimen material for these two taxa from various collection sites. One can anticipate that this research will provide much information on the phylogenic relationships of these two taxa to the other ten taxa in the subsection, as well as between the two taxa themselves.

B. Present legal or other formal status
1. National legal status
a. Fish and Wildlife Service: None
b. Forest Service: Region 4 Sensitive species (Ashley National Forest)

c. Bureau of Land Management: Sensitive species (BLM administered land in Wyoming and Utah).
2. Global Heritage rank: G2
3. State Legal Status: Utah: None; Wyoming: None; Colorado: species not known to occur.
4. State Heritage rank: Utah: S1; Wyoming: S1; Colorado: species not known to occur.

C. Description

1. General non-technical description: *Penstemon acaulis* is a perennial, dwarf cushion plant with much branched, woody stems bearing green, linear leaves ¼ to 5/8 inch (6-15 mm) long and 1/20 of an inch (1mm) wide. The flowers, mostly solitary, are sub-sessile, about ½ inch long, glandular-puberulent on the outside. The staminode is golden-bearded. Flower color varies from deep blue, to nearly white, to pink (see Figure 1). The kidney-shaped black seeds, 1-2 mm long, are borne in small subglobose to globose capsules that often remain buried in sediment trapped in the plant. The capsules may not open for several years.

2. Technical description: Stems: Low, caespitose (growing in low, dense tufts), essentially acaulescent (stemless) perennial forming mats up to 30 cm (12") across by short stolons, leafy flowering stems very short with compressed internodes, the old stems woody and much-branched, rooting at the nodes, herbage scabrous (rough to touch) the hairs blunt, nipple-shaped, erect, sticky. Leaves: Linear, 6-15 mm (1/4-5/8") long & 0.8-1.3 mm wide, broadest above the middle, entire, sharply acute. Inflorescence: Much-reduced, the flowers solitary, sub-sessile (short-stemmed). Calyx: 3.5-4.8 mm long, hidden in leaves, segments lanceolate, viscid-pubescent (sticky-hairy) and rough to touch, the margins of the broadened base of segments somewhat thinned. Corolla: Tiny, 11-15 mm (3/8-1/2") long, blue, moderately belled, the throat weakly 2-ridged, beneath, glandular-puberulent (sticky-downy) on the outer surface, the palate pale yellow-bearded. Anther cells: 0.7-0.9 mm long, opening full length, but not flat, becoming widely spreading, smooth except for nipple-toothed cell edges. Staminode: Golden-bearded, fertile stamens more or less exserted from orifice. Infructescences: Capsule nearly globose, contains 2-4 lunate black seeds.
This technical description is extracted from the descriptions of several hundreds penstemons on the website of the American Penstemon Society (American Penstemon Society 2012).

3. Local field characters: *Penstemon acaulis* can be recognized by its small, erect, linear leaves that grow in small compact, acaulescent tufts. If the edge of the mat is easily lifted above ground with the end of the walking stick, the mat is not *P. acaulis*. Additionally, generally the flowers are solitary. *Penstemon caespitosus* forms mats of trailing branches. *Penstemon yampaensis* has leaves about twice as wide and long as those of the stemless beardtongue and its inflorescences are multi-flowered (2-4 and up to 6). Overall *P. yampaensis* looks like a robust form of *P. acaulis*.

4. Similar species: The study of corrections and annotations on herbarium specimen labels showed that, often, *Penstemon acaulis* has been confused with *Penstemon caespitosus*; the later is easily differentiated by the trailing character of the branches and the alternate-leaves attachment on the branch. *P. acaulis* looks like a miniature or weaker sibling of *Penstemon yampaensis*. The leaves of *P. acaulis* are half the size of those of *P. yampaensis* both in width and length. The flowering shoots of the stemless beardtongue is usually with single flower, occasionally two-flowered, whereas the inflorescence of the Yampa beardtongue is multi-flowered, usually 2-4 and occasionally up to 6.

Figure 1. Color variations in flowers of *Penstemon acaulis* (photographs by Marcel R. Jouseau)

D. Geographical distribution

1. Range: *Penstemon acaulis* is a regional endemic of southwestern Wyoming and northeastern Utah (Franklin 1992, Fertig and Welp 2001). In 1932, L.O. Williams (Williams 1934) collected this taxon in the vicinity of McKinnon, a small town in southwestern Sweetwater County, Wyoming. In subsequent years, a number of collections were made in the proximity of McKinnon and Manila, Daggett County, Utah. A few collections were made in the area of Browns Park, in the far northeastern corner of Utah; however, the taxonomy of these specimens has been questioned and E. Neese determined that those specimens belong to *Penstemon yampaensis* (Neese 1986). Ben Franklin (Franklin 1992) and later Walter Fertig and Laura Welp (Fertig and Welp 2001) conducted surveys and provided the most complete distribution documentation in the two states. The total range extent of *P. acaulis* up to 2001 time spanned an area of about 40 miles by 10 miles. As a result of more recent surveys, current range extent spans an area of about 40 miles by 14 miles, falling within 10 watersheds (Figure 2).

2. Extant sites: In keeping with earlier work, *Penstemon acaulis* was known from nine occurrences in Utah and three occurrences in Wyoming, at least two of which may straddle the state line. As a result of more recent surveys, this distribution has been significantly expanded, particularly in Wyoming. There are up to nine additional occurrences in Wyoming. Many existing occurrences have also been expanded (Table 1). The results below are provisional pending further review and data entry by WYNDD and UTNHP.

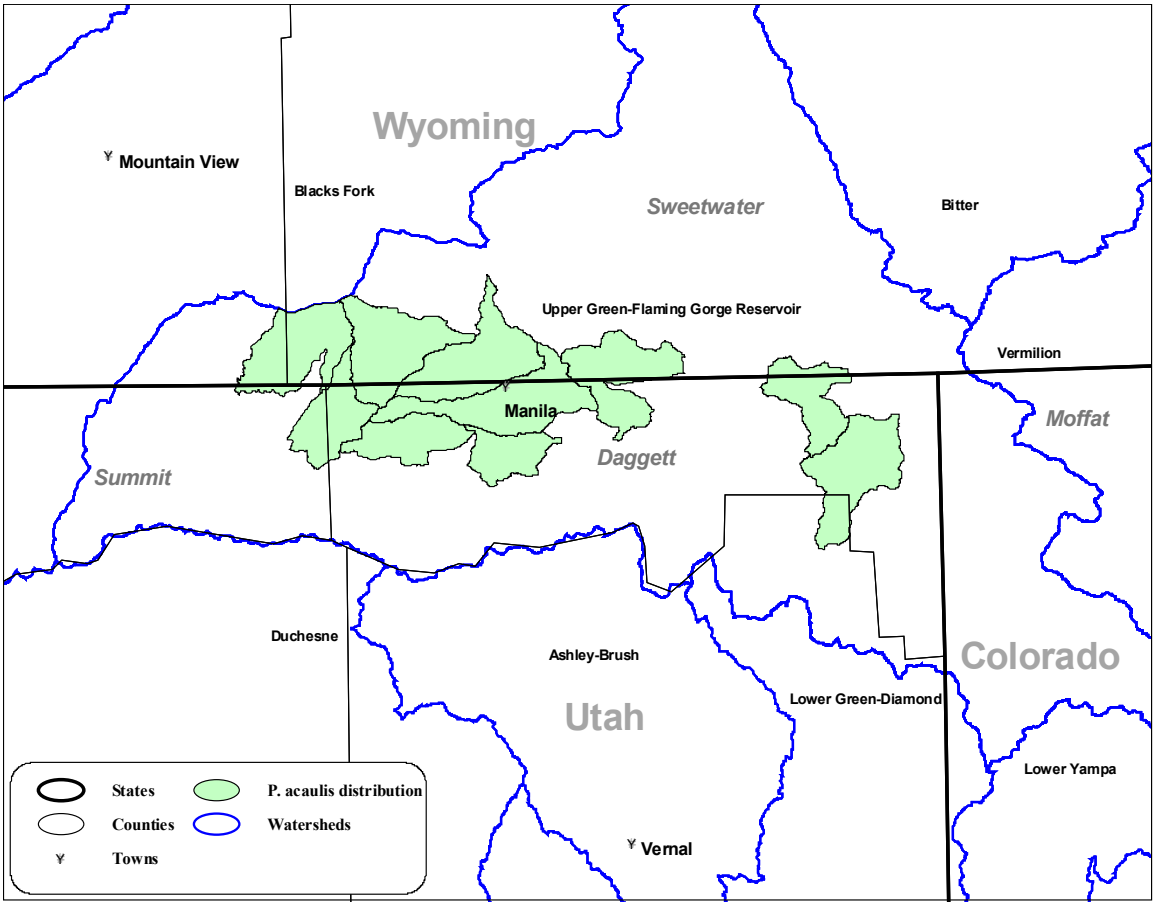


Figure 2. Generalized distribution of *Penstemon acaulis*

Table 1. Extant, expanded and proposed new occurrences of *Penstemon acaulis*

Occurrence number	Original number of subpopulations	Updated number of subpopulations	Comments
WYOMING			
001	4	13	
004	5	7	Connected to Utah 001
008	1	2 (1 not relocated, 1 added)	Connected to Utah 006
NEW-1	-	2	
NEW-2	-	1	
NEW-3	-	1	
NEW-4	-	1	
NEW-5	-	1	
NEW-6	-	2	
NEW-7	-	2	
NEW-8	-	6	
NEW-9	-	1	
UTAH			
001	1	1	
002	1	1	
003	4	4 (1 extirpated, 1 added)	
004	2	2	
005	1	3	
006	1	?	Not relocated in 2009-11
007	1	0	Map correction needed
008	1	0	Map correction needed
009	1	1	

More complete information on occurrence locations is presented in Appendix B.

3. Historical sites: None known. The first collection in Wyoming was made in 1932 by L.O. Williams, voucher Williams 407, "Collected in flower on dry hilltops near McKinnon, Sweetwater Co., Wyoming, altitude about 6,500 feet, May 28, 1932" (Williams 1934). This collection point is within Wyoming extant Occurrence #001.

4. Unverified/Undocumented reports: None known.

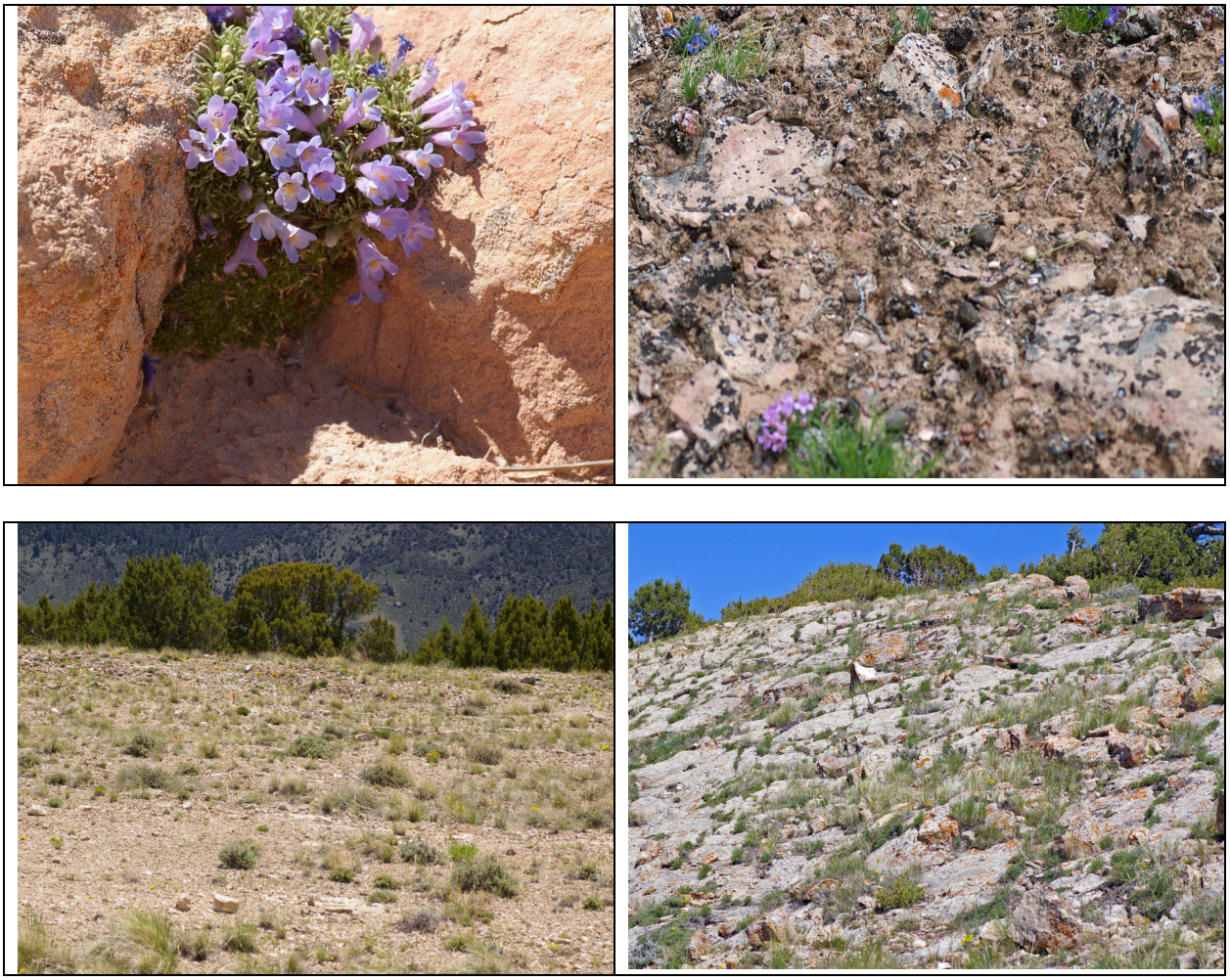
5. Sites where present status not known: Wyoming #008 and Utah #006 which could not be re-located during surveys of 2009-2011 and Utah #003, polygon near the sewage treatment lagoon was not visited during the surveys of 2009-2011.

6. Areas surveyed but species not located: A number of areas were surveyed but did not result in the locating of populations of *Penstemon acaulis*. In Utah, Ben Franklin in his 1992 report identified areas east of Flaming Gorge Reservoir without stemless beardtongue T003N R022E sections 26, 27, 28, 29, 33, 34, 35. Similarly Franklin was unable to locate this taxon within Goslin Mountain Area T003N R23E Sections 25, 26, 27, 28, 36 and T002N R023E Sections 1 & 2. Similarly no stemless beardtongue were found in Antelope Flat T003N R021E Sections 22, 23, 24, 28 and Antelope Flat East T003N R022E Sections 19 & 30 and in Sheep Creek Hill T002N R19E sections 10 & 11 and in Lower Sheep Creek Hill T002N R019E, the south halves of Sections 7 & 8. The author of the present report also failed to find *P. acaulis* east of the Flaming Gorge reservoir during the 2011 survey of T003N R021E Sections 27, 28, 34, 35 and T003N R022 Section 30. Search of T002N R020E section 16, hill slopes south of Flaming Gorge Reservoir in 2006 did not produce any *P. acaulis* and, similarly, in T002N R020E Sections 4 & 33. In 2011, survey by this author of areas along Utah Hwy 165, west and south of McKinnon T003N R017E Sections 13, 23, 25, 26 did not locate any *P. acaulis*.

   In Wyoming, in 2000, Laura Welp surveyed a number of areas in which she was unable to record stemless beardtongue (Fertig and Welp 2001). These areas included T012N R109W Sections 7, 17, 18 and the west half of 16. The author of the present report resurveyed these areas in 2011 but the search was also fruitless, despite the presence of the taxon in adjacent sections. Similarly fruitless was L. Welp's search of various areas north of Henrys Fork along Sweetwater Co. Rd 1. This author further searched areas primarily west of Sweetwater Co. Rd 1, to the slopes of Cedar Mountain, including T012N R111W Sections 19 and T013N R111W Sections 33, 32, 28, 26, 23, 22, 21, 20, 14, again without locating *Penstemon acaulis*. This author's survey of T012N R109W north halves of sections 13, 14 and 18 did not produce locations of *P. acaulis*. Finally a survey of the Cedar Basin area by this author in 2010 provided no *P. acaulis* in T012N R113W Sections 1, 2, 11,12.

E. Habitat:
   Penstemon acaulis is found on dry, open, sparsely vegetated rocky slopes, tops of ridges, ledges, among flagstones, or gravelly soils, as well as deposition fans from eroded steep slopes. See Figures 3-8 for examples of habitats occupied by *P. acaulis*.

Figures 3-4. *Penstemon acaulis* habitat (Photographs by Marcel R. Jouseau)



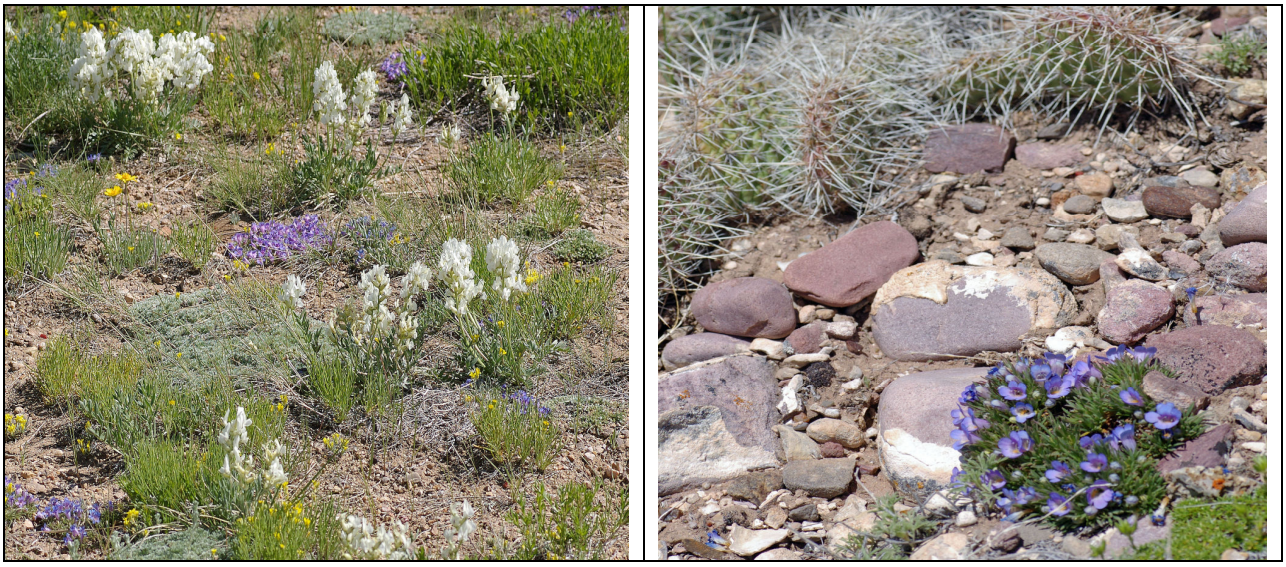
Figures 5-8. *Penstemon acaulis* habitat (Photographs by Marcel R. Jouseau)

1. Associated vegetation: Bunch grasses and cushion plants are frequently associated with the habitat of *Penstemon acaulis*. However, quite frequently *P. acaulis* is found in areas dominated by the shrubby *Artemisia nova* particularly in the area of occurrence UT-EO-001, as well as in small clearings among the big sagebrush, *Artemisia tridentata* var. *wyomingensis* in the northern half of occurrence WY-EO-004. In the area of occurrence UT-EO-002, and the areas of various proposed new populations in Wyoming (New 4 through 8) the taxon is associated with the pinyon-junipers plant community.

2. Frequently associated species: Numerous species are associated with *Penstemon acaulis*. Forb species often cited include: *Arenaria hookeri*, *Hymenoxys acaulis*, *Oxytropis sericea*, various *Lesquerella* species, *Phlox hoodii*. The most common shrubby species are *Artemisia nova* and *Artemisia tridentata* var. *wyomingensis*. Occasionally, *P. acaulis* is found growing with cacti. See Table 2 for a more inclusive list of the plants associated with *P. acaulis* and Figures 9-10 for illustrations of some of the associated species.

Table 2. Species frequently associated with *Penstemon acaulis*

Scientific name	**Common Name**	**Habit**
Abronia elliptica	Fragrant white sand verbena	Perennial forb
Agropyron cristatum	crested wheatgrass	Graminoid
Arenaria hookeri	Hooker dandwort	Perennial forb
Artemisia nova	Black sagebrush	Shrub
Artemisia tridentata var. wyomingensis	Wyoming big sagebrush	Shrub
Astragalus jejunus var. jejunus	Starveling milkvetch	Perennial forb
Astragalus spatulatus	Spoonleaf milkvetch	Perennial forb
Castilleja flava	Yellow Indian paintbrush	Perennial forb
Cercocarpus montanus	Alderleaf mountain-mahogany	Shrub
Chrysothamnus nauseosus	Rubber rabbbitbrush	Shrub
Chrysothamnus viscidiflorus	Green rabbitbrush	Shrub
Cryptantha caespitosa	Tufted cryptantha	Perennial forb
Delphinium geyeri	Geyer's larkspur	Perennial forb
Draba oligosperma	Few-seeded whitlow grass	Perennial forb
Elymus spicatus	Bluebunch wheatgrass	Graminoid
Eriogonum brevicaule	Shortstem buckwheat	Perennial forb
Eurotia lanata	Winter fat, White sage	Shrub
Gutierrezia sarothrae	Broom snakeweed	Shrub
Haplopappus acaulis	Stemless mock goldenweed	Perennial forb
Haplopappus armerioides	Thrift goldenweed	Perennial forb
Haplopappus nuttallii	Nuttall's goldenweed	Perennial forb
Hymenoxys acaulis	Stemless hymenoxys	Perennial forb
Hymenoxys richardsonii	Richardson's hymenoxys	Perennial forb
Hymenoxys torreyana	Torrey's hymenoxys	Perennial forb
Koeleria macrantha	Prairie junegrass	Graminoid
Lesquerella alpina	Alpine bladderpod	Perennial forb
Lesquerella intermedia	Mid bladderpod	Perennial forb
Lesquerella ludoviciana	Foothill bladderpod/Louisiana bladderpod	Perennial forb
Lupinus pusillus	Rusty lupine	Perennial forb
Machaeranthera grindelioides	Rayless tansyaster	Perennial forb
Opuntia sp.	Paddle cactus	Cactus
Oryzopsis hymenoides	Indian ricegrass	Graminoid
Oxytropis sericea	White locoweed	Perennial forb
Pediocactus simpsonii	Mountain ball cactus	Cactus
Penstemon pachyphyllus	Thickleaf beardtongue	Perennial forb
Phlox hoodii	Moss phlox	Perennial forb
Poa secunda	Sandberg bluegrass	Graminoid
Sedum lanceolatum	Lance-leaved stonecrop	Perennial forb
senecio multilobatus	Basin groundsel	Perennial forb
Spaeralcea grossulariifolia	gooseberryleaf globemallow	Perennial forb
Stipa comata	Needle-and-thread grass	Graminoid
Townsendia incana	Easter daisy	Perennial forb
Trifolium andinum	Andean clover	Perennial forb
Wyethia scabra	badlands mule-ears	Perennial forb



Figures 9-10. Species associated with *Penstemon acaulis* (Photos by Marcel. R. Jouseau)

3. Topography: *Penstemon acaulis* is found over a variety of topographic features such as flat ridge tops, side and rim of buttes, very steep slopes and shallow slopes, depositional flats, alluvium fans, flat ledges on top of rocky escarpments at elevations ranging from about 6,000 feet to 8,400 feet.

Figure 11. *Penstemon acaulis* on Laney member Green River Formation (Photograph by B. Heidel)

Table 3. Soils associated with *Penstemon acaulis* and some characteristics of these soils

Texture Definition	Soils	pH	pH-2nd depth	Available Water Capacity	Organic Matter	Clay %
loam, gravelly below 30cm	Babb-Teeler complex, 5 to 35 % slopes	6.6-7.8	6.6-7.8	0.17-0.21	2-5%	18-25%
fine sandy loam	Blackhall-Kappes-Rentsac complex, 0 to 8 % slopes	7.4-7.8	7.4-9.0	0.05-0.14	0.5-25	5-18%
fine sandy loam; shallow	Blackhall-Rentsac complex, 6 to 25 % slopes	7.4-8.4		0.05-0.14	0.5-2%	5-18%
loam; shallow	Blazon thin solum-Blazon-Lilsnake complex, 2 to 40 % slopes	7.9-9.0	7.9-9.0	0.16-0.21	0.5-1%	15-35%
clay loam	Blazon-Delphill complex, 6 to 30 % slopes	7.9-9.0	7.9-9.0	0.16-0.21	0.5-1%	15-35%
gravelly sandy loam	Brownsto gravelly sandy loam, 0 to 3 % slopes	7.4-8.4	7.9-8.4	0.04-0.10	1-2%	10-20%
gravelly sandy loam	Brownsto gravelly sandy loam, 3 to 6 % slopes	7.4-8.4	7.9-8.4	0.04-0.10	1-2%	10-20%
very gravelly sandy loam	Brownsto-Luhon complex, 10 to 35 % slopes	7.4-8.4	7.9-9.0	0.04-0.14	1-2%	7-25%
gravelly sandy loam	Brownsto-Luhon-McFadden complex, 3 to 15 % slopes	7.4-8.4	7.9-9.0	0.04-0.12	0.5-2%	10-18%
fine sandy loam	Goslin fine sandy loam, 6 to 10 % slopes	7.4-8.4	7.4-8.4	0.10-0.14	1-2%	5-18%
very stony sandy loam	Haploborolls-Torriorthents complex, 10 to 70 % slopes	6.6-7.8		0.05-0.10	0-1%	8-30%
fine sandy loam	Kappes-McFadden fine sandy loams, 2 to 6 % slopes	7.4-8.4	7.9-9.0	0.10-0.15	1-2%	8-18%
loam	Luhon loam, 0 to 3 % slopes	7.9-8.4	7.9-9.0	0.16-0.20	0.5-1.0%	15-30%
loam	Luhon loam, 3 to 6 % slopes	7.9-8.4	7.9-9.0	0.15-0.20	1-2%	18-30%
gravelly loam	Luhon-Evanston complex, 3 to 30 % slopes	6.6-7.8	7.9-9.0	0.12-0.20	1-3%	15-35%
loam	Luhon-Rockinchair loams, 1 to 6 % slopes	7.4-8.4	7.9-9.0	0.11-0.20	1-2%	15-35%
fine sandy loam	McFadden fine sandy loam, 0 to 6 % slopes	7.4-8.4	7.9-9.0	0.10-0.14	1-2%	8-18%
gravelly sandy loam	McFadden gravelly sandy loam, 2 to 6 % slopes	7.4-8.4	7.9-9.0	0.07-0.11	0.5-1.0%	5-18%
gravelly sandy loam	McFadden-Brownsto-Rock outcrop complex, 20 to 60 % slopes	7.9-8.4	7.9-9.0	0.07-0.11	0.5-1.0%	5-18%
loam	Poposhia loam, 3 to 6 % slopes	7.9-8.4	7.9-9.0	0.14-0.20	1-2%	15-35%
loam	Poposhia loam, 6 to 10 % slopes	7.9-8.4	7.9-9.0	0.14-0.20	1-2%	15-35%
channery fine sandy loam; shallow	Redcreek-Blackhall-Rock outcrop complex, 6 to 35 % slopes	7.4-8.4	7.4-8.4	0.09-0.12	0.5-1.0%	5-15%
very channery sandy loam	Rentsac very channery sandy loam-Rentsac channery sandy loam-Rock outcrop complex, 20 to 35 %	7.4-7.8	7.4-8.4	0.04-0.11	0.5-2.0%	7-18%
channery loam	Roto-Rockinchair-Rencot complex, 1 to 10 % slopes	7.9-8.4	7.9-9.0	0.06-0.15	0.5-3.0%	10-35%
sandy clay loam	Sinkson sandy clay loam, 1 to 8 % slopes	7.9-8.4	7.9-8.4	0.15-0.20	1-2%	18-35%
gravelly sandy loam	Strych gravelly sandy loam-Strych very cobbly sandy loam complex, 8 to 30 % slopes	7.4-8.4	7.4-8.4	0.05-0.08	0.5-3%	8-18%
gravelly loam	Thermopolis-Blazon-Sinkson complex, 3 to 60 % slopes	7.4-8.4	7.9-9.0	0.09-0.21	0.5-2%	18-35%
Fine sandy loam	Trembles-Lander-Comer (WY 188)	6.6-7.8	6.6-7.8	0.13-0.15	0.5-2.0%	5-18%
Fine sandy loam, unweathered bedrock	Huguston-Teagulf-Wint (WY 139)	8.4-9.6	9.0-9.6	0.06-0.15	0.5-1.0%	10-35%

Texture Definition	Soils	pH	pH-2nd depth	Available Water Capacity	Organic Matter	Clay %
sandy loam, sandy clay loam	Langspring-Clowers-Quealman (WY141)	7.9-8.4	7.9-9.0	0.13-0.16	0.5-1.0%	10-30%
loam; clay loam	Turson-Moslander-Tetonville (WY142)	7.4-8.4	7.9-9.0	0.09-0.19	0.5-4.0%	15-32%
gravelly-sandy loam; very cobbly	Brownsto-Dahlquist-Brownsto Variant (WY 144)	7.4-8.4	7.9-9.0	0.04-0.13	0-2.0%	5-25%
loam; channery-loam; UW	Mc Cullen Family-Haterton-Langspring (WY145)	7.9-9.0	7.9-9.0	0.09-0.18	0-1.0%	10-27%
loam; gravelly-loam	Thermopolis-Blazon-Delphill (WY146)	7.9-8.4	7.9-8.4	0.14-0.20	0-2.0%	15-35%
loam; clay loam	Fluetsch-Luhon-McFadden (WY148)	6.1-8.4	7.4-8.4	0.15-0.20	1.0-2.0%	15-35%
Fine sandy loam; UW	Rock Outcrop-Spool-Terada (WY147)	7.4-8.4	7.9-9.0	0.12-0.16	0-2.0%	5-18%
very stony-loam; extremely stony	Amsden-Amsden Variant-Libeg (UT017)	6.1-7.3	6.1-7.3	0.05-0.12	2.0-4.0%	10-35%
cobbly-sandy loam; extremely cobbly	Brownsto-Dahlquist-Brownsto Variant (UT013)	6.6-7.8	7.9-9.0	0.03-0.11	1.0-3.0%	7-35%
loam; UW	Thermopolis-Blazon-Delphill (UT014)	7.4-8.4	7.4-8.4	0.15-0.18	0-2.0%	18-35%
unweathered bedrock	Rock Outcrop-Spool-Terada (UT015)					
sandy loam	Fluetsch-Luhon-McFadden (UT016)	7.4-8.4	7.9-9.0	0.11-0.14	0.5-2.0%	8-18%
channery-loam; WB	Clapper-Mivida-Yarts (UT310)	7.9-9.0	7.9-9.0	0.08-0.14	0-1.0%	15-35%
gravelly-loam; very gravelly loam	Brownsto-Circleville-Rentsac Family (UT311)	6.6-8.4	7.4-8.4	0.07-0.18	0.5-4.0%	10-27%
very stony-loam; very channery	Namon Family-Windham Family-Duchesne (UT312)	7.4-7.8	7.4-7.8	0.08-0.11	2-4%	15-35%

Sources: Soil Survey of Henrys Fork Area, Utah-Wyoming- Parts of Daggett & Summit Counties, Utah and Sweetwater and Uinta Counties, Wyoming. USDA. Soil Survey of Utah, USDA. State Soil Geographic (STATSGO) database for Wyoming. USDA.

4. Soil relationships: *Penstemon acaulis* grows in a variety of soils. The textures of these soils vary from channery fine sandy loam to clay loam, fine sandy loam, to gravelly sandy loam, to sandy clay loam, to cobbly and extremely cobbly sandy loam, to very stony sandy loam, to weathered and unweathered bedrock. The soils are derived from various geologic formations: Bridger formation, Green River Formation, Baxton shale, Entrada formation, Wasach Formation, Laney member Green River Formation. *P. acaulis* is rarely seen on deep soils. The soils are generally quite shallow and very well drained. The available water capacity of these soils is low to very low. Typically the organic matter content is between 0 and 2 percent; the percentage of organic matter influences the percentage of the available water capacity, as does the clay content of the soil. The soil pH ranges from basic to strongly basic (7.4 to 8.4 and 7.9 to 9.0). See Table 3 for details of soils on which *P. acaulis* has been found growing. This author collected a composite soil sample at each of six sites with *P. acaulis* for chemical analyses. These analyses show soils rich in calcium carbonate but generally low phosphorus and nitrogen concentrations, explaining generally the lower density of vegetation growth in areas with *P. acaulis*. Concentrations in potassium are sufficient for good vegetation growth. See Table 4 for the results of the soil analyses for the six sites.

Table 4. Chemical analyses of soil samples from within populations of *Penstemon acaulis*

ID#	Populations	Olsen-P (ppm)	Total N (% N)	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)		
1	WY – EO-004	12	0.12	4534	155	240	6		
1 Dup.		11	0.11	4487	153	243	3		
2	WY - EO-001	8	0.14	5015	446	228	7		
3	UT- EO-002	6	0.11	3825	97	200	4		
4	UT-EO-002	5	0.14	4767	128	192	6		
5	WY-EO-001	22	0.13	4313	167	222	8		
6	WY-EO-004 North half	13	0.14 / 0.13	4538	150	212	4		
Mean		11	0.125	4497	185	220	4.6		
ID#	Populations	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	Pb (ppm)	Ni (ppm)	Cd (ppm)	Cr (ppm)
1	WY – EO-004	2.175	6.217	0.310	0.428	0.507	0.134	0.044	<0.028
1 Dup.		2.055	6.431	0.307	0.427	0.513	0.135	0.042	<0.028
2	WY - EO-001	2.467	2.374	0.257	0.445	0.815	0.244	0.030	<0.028
3	UT- EO-002	2.666	2.674	0.332	0.475	0.412	0.104	0.023	<0.028
4	UT- EO-002	2.249	2.590	0.305	0.495	0.896	0.117	0.025	<0.028
5	WY-EO-001	3.970	2.716	0.795	0.486	0.800	0.148	0.041	<0.028
6	WY-EO-004 North half	2.247	3.796	0.279	0.474	0.680	0.155	0.025	<0.028
Mean		2.547	3.828	0.369	0.461	0.660	0.148	0.033	<0.028
ppm = parts per million									
Olsen-P (phosphorus), Total N (total nitrogen), Ca (calcium), Mg (magnesium), K (potassium), Na (sodium)									
Fe (iron), Mn (manganese), Zn (zinc), Cu (copper), Pb (lead), Ni (nickel), Cd (cadmium), Cr (chromium)									
.									

5. Regional climate: Because of the paucity of long term meteorological monitoring stations within the area of known distribution of *Penstemon acaulis*, this author has used data for precipitation and minimum and maximum temperatures produced by Climate Source (Climate Source 2000) to get an insight on the climate experienced by this taxon over its entire distribution. Similarly, the high precision grass-reference evapotranspiration map developed by Park and Junna (2011), at the University of Wyoming, was used to

understand the level of moisture stress that *P. acaulis* might experience. The annual precipitation within the area occupied by *P. acaulis* ranges from 221 to 519 mm (from about 10 inches to 20 inches) with a mean and median of 268 and 266 mm, respectively. The monthly minimum temperatures range from –16 to -11°C (3°F to 13°F) for January to 4.7 to 11.7°C (40°F to 53°F) in July. The monthly maximum temperatures range from –2.3 to 2.1°C (28°F to 36°F) in January and 23.5 to 30.1°C (74°F to 86°F) in July. Table 5 shows the grass reference evapo-transpiration (eT) for the same *P. acaulis* distribution. These data show that grass reference eT far exceeds the corresponding seasonal rainfall. While *P. acaulis* does not have the same water requirements as a well-established grass lawn, it must nonetheless cope and develop a strategy to palliate the high evaporative environment.

Table 5. Grass reference evapotranspiration for periods in *Penstemon acaulis* habitat

Season	Reference Evapotranspiration Range (mm)		Mean (mm)	Standard Deviation (mm)
April-May-June	405	486	451	14.7760
June-July-Aug.	541	636	592	14.9538
May-June-Jul.-Aug.	678	799	745	20.0329
April Through Sept.	891	1056	983	27.7085

6. Local microclimate: The nearest meteorological monitoring station is Manila (National Weather Service ID: MANU1). The climate of the area surrounding Manila is a semi-arid, mid-latitude steppe climate (BSk) according to Köppen Climate Classification (Godfrey 1999). The average annual temperature is 45.7°F, while the annual mean low and annual mean high are 32.0°F and 59.5°F, respectively. The annual mean precipitation is 9.5 inches (241 mm); April, May and June receiving 1.15, 1.5 and 1.0 inch, respectively. See Figure 12 below for details. These precipitation data put Manila at the low end of the precipitation range shown in the regional climate section.

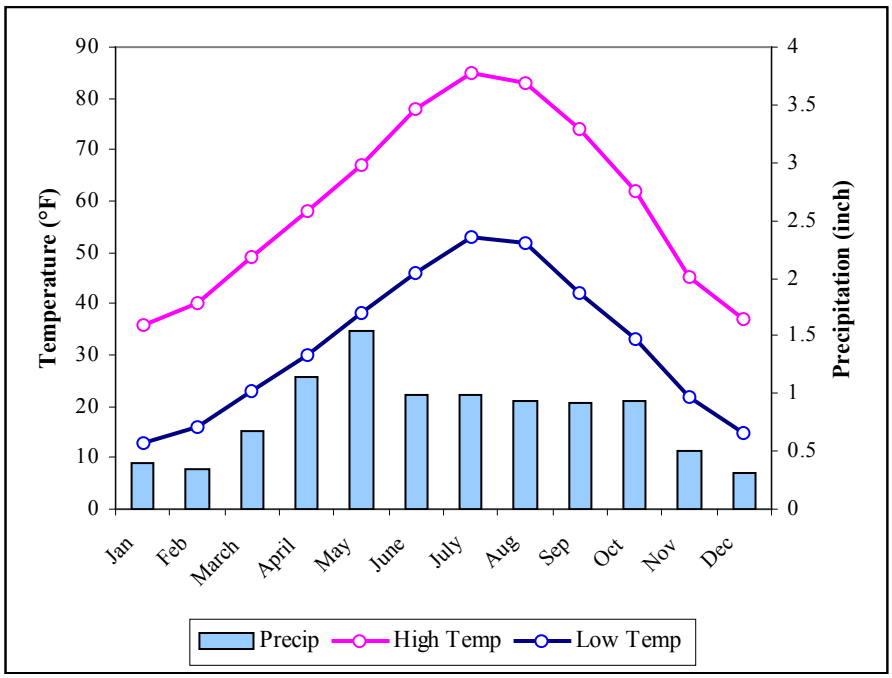


Figure 12. Climate normals for Manila, Utah

F. Population biology and demography:

1. Phenology: Flowering of *Penstemon acaulis* in the Manila area occurs from approximately late May to mid-to-late June. In 2009, plants were in bloom on May 25; in 2010, flowers began to appear May 30 but plants on top of the escarpments east and west of Linwood Canyon did not open until June 3. In 2011, the stemless beardtongue flowers began blooming around June 5. Data recorded on labels of specimens in herbaria show that plants have been collected in flower as early as May 24 (Lichvar R.W. 1711) and as late as June 27 (Porter C.L. 5657 and Franklin M.A. 7402). The information collated from the labels does not necessarily establish the actual range of the flowering period. Specimens have been collected in early July and in early August but only in fruit. There are no specimens with a collection date prior to May 24th. Data on fruit maturation dates are not available.

2. Population size and condition: To date Utah contains by far the largest number of known *Penstemon acaulis*. Utah EO-001, the largest known population of this taxon, is estimated to contain hundreds of thousands plants in 4100 acres spread over 17 square miles (Franklin 1992). In 2011, this population appears to be in excellent condition. There is evidence of some quarrying activities in the past but none were seen in 2009, 2010 or 2011. UT EO-002 was estimated at over 2,500 plants in 65 acres. Visits in 2009-2011 did not provide any evidence of deterioration. B. Franklin, in 1991, estimated the population of occurrence UT EO-003 to have 750-1,000 plants. This author visited this area in 2005, 2006, 2009-2011 and would estimate this population to have been reduced, as the polygon near the boat launch could not be relocated and has most likely disappeared. However, the polygon near the wastewater treatment lagoon was not visited. Permission was not sought to go into this security-controlled area. Utah UT-EO-004 was not re-visited by this author. However, numerous visits to adjacent land in 2009-2011 showed little disturbance on the slopes occupied by *P. acaulis* in the area, so it can be assumed that this population has maintained the normal vigor noted by Ben Franklin in 1991. At that time there were a total of 400 plants in four acres. The size of the population known-as Birch Spring UT EO-005 was not recorded in Franklin's 1992 report. The area appears to have changed little since. Ben Franklin, in 1991, estimated that the population in Utah Occurrence #006 and contiguous Wyoming Occurrence #008 contained 450-500 plants in 3 acres. This author could not relocate the two populations in 2011; therefore no estimate can be provided for UT EO-006.

   Occurrences of *Penstemon acaulis* in Wyoming were documented in Fertig and Welp (2001). The report references three occurrences: WY EO-001, WY EO-004 and WY EO-008; however, data are provided for only EO-004 and EO-008. These two occurrences were estimated to have 4,420 and 150 plants, respectively. Surveys conducted in 2009 through 2011 added a substantial number of colonies or sub-populations to the known occurrences. In addition, possibly up to nine new populations, pending data entry and criteria review by WYNDD staff, have been identified. The number of plants of *P. acaulis* in these new populations is estimated to be about 17,000 plants. Table 6 summarizes the number of plants in known occurrences and newly identified populations. It should be noted that WY-EO-008 was not relocated, despite several attempts on different years. Track data recorded with the GPS indicate that this author crisscrossed both WY EO-008 and the contiguous UT EO-006 but no plants were located. See Figure 2 for the generalized location of *P. acaulis* populations in Wyoming and Utah.

Table 6. Summary of populations of *Penstemon acaulis* in Wyoming and Utah

Occurrence number	Original Population Size	Updated 2011 Population Size	Comments
WYOMING			
001	??	21,500	
004	4,420	5,320	Connected to Utah 001
008	150	(Original not relocated, 1 added +100 plants) 250?	Connected to Utah 006
NEW-1	-	120	
NEW-2	-	75	
NEW-3	-	3,000	
NEW-4	-	5,000	
NEW-5	-	1,000	
NEW-6	-	1,700	
NEW-7	-	2,800	
NEW-8	-	2,870	
NEW-9	-	300	
UTAH			
001	>200,000	>200,000	
002	2,500	2,500	
003	750 -1,000	770 (1 extirpated, 1 added, one not looked for)	
004	400	400	
005	??	11,200	
006	300	?	Not relocated in 2009-11
007	??	Site unknown	Map correction needed
008	??	Original collection site (Antelope) by Alexander in 1936, likely in UT 001	Map correction needed
009	??	??	

Population numbers fluctuate from one period to another for a variety of reasons such as weather conditions particularly temperatures and rainfall. Furthermore, the timing of the walk-through survey and lack of rain in prior weeks may determine how visible/noticeable *Penstemon acaulis* might be, thus influencing the plant counts or whether a population is relocated.

There are no trend data available for *Penstemon acaulis*. In Wyoming, three transects were established in 2000 for the purpose of long-term monitoring of trends in the respective populations (Fertig & Welp 2001). Plant data were collected on the basis of quadrats set along the transects; however, these transects have not been re-surveyed to date.

G. Reproductive biology:

1. Type of reproduction: *Penstemon acaulis* produces fruits called capsules that are often buried by wind or water-deposited sediments. Keck, in his studies in Penstemon IV (Keck 1937) quotes E.J. Alexander, who had just returned from a seed collecting expedition in the Rocky Mountain, for the New York Botanical Garden, to state "that the stems are annually buried under soil wash." Reproduction by seed appears to be the only known natural reproductive means in *P. acaulis*. There is no known reproductive means such as the stolons, or rhizomes, or the viviparous means seen in some ferns and waterlilies.

2. Pollination biology: A search of the literature has revealed no information on pollination in *Penstemon acaulis*. In the field, this author has observed that small bees and flies move from plant to plant, thus cross-pollinating flowers of *P. acaulis*. Bees are known as the principal pollinating agent for many species of beardtongue (Castellanos et al. 2003). Occasionally the author of this report has also noticed ants on the flowers but it is not known whether they play a role in the pollination or the transport of seeds of the *P. acaulis.*

3. Seed dispersal and biology: There is no known dispersal mechanism for seeds of *Penstemon acaulis*. Seed collectors often mentioned that seed capsules remain attached to the plant, buried in sediments for many years. Keck, in his studies in Penstemon IV (Keck 1937) states that E.J Alexander, who collected *P. acaulis* in Antelope and southeast of Manila, reported that:

> "fruiting specimens show that the capsules…are indehiscent and long persistent, as was found when plants were dug up. Those with the seed still intact were found in the branch axils of two to five years previous….The unusually shaped, lunate-reniform seeds are set free by decay underground and increase the plant by germination in situ, a unique occurrence in *Penstemon*."

In this taxon, seed dispersal is limited likely to the occasional ants carrying away a seed, or to surface water runoff or wind eroding soil and moving seeds along to some distance. In 2001, Fertig and Welp reported the results of the monitoring of three transects by L. Welp. Each transect contained 50 quadrats 1.0 meter by 0.50 meter. The monitoring resulted in a total of 492 plants in 150 quadrats but not one of these plants was identified as a seedling. Furthermore, only 19 of the 492 (4 percent) of the plants were reproductive. Of course the absence of seedlings and the low ratio of reproductive plants in this 2000 monitoring of three populations is no indication of a general lack of reproduction amongst the plants in these three populations; after all this is the result of one-year and many conditions could have affected seed production, germination, flowering and pollination. No weather data were available for that year for the area of the transects and so it is not possible to determine if weather abnormalities played a role in flower production, pollination, seed production or seed germination and seedling survival. Unfortunately, Manila (MANU1), in the National Weather Service network, was not operative for the years 1990 to 2001. It would be useful to have periodic monitoring data for the three transects set in 2000 to identify trends in the populations.

H. Population ecology:

1. General summary: The 2009-2011 walk-through surveys have expanded the known range of *Penstemon acaulis*, primarily through finding several populations of the taxon at geographic

locations north of Henrys Fork, which until then, was defining the northern boundary of the *P. acaulis* range. However, the inability of this author to relocate some previously known colonies and two occurrences, together with the 2000 monitoring data showing no seedlings and a very low ratio of reproductive plants could be viewed as cause for concern. This may warrant spending resources to re-survey the three 2000 transects to determine whether the new data would point to a trend in the survival of *P. acaulis*.

2. Competition: *Penstemon acaulis* is found primarily in areas of sparse vegetation, such as cushion plants communities, low density graminoid community, bare soils in openings in sagebrush zones or pinyon-juniper communities, or in crevices in rock outcrops, or in joints in flagstone paving on ledges of rock escarpments. Soil nutrients such as nitrogen and phosphorus, while in low concentrations (Table 4), are sufficient to support vegetation and therefore are not a limiting factor. This author observed rapid changes in the number of presence/absence of *P. acaulis* over distances of inches because of change in density of graminoids. In sagebrush communities, stemless beardtongue grows only in bare ground openings. Whether *P. acaulis* is unable to compete with other species because of its rate of growth and low stature, or because its seeds cannot be transported by wind, water runoff or insects into dense, vegetated areas or, yet, whether light intensity may affect germination cannot be elucidated at this time. The high evapotranspiration combined with low rainfalls favor plants with strong, well-developed root system together with well-developed symbiosis with mycchoriza or that have developed some other survival strategy.

3. Herbivory: The reduced height and size of tufts of *Penstemon acaulis* make it difficult for larger herbivores to feed on this plant, assuming that it is even palatable to them. No uprooted plants or plants with damaged leaves were noticed during the 2009-2011 surveys. In sagebrush areas, at times, many fragments of leaves of sagebrush could be seen on the ground but no broken *P. acaulis* or fragments of leaves could be noted. In a number of areas one could note damage to colonies of *P. acaulis* resulting from cattle trampling on the plants or tearing the soil surface, it was particularly noticeable where cattle regularly congregated.

4. Hybridization: No report of hybridization in *Penstemon acaulis* could be found in the literature. It should be noted, however, that various authors have remarked that vouchers of *P. acaulis* from the Browns Park area, near the Colorado/Utah stateline and the Green River, have broader leaves and the plants appear to be morphologically transitional towards *Penstemon yampaensis* (Franklin 1992, Welsh et al. 1993, Fertig & Welp 2001). The characteristics of these vouchers caused Neese to reclassify *P. yampaensis* to a varietal level of *P. acaulis* (Neese 1986).

I. Land ownership: The majority of known populations of *Penstemon acaulis* found in Utah are on land within the jurisdiction of the US Forest Service (Region 4-Ashley National Forest), BLM and state- administered lands. In Wyoming about half of the areas of known populations are within federal-administered land (BLM and US Forest Service) and state-administered land.

Penstemon yampaensis Penland

1. Scientific name: *Penstemon yampaensis* Penland (Penland 1958).
2. Synonyms: *Penstemon acaulis* (Williams) var. *yampaensis* (Penl.) Neese, (Neese 1986).
3. Common names: Yampa beardtongue; Penland's beardtongue.
4. Family: Plantaginaceae (Scrophulariaceae).
5. Size of genus: See this section, page 5, under "*Penstemon acaulis*".
6. Phylogenetic relationships: See this section, page 5, under "*Penstemon acaulis*".

J. Present legal or other formal status

1. National legal status

a. Fish and Wildlife Service: None
b. Forest Service: None
c. Bureau of Land Management: None (BLM administered land in Colorado, Utah, Wyoming)

2. Global Heritage rank: G3Q, the designation is the result of the taxonomic uncertainty of the taxon classification.
3. State Legal Status: Utah: None; Colorado None; Wyoming: None.
4. State Heritage rank: Utah: S1; Colorado (S3): Wyoming: None, only recently found in state.

K. Description

1. General non-technical description: *Penstemon yampaensis* is a low growing (2-4 cm in height), tuft forming perennial plant with much-branched woody stem and cineraceous leaves. The leaves, 15-30 mm long, 2-5 mm wide, oblanceolate, acute. The papilliform hairs on upper end of the leaf and recurved, spiculate hairs toward the base and petiole are viscid. Flowers 2-6 on each of very short ultimate branches. Calyx lobes long and acuminate; corolla 15-18 mm long, blue to lilac. Staminode exserted from throat, golden hairs. Seed capsules sub-globose to globose containing 2-4 seeds. Seed lunate or reniform, 2-3 mm, black.

2. Technical description:
   Stems**:** Low, caespitose (stems in low, dense tufts), essentially acaulescent (stemless) perennial forming mats up to 30 cm (12") across by short stolons, herbage scabrous (rough to touch), the hairs blunt, papilliform (nipple-shaped), erect, viscid (sticky), flowering stems very short, leafy, with compressed internodes, the old stems woody and much branched, rooting at the nodes. Leaves: 1.3-2.5 cm (1/2-7/8" long & 1.2-3 mm wide, oblanceolate to narrowly oblanceolate, tapering to a long, narrowly winged (widened at base) petiole (stem), the edges usually entire, obtuse tips. Inflorescence: 2-6 flowers, sub-sessile (short stems), the flowers included in the foliage. Calyx: 5.5-7.5 mm long, the segments lanceolate, viscid-pubescent (sticky-hairy) as well as scabrous, and the edges green. Corolla: 11-16 mm 3/8-1/2") long, blue to lilac, the throat only weakly 2-ridged above, glandular-puberulent (tacky-downy) externally, the palate golden-yellow-to whitish-bearded, the upper lobes arched-erect, the lower lobes spreading. Anther cells: 0.8-1 mm long, opening full length, but not flat, becoming widely spreading, smooth except for the nipple-shaped cell edges. Staminode: Golden-yellow-bearded; fertile stamens with one pair projecting. Infructescences: Capsules nearly globose, about 4 mm in size, glabrous when mature; contains 2-4 seeds. Seeds lunate, 2-3 mm long, black.
   This technical description is extracted from the descriptions of several hundreds penstemons on the website of the American Penstemon Society (American Penstemon Society 2012).

3. Local field characters: *Penstemon yampaensis* has oblanceolate, cineraceous leaves, usually 2/3 to 1.0 inch long and 1/6 inch wide and tapering to the petiole. Leaf often will show venation of three nerves (see in Figure 13 the leaves to the N.E of the lower flower). Flowers are usually 4 to each ultimate flowering stem, Flowers lilac blue. The small woody tufts are not trailing, thus the end of branches cannot be lifted off the ground. The Yampa beardtongue is about twice the size of *Penstemon acaulis*.

4. Similar species: *Penstemon yampaensis* is easily differentiated from *Penstemon acaulis* by its leaves twice as long and wide as those of *P. acaulis*, grayish, lanceolate leaves versus the green, linear leaves of *P. acaulis*. Often the flowers of *P. yampaensis* are given as lilac-blue; whereas the color of flowers in *P. acaulis* is given as bright blue. However, Figure 1 shows much variation in the color of *P. acaulis* flowers and color should not be diagnostic or the main factor in the determination of the plant. *Penstemon caespitosus* forms mats with long, thin, railing branches with alternate leaves and the tip of branches is easily lifted off the ground. Leaves in *P. caespitosus* are grayish, up to 3/8 inch long and 1-3 mm wide with sharp mucronate tips. The flowers of *P. caespitosus* are borne singly in suspicate thyrse; they have blue lobes and the throat is white with reddish lines.

L. Geographical distribution

1. Range: *Penstemon yampaensis* is a regional endemic of Moffat Co., northwestern Colorado with distribution extending westward to Uintah and Daggett Counties in Utah and Sweetwater Co. in Wyoming. In Wyoming the taxon is known from only one record, recently found. In Utah, the taxon is known from Browns Park on both side of the Green River, Clay Basin and Sears Canyon. The distribution of this taxon is centered on western Moffat County.

2. Extant sites: *Penstemon yampaensis* is known from 25 element occurrences CO-EO 1117, 1265, 2471, 2625, 3136, 3229, 3730, 3980, 4051, 5230, 5451, 6831, 6832, 7113, 8477, 8831, 9066, 9558, 9749, 9778, 10038, 10401, 10419, 11051, 13613; records for which are maintained by the Colorado Natural Heritage Program. This not-for-profit program within the Colorado State University tracks, directly or with the assistance of botanists outside the organization, volunteers, staff from federal and state agencies, the state of the colonies within these element occurrences. All of these are within Moffat County, Colorado. In Moffat County, Colorado, nine other extant sites have been memorialized by Pease, Penland, Peterson, Weber and Wiley through specimens deposited in various herbaria (CS, COLO, NY, RM). Additionally, another five sites in Colorado have been made known to this author by members of the American Penstemon Society who supplied specific coordinates and identification supported by photographic records of the plant permitting determination. This author himself also found sites in the Deception Creek watershed and along Moffat County Rd 10 approximately 15 km from CO HWY 318. See Figure 14 for a generalized distribution of *P. yampaensis* on a watershed basis.

Figure 13. *Penstemon yampaensis* (Photograph by Marcel R. Jouseau)

There are nine records of collection of *Penstemon yampaensis* from within Daggett County, Utah: two records for the Brown Hole area, four for Clay Basin and three for Browns Park in the Red Creek watershed. One record of *P. yampaensis* is also available for Uintah County in the remote Sears Canyon area.

In Wyoming, during the course of the 2010 survey for *Penstemon acaulis,* the author discovered *Pentemon yampaensis* on land managed by the Bureau of Land Management. This taxon was present as a cluster of several plants within a much larger *P. acaulis* subpopulation. This is the only location where the two taxa are reported to be sympatric. They flower at the same time. Plants with intermediate characteristics were not observed in the vicinity. A voucher plant was deposited in the Rocky Mountain Herbarium and a note was published in Castilleja, the newsletter of the Wyoming Plant Society (Jouseau 2011).

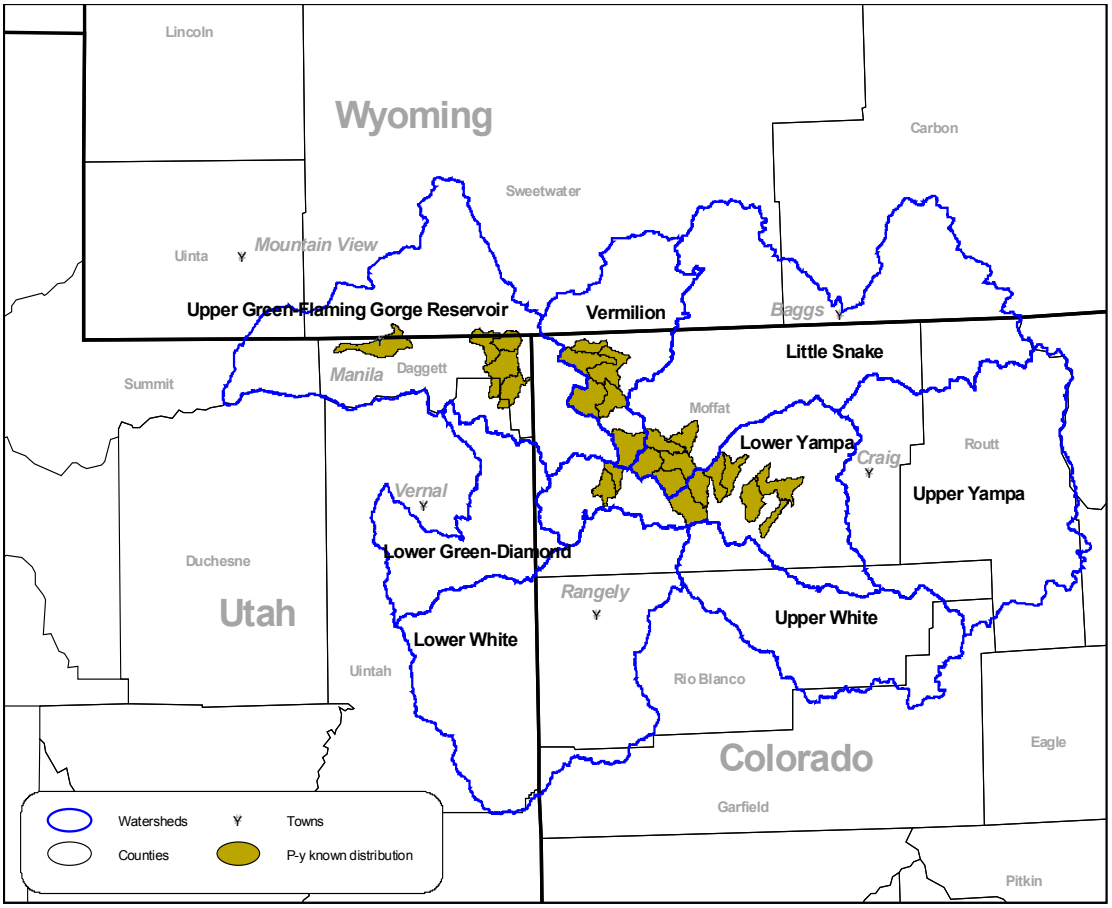


Figure 14. Distribution of known populations and sites of *Penstemon yampaensis*

For all of the sites, with the exception of a few of those listed as CO-Element Occurrences above, there is no quantified data on the size of the sites, density of plants or number of individuals within the sites. Anecdotal information is available generally depicting *Penstemon yampaensis* as more abundant than *Penstemon acaulis*. Kelaidis (2001) states:.. "It [*yampaensis*] is MUCH more abundant, I have found this growing almost solidly for acres and acres at the north end of Brown's Park. As you go southward in the Uinta Basin it is restricted more and more to ridge tops, but even along Highway 40 there are some good

populations (including the type locality) if you know where to look."… Others consider the distribution of *P. yampaensis* as widespread. M.Kintzen (2010) wrote: …"[W]hile I have never found more than twenty plants of *P. yampaensis* in anyone spot, it seems to be rather wide spread through out Northwestern Moffat County."

3. Historical sites: None known. The first collection in Utah was made in 1951 by C. William T. Penland, voucher Penland 4236, "Sandy calcareous knoll, scattered grass and sage; 5.5-6 miles east of Elk Springs, Moffat County, Colorado, 9 June 1953" (Penland 1958). This collection point is within Colorado extant Occurrence #9778.

4. Unverified/Undocumented reports: None known.
5. Sites where present status not known: None known.
6. Areas surveyed but species not located: None known. There has been no attempt in Colorado, Utah, or Wyoming to systematically survey the region for *Penstemon yampaensis* and overall there is a lack of data to clearly define the range of this taxon, the number of populations, the acreage of occupied niche, density or number of individual plants on either public land or private land.

M. Habitat: *Penstemon yampaensis* is found on dry, open, sparsely vegetated rocky slopes, tops of ridges, or gravelly soils, as well as deposition fans from eroded steep slopes.

1. Associated vegetation: Cushion plants are frequently associated with the habitat of *Penstemon yampaensis*. It is frequently found in areas dominated by the shrubby *Artemisia nova*, as well as in clearings among the big sagebrush, *Artemisia tridentata*. Occasionally *P. yampaensis* is associated with the pinyon-junipers plant community.

2. Frequently associated species: Numerous species are associated with *Penstemon yampaensis*. Forb species often cited include: *Arenaria hookeri*, *Stenotus acaulis*, *Oxytropis sericea*, various *Lesquerella* species, *Phlox hoodii*. The most common shrubby species are *Artemisia nova* and *Artemisia tridentata*. See Table 7 for a more comprehensive but not exhaustive list.

3. Topography: *Penstemon yampaensis* is found over a variety of topographic features such as flat ridge tops, side and rim of buttes, very steep slopes and shallow slopes, depositional flats and alluvium fans at elevations ranging from about 5,800 feet in the Red Creek area, in Utah, to about 8,200 feet on Diamond Peak eastern shoulder, in Colorado.

Table 7. Species frequently associated with *Penstemon yampaensis*

Scientific name	Common Name	Habit
Agropyron spicatum	Bluebunch wheatgrass	Graminoid
Antennaria sp.	Pussytoes	Perennial forb
Arenaria hookeri	Hooker dandwort	Perennial forb
Artemisia nova	Black sagebrush	Shrub
Artemisia tridentata	Big sagebrush	Shrub
Aster spp.	Asters	Perennial forb
Astragalus spathulatus	Spoonleaf milkvetch	Perennial forb
Bolophyta ligulata	Ligulate feverfew	Perennial forb
Castilleja chromosa	Desert paintbrush	Perennial forb
Chrysothamnus nauseosus	Rubber rabbbitbrush	Shrub
Chrysothamnus viscidiflorus	Green rabbitbrush	Shrub
Draba sp.	Draba	Perennial forb
Eriogonum heracleoides	Parsnipflower buckwheat	Perennial forb
Eriogonum ovalifolium	Cushion buckwheat	Perennial forb
Eriogonum umbellatum	Sulphur-flower buckwheat	Perennial forb
Euphorbia fendleri	Fendler's sandmat	Perennial forb
Haplopappus acaulis (Stenotus acaulis)	Stemless mock goldenweed	Perennial forb
Hymenoxys richardsonii	Richardson's hymenoxys	Perennial forb
Ipomopsis congesta	Ballhead ipomopsis	Perennial forb
Juniperus osteosperma	Utah juniper	Tree
Lesquerella alpina	Alpine bladderpod	Perennial forb
Lesquerella sp.	Bladderpod	Perennial forb
Linum lewisia	Lewis Flax	Perennial forb
Lupinus pusillus	Rusty lupine	Perennial forb
Machaeranthera grindelioides	Rayless tansyaster	Perennial forb
Opuntia sp.	Paddle cactus	Cactus
Oryzopsis hymenoides	Indian ricegrass	Graminoid
Oxytropis besseyi var. obnapiformis	Bessey's locoweed	Perennial forb
Oxytropis sericea	White locoweed	Perennial forb
Pediocactus simpsonii	Mountain ball cactus	Cactus
Phlox hoodii	Moss phlox	Perennial forb
Poa secunda	Sandberg bluegrass	Graminoid
Purshia tridentata	Antelope bitterbrush	Shrub
Sphaeralcea coccinea	Scarlet globemallow	Biennial/perennial
Stipa comata	Needle-and-thread grass	Graminoid
Tetraneuris acaulis	Stemless four-nerve daisy	Perennial forb
Townsendia incana	Easter daisy	Perennial forb

4. Soil relationships: *Penstemon yampaensis* grows in a variety of soils. The textures of these soils vary from channery fine sandy loam to clay loam, fine sandy loam, to gravelly sandy loam, to sandy clay loam, to cobbly and extremely cobbly sandy loam, to very stony sandy loam, to weathered and unweathered bedrock. The soils are derived from many geologic formations; among others: Bridger formation, Morgan Formation and Round Valley limestone, Green River Formation Luman Tongue and Tipton shale Tongue, Mancos Shale, Madison Limestone, Browns Park Formation, Baxter Shale, Wasatch Formation Cathedral Bluffs Tongue. *P. yampaensis* generally grows in quite shallow and very well-drained soils. The available water capacity of these soils is low to very low. Typically the organic matter content is between 0 and 2 percent. The soil pH ranges from basic to strongly basic (7.4 to 8.4 and 7.9 to 9.0). While the soil data table shows several instances of soils slightly acidic, most likely this is an artifact of soil complexes that results from lumping soils during the field mapping process. Most likely the Yampa beardtongue is not found on the slightly acidic soil within these soil complexes. See Table 8 for soils associated with the *P. yampaensis*.

   Table 8. Soils associated with *Penstemon yampaensis* and some of their characteristics

Soils	**Soil pH**	**pH 2nd depth**	**Clay%**	**AWC**(1)	**O.M.%**
Avalon-Mack complex, 1 to 12 % slopes	7.4 - 8.4	7.9 - 9.0	14-18	0.12-0.14	0-1.0
Berlake sandy loam, 3 to 12 % slopes	7.4 - 7.8	6.6-7.8	12-15	0.09-0.18	0-2.0
Brownsto-Luhon complex, 10 to 35 % slopes	7.4-8.4	7.9-9.0	7-15	0.04-0.14	1.0-2.0
Brownsto-Luhon-McFadden complex, 3 to 15 % slopes	7.4-8.4	7.9-9.0	10-18	0.07-0.20	0.5-2.0
Carbol-Irigul-Rock outcrop complex, 3 to 25 % slopes, very stony	6.1 - 7.3	6.1-7.3	15-20	0.13-0.17	0.5-2.0
Carbol-Miracle complex, 3 to 12 % slopes	6.1 - 7.3	5.6-7.8	15-20	0.13-0.17	1.0-4.0
Castee loam, 3 to 12 % slopes	7.4 - 8.4	7.9 - 8.4	12-18	0.14-0.17	0-2.0
Chroder sandy loam, 3 to 12 % slopes	7.4 - 8.4	7.9 - 9.0	11-15	0.10-0.14	0.0-0.5
Clapper gravelly loam, 2 to 25 % slopes	7.9-9.0	7.9-9.0	18-27	0.07-0.13	0.5-2.0
Clifsand-Chroder complex, 3 to 12 % slopes	7.9 - 8.4	7.9 - 9.0	5-10	0.07-0.11	0-1.0
Cortyzack-Flynncove association, 3 to 25 % slopes	6.6-7.8	7.4-7.8	13-25	0.10-0.20	1.0-4.0
Coyet loamy sand, 3 to 12 % slopes	7.4 - 8.4	7.9 - 9.0	5-12	0.08-0.11	0-1.0
Coyet-Crestman, moist complex, 20 to 50 % slopes	7.4 - 8.4	7.4 - 9.0	5-12	0.08-0.11	0-1.0
Crago-Pensore-Grapit association, 6 to 75 % slopes	7.9 - 8.4	7.9 - 9.0	20-27	0.07-0.14	0.0-3.0
Forelle loam, 3 to 12 % slopes	7.4 - 7.8	7.9 - 8.4	15-27	0.16-0.21	0-1.0
Forelle-Evanot complex, 12 to 25 % slopes	6.6 - 8.4	7.9 - 9.0	15-27	0.09-0.18	0.5-2.0
Gracot-Maybell complex, 5 to 30 % slopes	7.4 - 8.4	6.6 - 7.3	8-12	0.03-0.05	0.5-2.0
Grieves-Crestman complex, 10 to 40 % slopes	7.4 - 8.4	7.9 - 8.4	5-12	0.08-0.11	0-1.0
Haploborolls-Torriorthents complex, 10 to 70 % slopes	7.4-7.8	7.4-7.8	15-30	0.05-0.10	0-1.0
Joebas-Rock outcrop complex, 5 to 40 % slopes	6.6 - 7.8	6.6 - 8.4	10-27	0.08-0.10	0.5-2.0
Losee-Thornburgh dry, complex, 25 to 65 % slopes	7.4 - 7.8	6.6 - 7.8	5-30	0.04-0.10	1.0-4.0
Luhon loam, 0-3% slopes	7.9-8.4		15-30	0.12-0.15	0.5-1.0
Luhon-Hickey-Heath complex, 3-25% slopes	7.9-8.4		20-40	0.11-0.20	0.5-2.0
Maybell sand, 12 to 45 % slopes	6.6 - 7.3	6.6 - 7.8	4-7	0.08-0.10	0-2.0
Miracle-Coldspring complex, 3 to 12 % slopes	6.6 - 7.3	6.6 - 7.8	10-35	0.12-0.15	2.0-4.0
Ninot-Crago-Garlips complex, 15 to 45 % slopes	7.9 - 8.4	7.4 - 7.8	15-25	0.09-0.11	1.0-4.0
Poposhia very fine sandy loam, strongly alkaline 1-3% slopes	7.9-9.0		7-35	0.13-0.15	1.0-2.0
Poposhia loam, 3-6 % slopes	7.9-9.0		15-35	0.14-0.20	1.0-2.0

Soils	Soil pH	pH 2nd depth	Clay%	AWC(1)	O.M.%
Redcreek-Blackhall-Rock outcrop complex 6-35% slopes	7.4-8.4		5-15	0.08-0.13	1.0-2.0
Rentsac channery sandy loam, 25 to 65 % slopes	7.9 - 8.4	7.9 - 8.4	10-18	0.07-0.10	0-1.0
Rock outcrop-Haploborolls complex, 10 to 40 % slopes	---	6.6 - 7.3	0	0.00	---
Rock outcrop-Torriorthents complex, 50 to 75 % slopes	---	7.4 - 8.4	0	0.00	---
Rock River loam, 2 to 8 % slopes	7.4-7.8	7.4-8.4	15-27	0.13-0.17	1.0-2.0
Rock River sandy loam, 3 to 12 % slopes	6.6 - 7.3	7.9 - 8.4	10-30	0.12-0.14	0.5-2.0
Ryan Park loamy sand, 3 to 15 % slopes	7.4 - 7.8	7.9 - 8.4	5-18	0.08-0.10	0.5-2.0
Ryan Park sandy loam, 0 to 3 % slopes	7.4 - 7.8	7.9 - 8.4	8-18	0.10-0.13	0.5-2.0
Ryan Park-Coyet complex, 5 to 25 % slopes	7.4 - 7.8	7.4 - 8.4	5-10	0.08-0.10	0.5-2.0
Strych gravelly sandy loam-Strych cobbly s.l. complex, 8 to 30 % slopes	7.4-8.4	7.4-8.4	8-18	0.05-0.07	0.5-3.0
Stunner sandy loam, 1 to 8 % slopes	6.6 - 7.3	7.9 - 9.0	10-27	0.10-0.13	0-1.0
Talamantes loam, 0 to 6 % slopes	7.4 - 8.4	7.4 - 9.0	18-35	0.14-0.18	0.0-1.0
Tipperary loamy fine sand, 3 to 12 % slopes	7.9 - 8.4	7.9 - 9.0	5-12	0.08-0.11	0.0-0.5
Tipper-Crustown complex, 10 to 40 % slopes	7.9 - 8.4	7.9 - 9.0	5-12	0.06-0.08	0.5-1.0
Torriorthents-Rock outcrop, sandstone complex, 25 to 75 % slopes	7.4 - 9.0		10-35	0.07-0.10	0.5-1.0
Torriorthents-Rock outcrop, shale complex, 30 to 75 % slopes	7.4 - 8.4		27-40	0.07-0.12	0.5-1.0
Torriorthents-Torripsamments complex, 12 to 40 % slopes	7.9 - 8.4	6.6 - 7.8	27-40	0.17-0.20	0.5-1.0
Youngston loam, cool, 0 to 3 % slopes	7.9 - 8.4	7.9 - 9.0	18-30	0.12-0.20	0-1.0
Note (1) : AWC = available water capacity					

Sources: Soil Survey Geographic (SSURGO) database for Moffat County Area, Colorado, USDA; Utah Soil Survey, USDA

5. Regional climate: Because of the paucity of long term meteorological monitoring stations within the area of known distribution of *Penstemon yampaensis*, this author has used data for precipitation and minimum and maximum temperatures that were computed through modeling by Climate Source (Climate Source 2000). This computed data provide some insight on the climate experienced by this taxon over its entire distribution. Similarly, the high precision grass-reference evapotranspiration map developed by Park and Junna (2011), at the University of Wyoming, was used to understand the level of moisture stress that the *P. yampaensis* might experience. The annual precipitation within the area occupied by the Yampa beardtongue ranges from 231 to 479 mm (9 to 18.9 inches) with a mean and median of 318 (12.5 inches) and 309 mm, respectively. The monthly minimum temperatures range from –17.7 to –9.3°C (0°F to 15°F) for January, to 8.2 to 12.5°C (47 to 54.5°F) in July. The monthly maximum temperatures for the known distribution area of *P. yampaensis* range from –1.5 to 2.0°C (29 to 35.6°F) in January and 24.3 to 30.4°C (76 to 87°F) in July. Table 9 shows the grass reference evapotranspiration for the same *P. yampaensis* distribution.

Table 9. Grass reference evapotranspiration for seasons in *Penstemon yampaensis* habitat.

Season	Reference Evapotranspiration Range (mm)		Mean (mm)	Standard Deviation (mm)
April-May-June	427	497	473	12.7501
June-July-Aug.	570	645	614	16.8206
May-June-Jul.-Aug.	713	812	773	20.8444
April Through Sept.	939	1077	1023	27.9130

6. Local microclimate: The nearest meteorological monitoring stations are Maybell and Browns Park Refuge, both located within the known range of *Penstemon yampaensis*. The annual mean low and annual mean high temperatures are 25.1°F and 59.7 °F for Maybell and 27.3°F and 63.3°F for Browns Park Refuge. The annual mean precipitation is 12.5 inches and 8.5 inches (318 and 216 mm), respectively, for Maybell and Browns Park Refuge. Maybell has two wetter seasons: April, May June and then September October. A similar pattern is seen in the Browns Park weather records but the wet periods are shorter and of a lesser intensity. See Figure 15 below for details of rainfall and mean low and high temperatures.

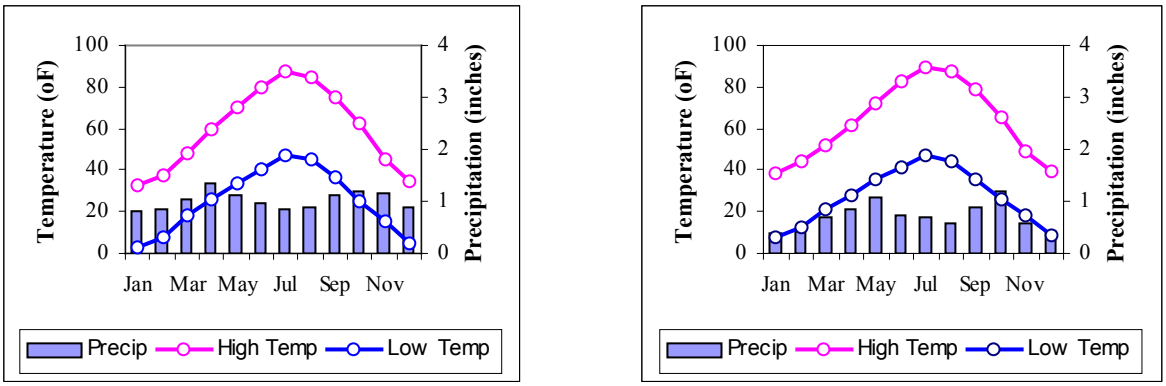


Figure 15. Climate Normals for Maybell and Browns Park Refuge, Moffat Co. Colorado.

As is the case with *Penstemon acaulis*, grass reference eT far exceeds the corresponding seasonal rainfall in likely most of the range of *P. yampaensis*.

N. Population biology and demography:

1. Phenology: The flowering of *Penstemon yampaensis* can be gleaned from herbarium labels on specimens collected, records of field trips narrated in newsletters of the American Penstemon Society or quarterly bulletins of the North American Rock Garden Society. Data recorded on labels of specimens in herbaria show that plants have been collected in flower as early as May 5 (Lichvar 3949) and as late as July 5 (Powell 1995-03). Of course those dates are no indication of the actual range of dates within which the taxon is in bloom. *P. yampaensis* discovered in Sweetwater Co., Wyoming, was in bloom on June 6, at the same time as *P. acaulis* plants surrounding the cluster of *P. yampaensis*. A search of the extremely limited literature, peered reviewed or otherwise, that mentions *P. yampaensis* did not provide additional information on the phenology of the taxon.

   Data on fruit maturation dates are not available; however, data on seed collection dates provided by the owner of a seed business show collection dates ranging from August 4 in 2000 to September 1 in 2011. With five years of recorded collections between 2000 and 2011, in two of those years collections were made during the first week of August, in two years seeds were collected in the last week of August and in one of the five years of records in early September. The limited data do not establish the date of maturity, as the date of collection listed might be more the product of convenience for the collector. However, since the establishment must collect seeds that are viable in order to maintain credibility with

purchasing customers, it seems that the seed is ripe between 2 to 3 months after pollination of the flower.

2. Population size and condition: There are no estimates or plant counts of individual *Penstemon yampaensis* in known populations in Utah or Colorado. Understandably, there is no estimate of the number of populations or tally of individual plants for Wyoming, as until the accidental discovery of the Yampa beardtongue in that state in 2010, the taxon was not known to occur in Wyoming. The only quantified data available on *P. yampaensis* is a brief comment on the NatureServe website (2012) "Less than half of the Colorado occurrences reported number of individuals. Of those that did, a total of 22,000 individuals are estimated (CNHP 1998)". Staff of the Colorado Natural Heritage Program confirmed to this author that there are no other known count or estimate of individual *P. yampaensis* (Menefee, personal communication 2012).

   Not surprisingly, there are no trend data available for *Penstemon yampaensis* in either Colorado or Utah or Wyoming.

   Because of the sensitivity of the data and the lack of precision in the land ownership parcel data available to this author, the geographic distribution of *Penstemon yampaensis* is shown at the watershed level. See Figure 14 for the known range of the taxon.

O. Reproductive biology:

1. Type of reproduction: *Penstemon yampaensis* produces fruits called capsules. Reproduction by seed appears to be the only known natural reproductive means in the Yampa beardtongue. There is no known reproductive means such as stolons, or rhizomes or the viviparous means seen in some ferns and waterlilies. Among plant growers, the Yampa beardtongue has a reputation as a plant difficult to germinate (American Penstemon Society 2010).

2. Pollination biology: A search of the literature has revealed no information on pollination in *Penstemon yampaensis*. In the field, this author has observed small bees moving from plant to plant, thus cross-pollinating flowers of *P. yampaensis*. Bees are known as the principal pollinating agent for many species of beardtongue (Castellanos et al. 2003).

3. Seed dispersal and biology: There is no known dispersal mechanism for seeds of *Penstemon yampaensis*. In this taxon, seed dispersal is limited likely to the occasional ants carrying away a seed, or to surface water runoff or wind eroding soil moving seeds along to some distance. Very likely, as with *Penstemon acaulis*, the seeds drop near or in the plant and, then, may be carried away by wind erosion or water runoff.

P. Population ecology:

1. General summary: Searches of the literature in the fields of botany, ecology and related disciplines provided no information on *Penstemon yampaensis*, except the original 1958 new species documentation by Penland. Efforts at tracking known locations of *P. yampaensis* are very limited to non-existent. A search of the Internet brings anecdotal statements of abundance of the taxon (Kelaidis 2001) or the widespread nature of its distribution (Kintzen 2010), as well as the need for data on abundance, threats and trends (Fertig 2009).

2. Competition: *Penstemon yampaensis* is found primarily in areas of sparse vegetation, such as cushion plants communities, low-density graminoid community, bare soils in openings in sagebrush zones or pinyon-juniper communities. In sagebrush communities, *P. yampaensis* grows only in bare ground openings. Whether *P. yampaensis* is unable to compete with other species because of its low rate of growth and low stature, or because its seeds cannot be transported by wind, water runoff or insects into dense, vegetated areas or, yet, whether light intensity may affect germination cannot be elucidated at this time.

3. Herbivory: The reduced height and size of tufts of *Penstemon yampaensis* make it difficult for larger herbivores to feed on this plant, assuming that it is even palatable to them. No uprooted plants or plants with damaged leaves were noticed during fieldwork by this author. In sagebrush areas, at times, many fragments of leaves of sagebrush could be seen on the ground but no broken *P. yampaensis* or fragments of leaves could be noted. In a number of areas, one could note damage to colonies of *P. yampaensis* resulting from cattle trampling on the plants, it was particularly noticeable where cattle regularly congregated.

4. Hybridization: No report of hybridization in *Penstemon yampaensis* could be found in the literature. In 2011, this author found a plant (database point mj-11-429, in proposed new population 5) that had leaves that were much too large to fit the *Penstemon acaulis* description. Because of the uniqueness of the sighting, unfortunately, no voucher could be collected. One can only wonder whether that is a case of a hybrid or perhaps another case of *P. yampaensis* in Wyoming. It should also be noted that several authors have remarked that vouchers of *P. acaulis* from the Browns Park area, near the Colorado/Utah stateline and the Green River, have broader leaves and the plants appear to be morphologically transitional towards *P. yampaensis* (Franklin 1992, Welsh et al. 1993, Fertig & Welp 2001). The characteristics of these vouchers caused Neese to reclassify *P. yampaensis* to a varietal level of *P. acaulis* (Neese 1986). Figure 16 shows the known geographic distributions of *P. acaulis* and *P. yampaensis*, together with the areas where the taxa are recorded as sympatric and where *P. acaulis* appears to be morphologically transitional.

Q. Land ownership: Over 90 percent of the known populations of *Penstemon yampaensis* found in Colorado are on land within the jurisdiction of either the Bureau of Land Management (BLM) or on state-administered lands. In Utah, it appears that all known records of the taxon are on land in public ownership administered by either the BLM or the State of Utah. The sole known record for Wyoming appears to be on land administered by the BLM; however, it is only a few meters away from the boundary of the Flaming Gorge National Recreation Area that is administered by the US Forest Service.

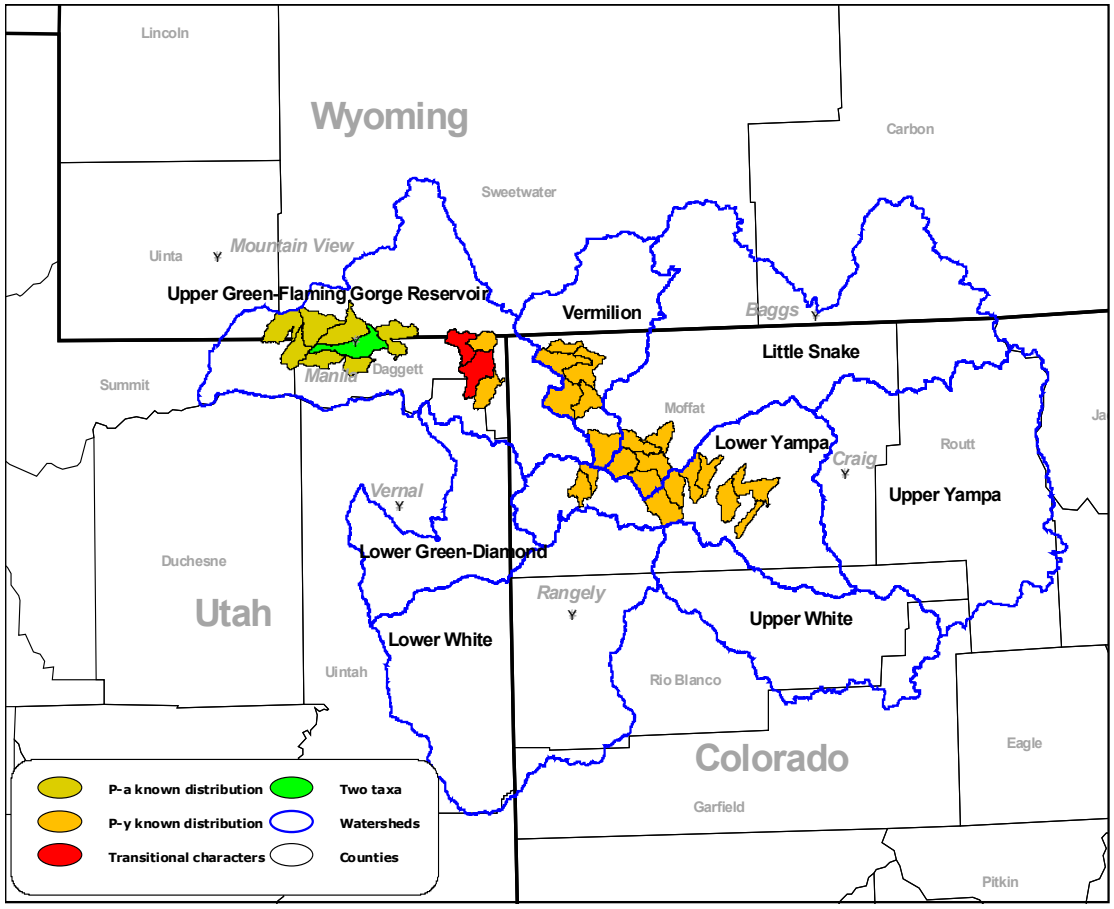


Figure 16. Distribution of *Penstemon acaulis*, *P. yampaensis*, sympatric existence of the taxa and location of *P. acaulis* with transitional characters.

IV. ASSESSMENT AND MANAGEMENT RECOMMENDATIONS FOR *P. ACAULIS* and *P. YAMPAENSIS*

A. Potential threats to currently known populations

A number of mining and extractive energy development (oil, gas, coal) are present in known habitat areas and near habitat areas of *Penstemon yampaensis*. These activities can have a substantial impact on the habitat through grading of access roads, drilling exploration or production wells and excavating for construction materials. Moreover, a number of populations of *Penstemon acaulis* and *P. yampaensis* exist within the right of way (R.O.W.) of roads; these populations could be adversely affected by the spread of invasive plant species, widening of the roadway, the grading of back slopes and drainage ditches, as well as herbicide applications to control weeds. The direct impact of the use of all-terrain recreational vehicles has been observed on a population of *P. acaulis*. Franklin (1992) related potential habitat loss and degradation from high recreation use along the Lucerne Valley Recreation Road. Potential threat exists also from the expansion of parking facilities or of other uses requiring grading and surfacing within recreation areas. Over-harvesting of the taxa for commercial use as ornamental garden plants was mentioned in Fertig and Welp (2001). This concern has also been pointed out to the author of the present report. *P. acaulis*

and *P. yampaensis* are highly desirable plants among rock gardeners and penstemon aficionados. Commercial establishments collect seeds annually for the purpose of satisfying the demand of plant growers. Likely some individual gardeners are also collecting seeds. There is no data to suggest that it is done on a substantial scale; however, these seed collections, if undertaken yearly on the same sites could affect the reproduction and ultimately the survival of populations at those sites. Nothing is known about the number of collecting establishments, or the amount of seed collected, or the pattern of collection (i.e. whether the collecting establishments are collecting repeatedly from just a few easily accessible sites.).

B. Management practices and response:
Grazing is not in itself a threat to either *Penstemon acaulis* or *Penstemon yampaensis*, as there is no evidence that the animals eat those plants. However, there is evidence that trampling of the plants can be destructive, particularly where the animals congregate for resting or on path traveled by the animals, especially on slopes.

In the Lucerne Valley there is extensive spray irrigation to improve hay crops or provide greater density of fodder for grazing animals. The distribution of *Penstemon acaulis* showed a sharp line of demarcation by not penetrating in irrigated land. While it is not known whether any of these irrigated land areas were under BLM administration, the agency should be aware of the potential negative impact of irrigation, through surface runoff or fugitive spray repeatedly saturating the soil of areas of habitat of the taxon contiguous to irrigated land. *P. acaulis* requires excellent drainage

All terrain vehicles used for recreation can have serious negative effects on landforms providing habitat to either *Penstemon acaulis* or *Penstemon yampaensis*. Repeated use of the same areas by these vehicles tends to create ruts, gullies and other such features that further degrade through the concentration of surface runoff. During the 2011 survey, near Manila, several areas actively used by ATV while this author was performing the survey, showed substantial erosion and a direct impact on *P. acaulis* plants.

Fertig and Welp (2001) and Franklin (1992) cited the construction of the Flaming Gorge Reservoir as having probably eliminated some populations in Utah and potential habitat in southern Wyoming. The construction of other public facilities such as Daggett County jail in Utah tucked into potential habitat and adjacent to an extant population can have direct and indirect impacts on populations of the taxa. Federal and state agencies administering public land should be vigilant to ensure the survival of known populations, as well as expand some efforts into surveying areas of potential habitat for the purpose of determining whether there are other occupied niches.

C. Conservation recommendations

1. Recommendations regarding present or anticipated activities: During the 2009-2011 surveys, substantial new populations of *Penstemon acaulis* and one small cluster of *Penstemon yampaensis* have been discovered on BLM-administered land in Sweetwater County, Wyoming, that have immediate use in carrying out BLM sensitive species policy. Other localities may yet be discovered particularly farther north and west in Wyoming. Surveys should be undertaken to identify where these populations might be and a management plan should be developed to manage land containing the recently discovered

populations and future populations in a manner that insures the survival of these narrow, regional endemic taxa.

P. yampaensis, in its habitat on BLM-administered land in Wyoming is potentially affected by various land uses that include grazing allotments, oil, gas and coal exploration leases. Similarly, in Utah, the taxon may also be affected by the same land uses. It is hoped that the Bureau of Land Management, in Wyoming, will find it possible to explore the areas surrounding the recorded site of *Penstemon yampaensis* including the proposed new populations 4 through 9 of *Penstemon acaulis.*

GIS overlays of the location of the Utah collection sites of herbarium specimens of *Penstemon yampaensis* onto digital land ownership maps shows that, likely, a number of sites are within BLM-administered land areas. To date, BLM personnel in Utah appear to be unaware that *P. yampaensis* may be found on land administered by the agency. These areas should be surveyed to obtain information on the specific locations, densities and numbers of plants, potential and existing threats for the purpose of developing a management plan for these areas. These efforts should be done in concert with the state of Utah, as some of the sites may be within state-administered land.

Figure 16 shows the distribution of plants that have been identified by Neese (1986), Franklin (1992), Welsh (1993) as morphologically transitional between *P. acaulis* and *P. yampaensis*. These populations in eastern Daggett Co., located mostly on BLM and state-administered lands are of particular interest as they might be genetically and taxonomically significant. The need to survey the identified area was recommended in Franklin (1992). The author of the present report renews this call for a survey of the area.

Lastly, in 2000, L. Welp established three transects for the purpose of long-term monitoring portions of extant populations of *Penstemon acaulis* in Wyoming and identifying trends affecting the survival of the taxon (Fertig and Welp 2001). Monitoring studies were initiated that year. The data collected in 2000 pointed to the total absence of seedlings in the 150 plots surveyed, together with a very low percentage (4 percent) of reproductive plants. Likely there were dozens of possible reasons for the low percentage of reproductive plants and absence of seedlings that year but the absence of subsequent surveys precludes determining whether that is the norm within these three populations and whether the populations are in sharp decline or surviving. Fertig and Welp (2001) recommended frequent follow-up monitoring of the transects and qualitative and semi-quantitative assessments to assess gross population trends. These recommendations appear to be as sound today as they were then; and, so, they are renewed here.

D. Summary: The 2009-2011 surveys have re-documented the presence of three extant populations of *Penstemon acaulis*, as well as added 12 colonies/subpopulations to these in Wyoming. Moreover these surveys have discovered up to 9 new populations of this taxon also in Wyoming. These three extant and up to nine new populations occupy 600 acres of habitat spread over about 30 square miles. The Wyoming total known population of *P. acaulis* is estimated at about 44,000 plants, a four-fold increase over the 2001status report. In Utah *P. acaulis* is known from 7 extant populations. No new populations were discovered in this state during the 2009-2011 surveys that focused primarily on Wyoming; however a few new colonies-subpopulations were found in Utah. In that state *P. acaulis* has

been documented on about 4,450 acres occupying all or part of about 29 square miles. The total population of *P. acaulis* in Utah is estimated at hundreds of thousands plants.

The new surveys show the range of *Penstemon acaulis* to be presently contained by a polygon extending 23 miles from east to west and about 14 miles from north to south, immediately west of Flaming Gorge Reservoir and north of the Uinta Mountains Range. The surveys have shown that *P. acaulis* is established over a wide range of topographic features from mountain slopes at elevation up to 8,200 ft to nearly flat alluvial or depositional fans in the valley bottom below 6,000 ft, to rocky ledges on vertical escarpments nearly devoid of soils at 6,500 ft. One common characteristic of these areas, however, is the rocky or gravelly nature of the soils providing fast drainage and generally limiting the development of a luxuriant vegetation.

Seventeen miles east of the Reservoir, generally in the Browns Park area, in the northeastern most corner of Utah, there are populations showing morphologically transitional characteristics that have lead collected specimens to be reclassified from *P. acaulis* to *P. yampaensis*. A just begun study of the relationships and taxonomic affinities among members of the genus *Penstemon* subsection *Caespitosi* may provide some clarifications about the taxonomy of these populations.

Much is yet to be learned about *Penstemon acaulis* as much potential habitat remains to be surveyed, especially west and north of the known populations. Moreover, there is no understanding of trends in the known populations. Further surveys, assessments and resuming the monitoring begun in 2000 would provide much needed information to help with the management of *P. acaulis* populations, which, in Wyoming, are overall very small. The greatest potential threats today for *P. acaulis* are animals on grazing allotments, quarrying, recreational use of the land, especially all-terrain vehicles, fugitive sprays and runoff from overhead spray irrigation and, perhaps, collection of plants or seed.

The 2010 survey provided an unexpected addition to the flora of Wyoming with the addition of one record of *Penstemon yampaensis* in Sweetwater Co., on BLM land. This also documented the first instance of sympatry between *Penstemon acaulis* and *P. yampaensis*. The distribution of *P. yampaensis* in Utah and Colorado spreads over approximately 95 square miles, in a polygon extending 90 miles from east to west and about 45 miles from north to south. All of this adds a taxonomically intriguing question and new fieldwork consideration in evaluating *P. acaulis* status. A study of the relationships and taxonomic affinities among members of the genus *Penstemon* subsection *Caespitosi* is beginning and may provide some clarifications about the taxonomy of this population and taxonomic relationships between these two species.

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