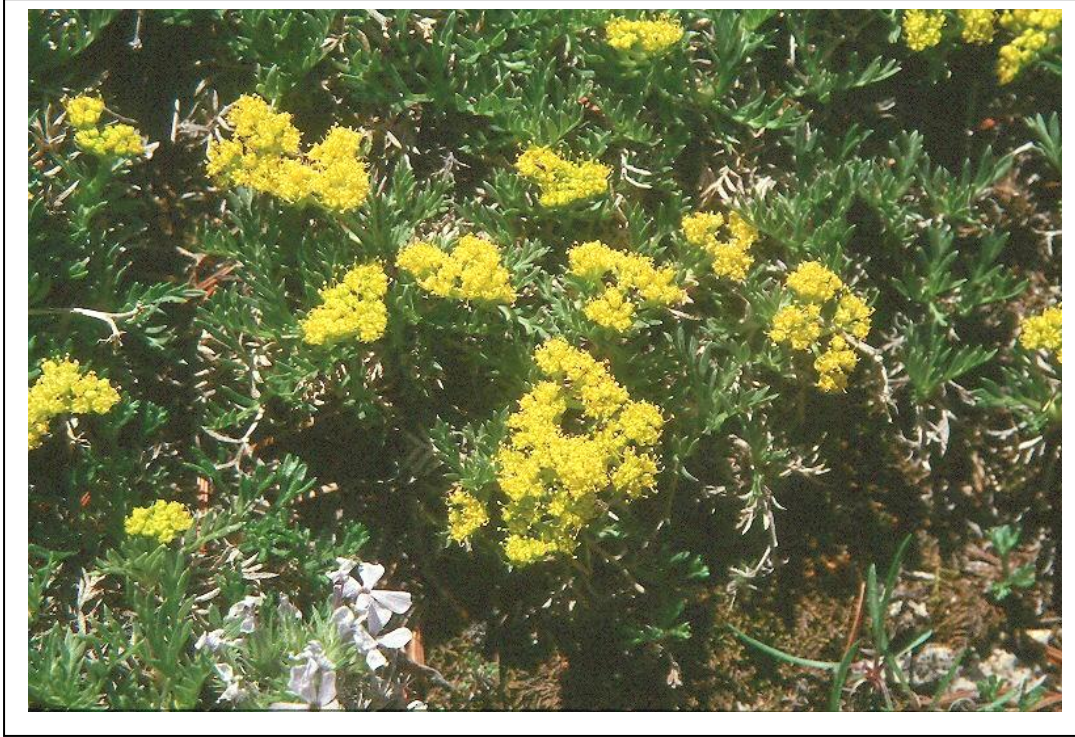


**STATUS OF *SHOSHONEA PULVINATA* (SHOSHONEA),
PARK COUNTY, WYOMING**



Bureau of Land Management – State Office and
Bureau of Land Management - Cody Field Office
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ABSTRACT

Surveys were conducted for *Shoshonea pulvinata* (Shoshonea) in Park County, Wyoming. This report represents a synthesis and update to prior work on *S. pulvinata* with focus Bureau of Land Management (BLM) lands in the Cody Field Office. A species conservation assessment has been prepared for *S. pulvinata* (Lyman 2005) in which research needs were identified that included expanded surveys and evaluating species' response to disturbance. As a result of this fieldwork, new subpopulations and extensions of existing ones were documented at four out of five *S. pulvinata* populations on lands administered by the Cody Field Office, but no new populations were found. The work covered most unsurveyed sections of BLM land identified as high probability in a potential distribution model. Information on disturbances is updated. The paucity of invasive species, limited public access and the ruggedness of its habitat are among the primary factors keeping threats in check. *Shoshonea pulvinata* has the capacity to survive wildfires at some level. Due to fire suppression and other factors, bark beetle infestations are greater than normal and raise the possibility of fire events that are outside the range of natural variability. There are only twelve total populations of *S. pulvinata* throughout its entire range, so protection of the species by the BLM in Wyoming contributes significantly to species' conservation.

ACKNOWLEDGEMENTS

Fieldwork was conducted with the assistance of Elizabeth Quinn Kenworthy. Private landowners are thanked for their permission to cross their property in accessing public land. Annie Munn (Wyoming Natural Diversity Database; WYNDD) assisted in assembling maps before the field season and in digitizing survey routes afterward. Joy Handley (WYNDD) provided GIS support and review. Scott Mincemoyer and Martin Miller, Montana Natural Heritage Program, provided Montana status information. The coordination of Destin Harrell, Bureau of Land Management (BLM), and his review of an earlier draft of the report is acknowledged with appreciation. This report draws heavily from the original status report of Robert Dorn (1989), and the subsequent work of WYNDD botanists Hollis Marriott and Walter Fertig. This study was conducted as a challenge cost-share project of the BLM Cody Field Office of BLM and Wyoming Natural Diversity Database. This report is dedicated to Erwin Evert, who discovered and described *Shoshonea pulvinata*. COPYRIGHT

Literature citation: Heidel, B. 2011. Status of *Shoshonea pulvinata* (Shoshonea), Park County, Wyoming. Prepared for the Bureau of Land Management – Cody Field Office. Wyoming Natural Diversity Database, Laramie, WY.

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INTRODUCTION

Shoshonea pulvinata (*Shoshonea*) is a regional endemic of northwestern Wyoming and adjoining south-central Montana in mountainous fringes of the Bighorn Basin. The type (*Evert 3424*, 6 Aug 1981, RM) was described by Erwin Evert and Lincoln Constance from Rattlesnake Mountain, Park Co., Wyoming (Evert and Constance 1982). Subsequent searches by Evert, Ronald Hartman, and Keith Dueholm of the Rocky Mountain Herbarium, Robert Lichvar of The Nature Conservancy, and David Martin of the U.S. Bureau of Land Management turned up additional populations in Park County and one in Fremont County (Dorn 1989). It was discovered in the Pryor Mountains of Montana by John Pierce in 1984 and in the Beartooth Mountains of Montana by Peter Lesica in 1985, and its Montana status was reported by Shelly (1988). The first status report for it in Wyoming was produced by Robert Dorn (1989), covering information for both Montana and Wyoming. It was later made the subject of surveys by Wyoming Natural Diversity Database (WYNDD) in the BLM Worland Field Office (Marriott 1992; Fertig 1992), and part of multi-species surveys on the Shoshone National Forest (Marriott 1988, Fertig 1996, 1997), which lead to the discovery of one new population and expansions of known populations.

In 2003, a potential distribution model was developed for *Shoshonea pulvinata* (Fertig and Thurston 2003) that remained to be field tested. A species conservation assessment was prepared for *S. pulvinata* (Lyman 2005) that identified outstanding tasks and needs, which included expanding surveys and evaluating species' response to disturbance. The distribution of the largest populations straddles the border between Shoshone National Forest and adjoining lands administered by Bureau of Land Management (BLM) – Cody Field Office, but there was limited information on BLM population portions, lying in BLM lands of the Cody Field Office. Some of the lowest elevation settings for *S. pulvinata* are in the Cody Field Office, and low elevations are often comparatively vulnerable to disturbance. Thus, we aimed to evaluate its known and potential distribution, particularly at low elevations, and evaluate potential threats.

METHODS

At the start of this project, information on the habitat and distribution of *Shoshonea pulvinata* was compiled and reviewed (Lyman 2005, Rocky Mountain Herbarium 2010, Montana Natural Heritage Program 2008, Wyoming Natural Diversity Database 2010). A two-part approach was employed in 2010 field surveys. First, each population was reviewed against public land maps and aerial digital color ortho quarter-quad photographs (doqqqs; photographed in 2000) to identify subpopulations on BLM lands that were not precisely mapped or incompletely mapped, and to identify places of potential habitat on BLM lands that may warrant new survey. Bedrock geology mapping (Love and Christiansen 1985) was also considered. Second, a potential distribution model (Fertig and Thurston 2003) was superimposed onto digital raster graphics

(drgs) and doqqs to identify potential habitat removed from known populations that might warrant new survey.

In preparation for fieldwork, doqqs with the most current mapping of *Shoshonea pulvinata* population boundaries were printed out onto 8 ½” x 11” pages of paper, representing about the same scale as 1:24,000 USGS topographic maps. The aerials and maps were both used for reference in setting field survey priorities and navigation in the field.

Surveys for *Shoshonea pulvinata* were conducted by a two-person team working between 2-6 August. When *S. pulvinata* was found in a survey area, determinations were made of its extent, estimates were made of its numbers, and characterizations were made of its environmental setting, vegetation, and plant associates. Information was compiled and recorded onto Wyoming Natural Diversity Database (WYNDD) sensitive plant survey forms, and later entered in the WYNDD database. Coordinates were recorded from GPS units for georeferencing population boundaries which were later digitized as polygons into the WYNDD database. Survey routes are represented in Appendix A.

RESULTS - SPECIES INFORMATION

Classification

Scientific name: *Shoshonea pulvinata* Evert

Synonyms: None

Common name: Shoshonea (called “Shoshonea carrot” in the USDA PLANTS database)

Family: Apiaceae (previously referred to as Umbelliferae; Parsley family, also called the Carrot family)

Size of genus: Monotypic genus characterized by fruits rounded in circumference, lacking a stylopodium, some fruits sessile, scaberulous throughout, and leaves all basal, arising from a taproot.

Phylogenetic relationships: The above-mentioned suite of morphological characteristics is “homoplastic” (derived from parallel or convergent evolution) among perennial, western North American Apiaceae subfamily Apioideae, closely parallels molecular data for the same taxa, and supports the case for re-evaluating genus treatments throughout the Apioideae (Sun and Downie 2010). Dorn (1988) suggested that the species might be better treated in an expanded concept of

Musineon. Thus, the validity of the *Shoshonea* genus and its relations to other genera are unclear while fundamental taxonomic circumscription is being re-evaluated.

Present legal or other formal status

U.S. Fish & Wildlife Service: None (formerly a C2 candidate for listing under the Endangered Species Act as published on 27 Sept 1985. The C2 list was discontinued in 1996.)

Agency status: Designated sensitive by Wyoming Bureau of Land Management and by U.S. Forest Service Region 2 (Rocky Mountain Region). Similarly, it is designated sensitive by Montana Bureau of Land Management and by U.S. Forest Service Region 1 (Northern Region). Thus, it is designated sensitive on all federal lands where it occurs.

Global Heritage rank: G2G3

State Legal status: None.

State Heritage rank: S2 in Wyoming, indicating that it may be imperiled. Ranked S1 in Montana, indicating that it is critically imperiled.

Description

General non-technical description: *Shoshonea* is a perennial herb that forms dense green mats 2-8 cm tall and up to 45 cm across. The leaves are 2-25 mm long, once-pinnately compound with 5-11 pairs of leaflets, and have swollen, papery petioles. Flowers are either bisexual or male (staminate), minute, yellow, and arranged in compact, flat umbels 0.75-1.5 cm wide. The fruit are sessile, oblong, and prominently ribbed. Both the fruits and the inflorescence are noticeably rough to the touch (scabrous). In fruit, the inflorescences are prostrate to decumbent (Evert and Constance 1982; Marriott 1992; Fertig et al. 1994; Dorn 1989; Figures 1-3).

Technical description: Acaulescent herbaceous perennial, 2-8 cm tall, from a woody taproot with branched caudices, caespitose-pulvinate (cushion-like), scaberulous to subscaberulous, pleasantly aromatic, leaves petiolate, subcoriaceous (almost leathery), imparipinnate, the blades 5-25 mm long, 3-20 mm wide, the 2-5 pairs of leaflets linear or oblanceolate, cuspidate. Inflorescence of subcompact compound umbels 0.75-1.5 cm wide at anthesis, involucre absent, involucre dimidiate, the 5-8 basally connate, entire bractlets linear or lanceolate, slightly exceeding the flowers, umbellets of 1-5 sessile perfect flowers and 2-6 pedicellate staminate flowers, flower yellow, the sepals 5, prominent, unequal, ovate-lanceolate, 1-1.5 mm long, the petals oblong-spatulate with a narrower inflexed apex, about 1.5 mm long, the stamens about 2 mm long, the styles slender, spreading, 1-1.5 mm long, the stylopodium absent (enlargement at base of style), the disk semicircular, the ovary densely scaberulous (slightly rough to the touch). Fruit sessile, scaberulous, oblong or ovoid-elliptic, subterete to slightly compressed laterally, not

equal, prominent to subprominent, ovate in cross-section, up to 0.3 mm long, 0.3 mm wide; pericarp (wall of the fruit) with lignified strengthening cells, carpophores absent or vestigial (prolongation of receptacle between the carpels), seed dorsally compressed, the face plane to concave. Chromosome number $2n=22$ (Evert and Constance 1982).

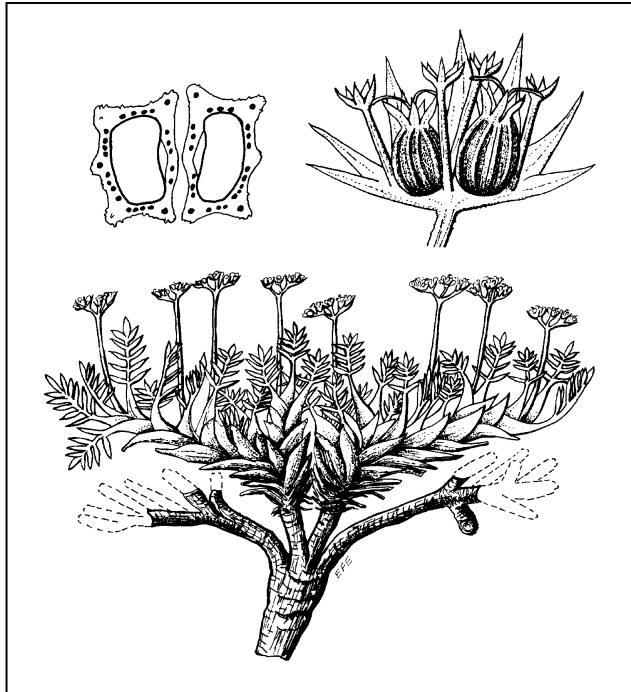


Figure 1. *Shoshonea pulvinata* illustration.
By Erwin Evert (Evert and Constance 1982)



Figure 2. *Shoshonea pulvinata* in fruit. By
B. Heidel



Figure 3. *Shoshonea pulvinata* in flower. By B. Heidel

Local field characters: *Shoshonea pulvinata* is the only umbel in Wyoming that forms dense, solid mats. The leaves are all basal and once compound, the inflorescence, ovary and fruits are scaberulous, and the perfect flowers and fruits are sessile. It is most conspicuous when in flower, though positive determination may be made in either fruit or flower.

Table 1. Characteristics that distinguish *Shoshonea pulvinata* from related species in the family (Dorn 2001, Evert and Constance 1982)

	Outline of young fruits	Fruits	Inflorescence surface	Flower color	Leaf positions	Leaf divisions
<i>Shoshonea pulvinata</i>	Subterete to slightly compressed laterally, with ribs	Sessile	Scaberulous	Yellow	All basal, forming dense mat	Once pinnate
<i>Musineon vaginatum</i>	Flattened at a right angle to commissure, with ribs	Stalked	Scaberulous, sometimes minutely so	Yellow, white	On flower stalks or above pseudoscape; alternate	Ternately-pinnately dissected into linear ultimate segments
<i>Musineon divaricatum</i>	Flattened at a right angle to commissure, with ribs	Stalked	Scaberulous, sometimes minutely so	Yellow	On flower stalks or above pseudoscape; mostly subopposite	Deeply pinnatifid, in deeply cleft or toothed segments
<i>Musineon tenuifolium</i>	Flattened at a right angle to commissure, with ribs	Stalked	Scaberulous, sometimes minutely so	Yellow, white	All basal	1- to 3-pinnate, dissected into linear ultimate segments
<i>Cymopterus</i> spp.	Flattened parallel to commissure, with wings	Variable	Often glabrous, sometimes hairy	Yellow, white, purple	W/o stem leaves, pseudoscape generally present	Ternately to more often pinnately dissected

Similar species: Species of *Musineon* have usually erect stems and stalked, glabrous fruit. *Cymopterus evertii* (Evert's desert-parsley) superficially resembles *Shoshonea pulvinata* and has only recently been collected in the immediate vicinity of *Shoshonea pulvinata* (Heidel 3484) in the Logan Mountain population (#005). but it and other members of the carrot family in Wyoming differ in having corky-winged fruit, twice or more compound leaves, glabrous inflorescences and fruits and elongate flowering stalks (Fertig et al. 1994). The species' unique suite of characters, including its densely-matted growth form, lignified pericarp, dimorphic flowers (perfect and staminate), vestigial carpophores, and unwinged fruit ribs, separate it from its nearest allies in the Apiioideae, including members of the genera *Oreoxis*, *Musineon*, *Neoparrya*, and *Aletes* (Lyman 2005). At a distance, it can also be confused with bright, green mounds of Hooker's sandwort (*Eremogone hookeri*).

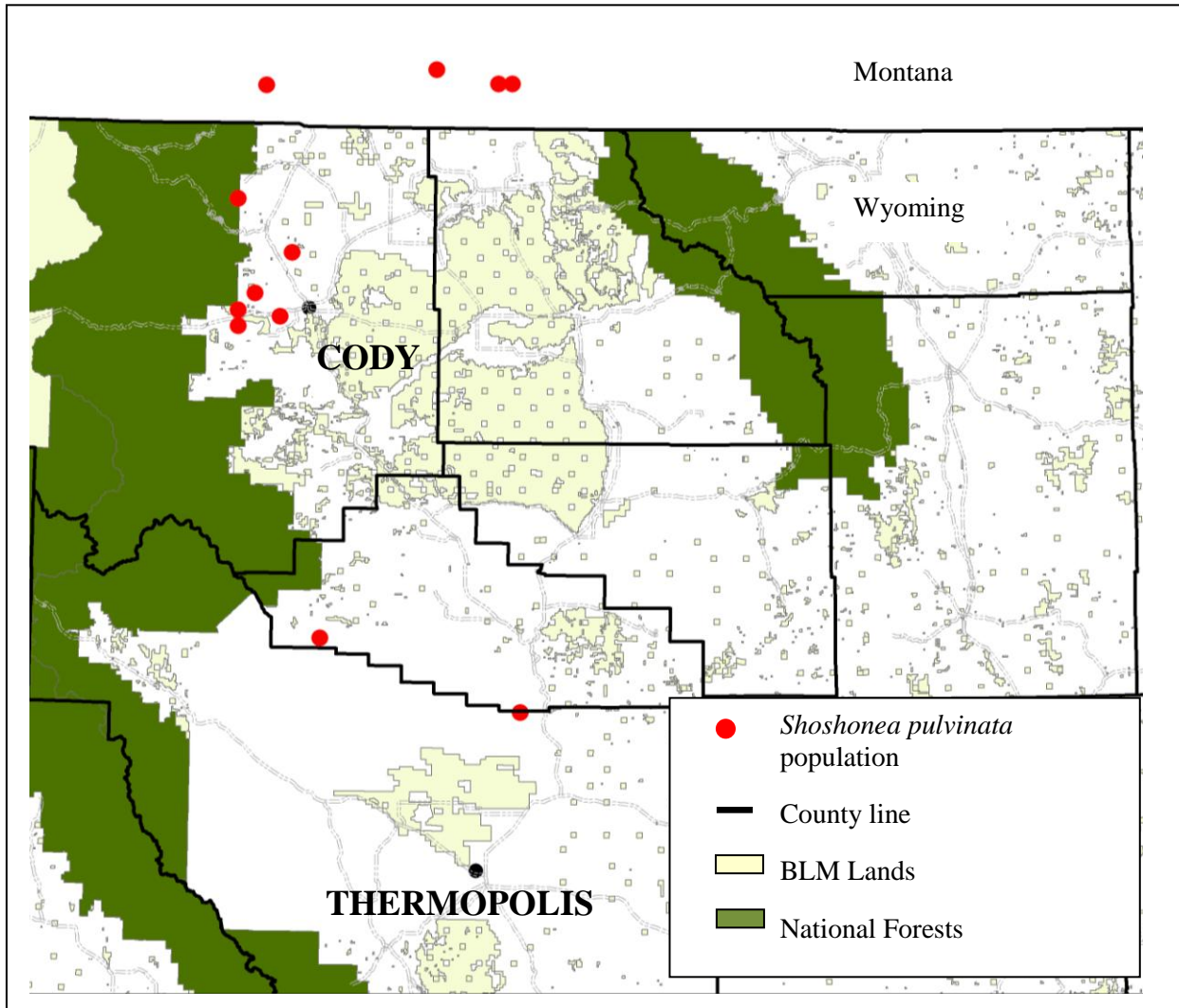


Figure 4. Rangewide distribution of *Shoshonea pulvinata*

Geographical distribution

Range: *Shoshonea pulvinata* is a regional endemic of northwest Wyoming and south-central Montana (Figure 4). In Wyoming, it is known from the eastern Absaroka and Owl Creek mountains in Fremont, Hot Springs, and Park counties. In Montana, it is known from the Beartooth and Pryor Mountains in Carbon County. Thus, it is limited to the mountainous fringes of the Bighorn Basin (Evert 2010).

Extant sites: *Shoshonea pulvinata* is known from eight populations in Wyoming and essentially three populations in Montana (Scott Mincemoyer personal communication 2011). All Wyoming populations have been surveyed since 1982, most recently in the 2010 partial population surveys

on BLM lands in Park County. Complete records and detailed maps of each population are presented in Appendix B.

Table 2. Location of *Shoshonea pulvinata* populations in Wyoming

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5' Quad	Agency/ownership
001	Sheep Mountain; ca 12-15 air mi west-southwest of Cody	Park	T52N R104W Sec. 14, 19, 22, 23, 24, 30	1951-2408 (6400-7900)	Castle Rock Creek	BLM
002	Stagner Mountain; ca. 15 air miles south of Thermopolis	Fremont or Hot Springs	T6N R5E	2286 (7500)	Boysen, Morrison Canyon	Reservation
003	Rattlesnake Mountain; ca. 5.5-17 air miles west and northwest of Cody	Park	T52N R102W T52N R102W Sec. 6; T52N R103W Sec. 1, 2; T53N R103W Sec. 17, 20, 21, 35, 36 T54N R104W Sec. 1, 2, 12, 22, 28, 24, 25, 26, 27, 33;	2073-2804 (6800-9200)	Dead Indian Meadows, Jim Mountain, Logan Mountain, Pat O'Hara, Shoshone Canyon	BLM, USFS
004	Bald Ridge; ca. 22 air miles northwest of Cody	Park	T56N R103W Sec. 18, 19, 30; T56N R104W Sec. 24, 25, 36	2134-2633 (7000-8640)	Bald Peak	BLM, USFS
005	Logan Mountain; 12-15 air miles west of Cody	Park	T52N R204W Sec. 1, 3, 11, 12, 23, 24, 25, 26	1768-2469 (5800-8100)	Castle Rock Creek, Logan Mountain	BLM, USFS
007	Heart Mountain; ca 10 air miles north of Cody	Park	T54N R102W Sec. 10, 11, 14, 15	2195-2475 (7200-8120)	Eaglenest Basin, Goff Lake	Pvt
009	Owl Creek Mountains; 8 air miles west-southwest of Anchor Reservoir	Hot Springs	T43N R101W ¹ Sec. 33	2473-2835 (9000-9300)	Eagle Nest Ranch	BLM, pvt
010	Cedar Mountain, ca 5.5 air miles west-southwest of Cody.	Park	T53N R102W Sec. 7, 8	2073-2451 (6800-8040)	Irma Flats	BLM, pvt

¹ Includes subpopulations in this township that are treated at township scale under WYNDD sensitive data policy.

Historical sites: None.

Unverified/Undocumented reports: None known.

Sites where present status not known: A potential distribution model had been developed for *Shoshonea pulvinata* (Fertig and Thurston 2003; Figures 5-7), in which bedrock geology proved to be the most important parameter in building the classification tree model, followed by land cover and relief. Since *S. pulvinata* is associated with calcium carbonate bedrock, its potential distribution model focuses on geological formations with calcium carbonate. However, there are few areas in the Cody Field Office predicted by the model that have not already been surveyed, and *S. pulvinata* is clearly more restricted than calcium carbonate bedrock.

No surveys for *Shoshonea pulvinata* have been conducted on the east side of the Bighorn Basin in the Bighorn Mountains, though they lie less than 20 air miles from the nearest population in the Pryor Mountains. There have been concerted floristic surveys in the Bighorn Mountains (Nelson and Hartman 1984) that have not documented it. Dorn (1989) identified potential habitat for *S. pulvinata* in the Big Horn Mountains of Big Horn County, on the Crow Indian Reservation, and on Sheep Mountain just south of Luther, Montana on the north side of the Beartooth Mountains. He also included a statement that there are numerous locations in the North Fork Shoshone River drainage that are difficult to reach which likely support the species. The latter has been extensively surveyed by Erwin Evert (Evert 2010) and later in a study for Shoshone National Forest (Taylor et al. 2005), which found extensions of known populations but no new populations.

One potential site was not surveyed, north of Bald Ridge on the north side of the Clarks Fork River on steep outcrops. Directly below Bald Ridge, to the east, are flatiron outcrops and rims of dissected drainages that have not been completely surveyed. The Heart Mountain population may have a small area of outcrop habitat extending onto a BLM tract. There are small, isolated BLM tracts in the Logan Mountain and Rattlesnake Mountain areas at least some of which have potential habitat. Finally, surveys have not been conducted on private lands in Sheep Mountain or on low elevation finger ridges and slump blocks on northern and northwestern flanks of Sheep Mountain. The only known population location that was revisited was on Cedar Mountain because it had not been visited in over 20 years. Maps of all survey routes are represented in Appendix A.

Areas surveyed but species not located: Survey for *Shoshonea pulvinata* was conducted on BLM land east of Carter Mountain in the Devils Tooth area, as identified in potential distribution modeling, but the species was not found and the substrate was igneous. Higher elevations in the Carter Mountain area are more likely to have suitable substrate, although floristic surveys and

sensitive species surveys previously conducted on the national forest lands in Carter Mountain area have not located it (Rosenthal 1988, 1989; Fertig 1997, respectively).

Land ownership: Six of the eight Wyoming populations are at least in part on Bureau of Land Management lands, five of which are in the Cody Field Office (Figure X). Three of these Cody Field Office populations extend into Shoshone National Forest. The Bald Ridge population segment on Shoshone National Forest lies within the potential Bald Ridge Research Natural Area. The only population currently known only from BLM lands is on the Sheep Mountain, though there has not been survey on contiguous private lands. The other two Wyoming populations are on the Heart Mountain Preserve (The Nature Conservancy) and reported from Wind River Indian Reservation.

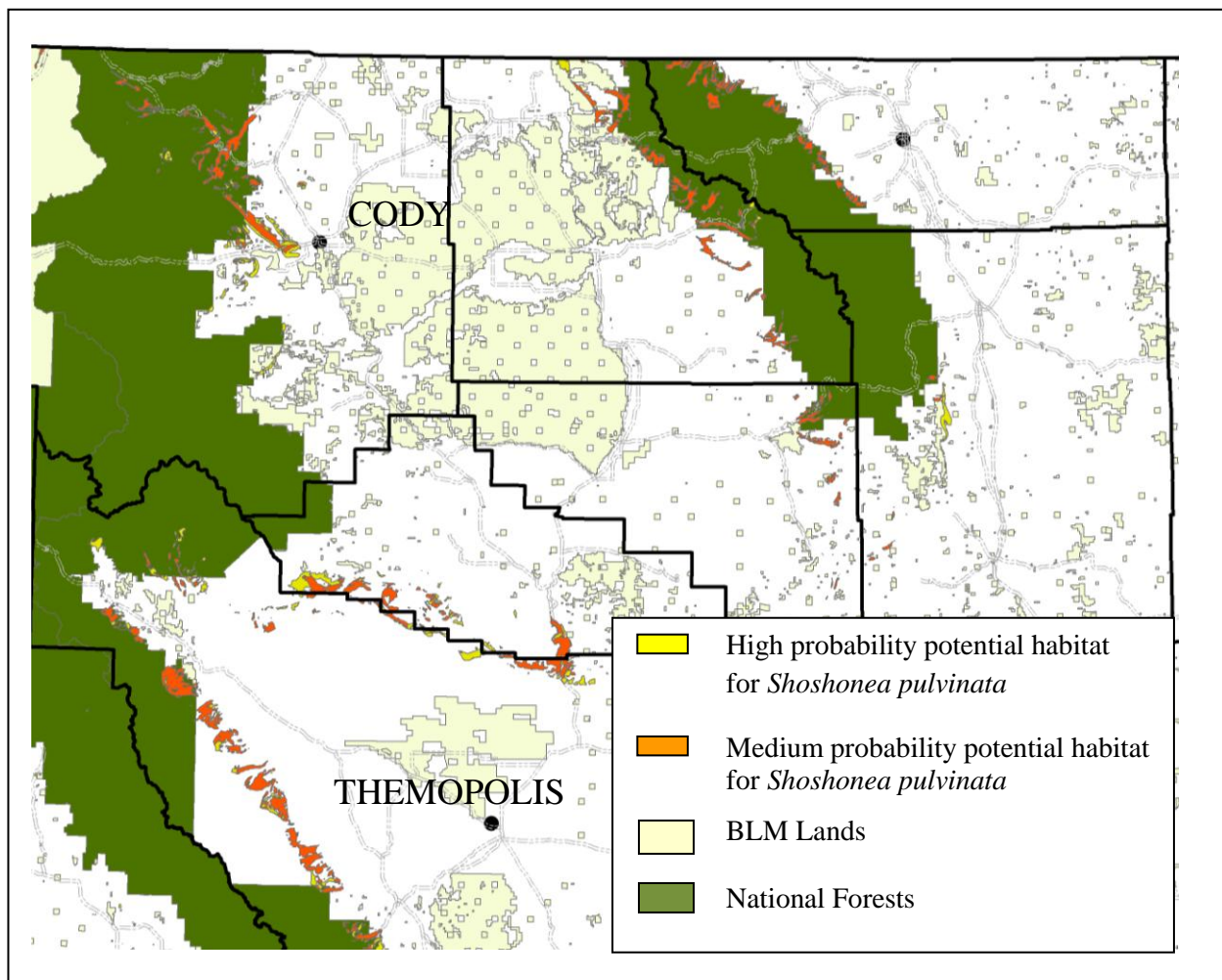


Figure 5. Predicted distribution of *Shoshonea pulvinata* (from Fertig and Thurston 2003)

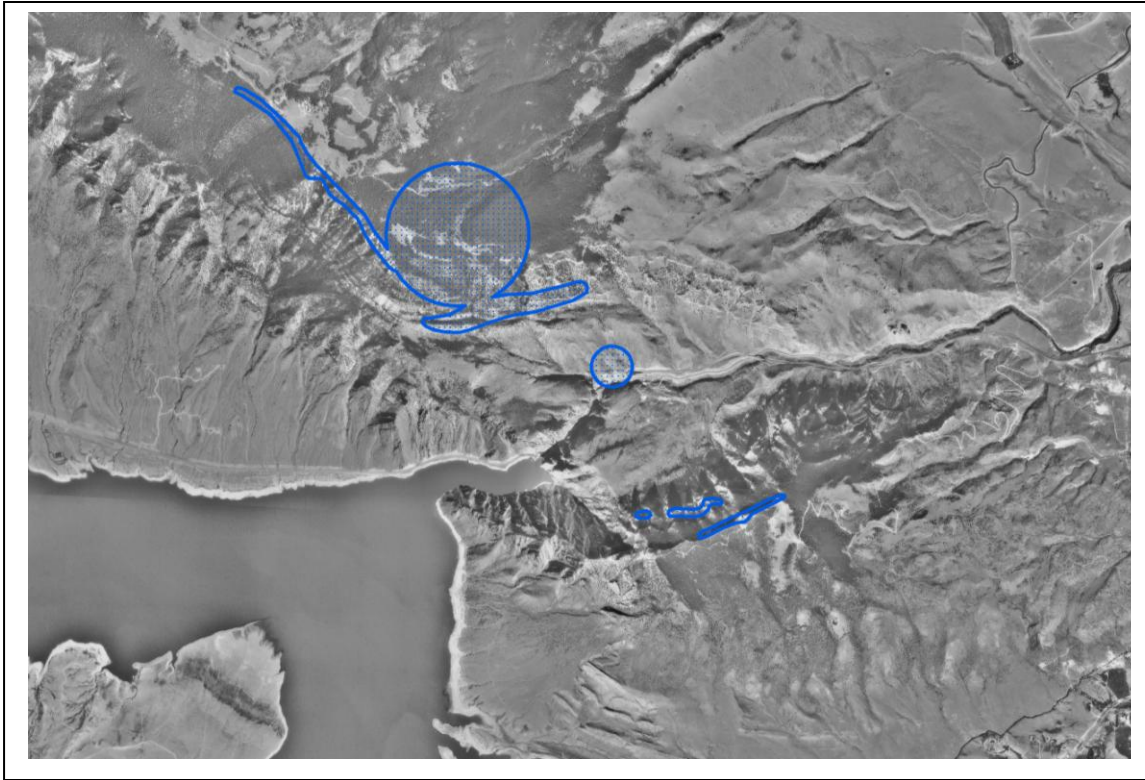


Figure 6. Digital aerial orthophotograph with *Shoshonea pulvinata* distribution mapped in blue in part of Rattlesnake Mountain (north) and Cedar Mountain (south) areas

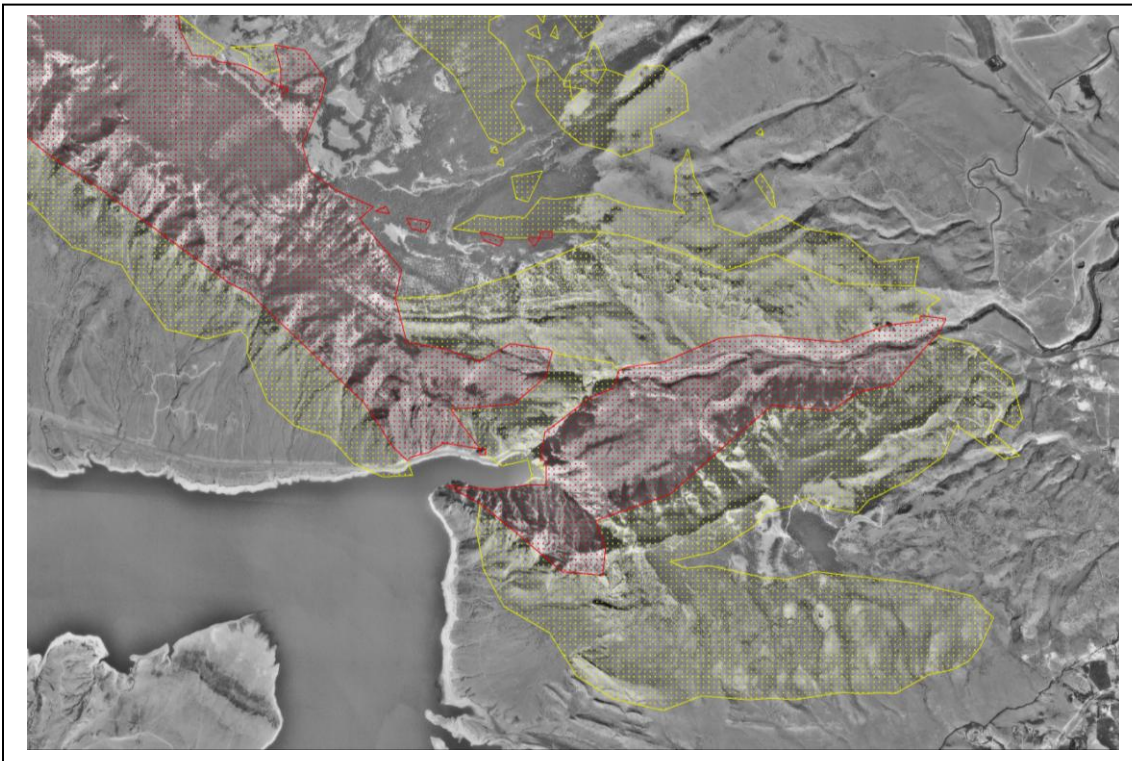


Figure 7. Digital orthophotograph of Rattlesnake Mountain (north) and Cedar Mountain (south) with potential distribution of *Shoshonea pulvinata* superimposed in red (high probability) and yellow (medium probability)

Habitat

Shoshonea pulvinata is restricted to shallow, stony calcareous soils associated with exposed limestone outcrops, ridgetops, and talus slopes (Dorn 1989; Figures 8-12). Vegetation on these sites is sparse and dominated by low herbaceous plants, many of which are also mat-forming. Dorn (1989) interpreted its habitat as “windblast areas” on the exposed settings surrounded by the Douglas-fir zone in Montana, and both the Douglas-fir and spruce-fir zones in Wyoming. The species ranges from 1768-2835 m (5800-9300 ft) in Wyoming, including the particularly extensive population on Rattlesnake Mountain (#003) that spans over 700 m (2100 ft). Evert (2010) reported that it extends as low as 1555 m (5100 ft), but there are no known records at that elevation. Montana populations are at intermediate elevations of app. 2100-2400 m (narrower than 7000-8000 ft).

Associated vegetation: *Shoshonea pulvinata* occupies sparsely-vegetated settings within forests and woodlands, less often bordering shrublands and grasslands. It is often part of a discrete cushion plant community, with or without a bunchgrass cover of *Elymus spicatus* (bluebunch wheatgrass), but can also form narrow bands or habitat ecotones within wooded habitat. Adjacent vegetation may be stands of Douglas-fir, spruce-fir, limber pine, or whitebark pine (Dorn 1989).

Dorn (1989) suggested that *Shoshonea pulvinata* prefers open, exposed, harsh sites with little competition, even though it sometimes occurs in shade. He indicated that plants in these areas appear to be less vigorous than those in full sunlight. Demographic monitoring in a range of habitats was conducted in Montana that indicated population growth rates were highest in one of the two transects with full sun, and flowering activity was highest in the other transect in full sun (Heidel 2001). By comparison, plants in the fully-shaded transect exhibited declining vigor, and low flowering and recruitment.

Frequently associated species: *Shoshonea pulvinata* is often associated with other calcareous cliff community specialists such as *Aquilegia jonesii* (Jones’ columbine), *Carex rupestris* (curly sedge), *Clematis columbiana* var. *tenuiloba* (Columbian virgin’s-bower), *Kelseya uniflora* (Kelseya), and *Telesonix jamesii* (false saxifrage; Evert and Constance 1982). Dorn (1989) expanded this list to include *Eritrichum howardii* (Howard’s forget-me-not), *E. nanum* (alpine forget-me-not), *Astragalus kentrophyta* (spiny milkvetch), *A. serioleucus* (cushion milkvetch), *Oxytropis parryi* (Parry’s locoweed), *Lesquerella alpina* (alpine bladderpod), *Erigeron ochroleucus* (buff fleabane), *Petrophyton caespitosum* (Rocky Mountain rockmat), *Tetraneuris acaulis* var. *acaulis* (stemless four-nerve-daisy) and *Stenotus acaulis* (stemless mock goldenweed). Those associated species noted on BLM lands in 2010 surveys are represented in Table 3, and all others are based on reports, labels or survey records.

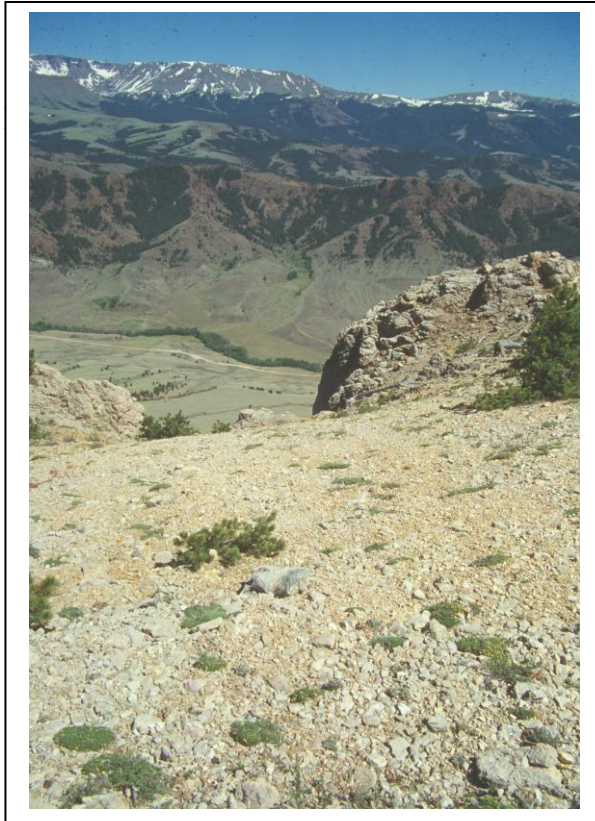


Figure 8. *Shoshonea pulvinata* habitat. Sheep Mountain (#001; foreground) and Logan Mountain (background). By Hollis Marriott.

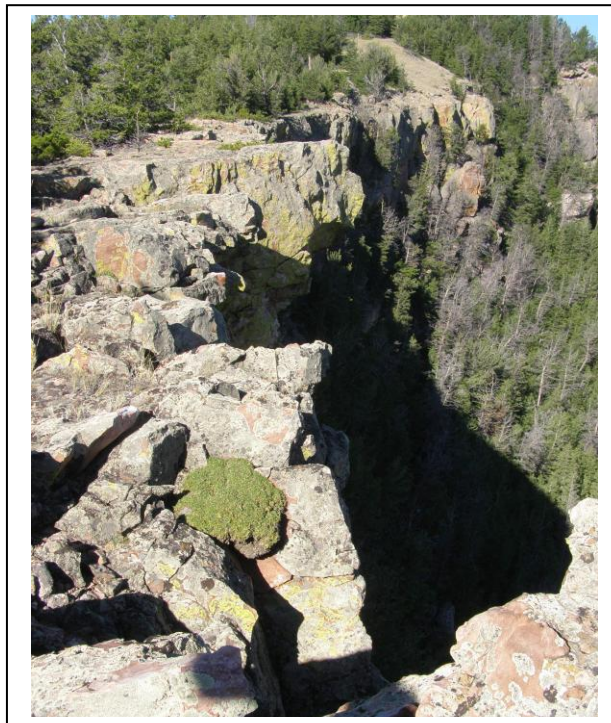


Figure 9 *Shoshonea pulvinata* habitat. Cedar Mountain (#010). By Bonnie Heidel.

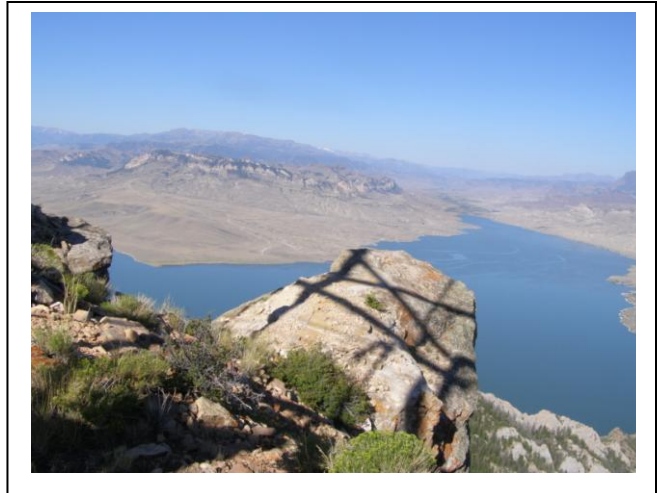


Figure 10. *Shoshonea pulvinata* habitat. Sheep Mountain (#001) as seen from Cedar Mountain. By Bonnie Heidel.



Figure 11. *Shoshonea pulvinata* habitat. Bald Ridge (#004). By Bonnie Heidel.



Figure 12. *Shoshonea pulvinata* habitat. Logan Mountain (#005). By Bonnie Heidel.

Table 3. Species frequently associated with *Shoshonea pulvinata* in Wyoming

Scientific name ²	Common name	On BLM?
<i>Allium cernuum</i>	Nodding onion	Y
<i>Androsace chamaejasme</i> ssp. <i>carinata</i> *	Sweet-flowered rock-jasmine	N
<i>Antennaria aromatica</i> *	Scented pussytoes	N
<i>Antennaria umbrinella</i>	Brown-bract pussytoes	Y
<i>Aquilegia jonesii</i>	Jones' columbine	N
<i>Artemisia frigida</i>	Fringed sagewort	Y
<i>Artemisia nova</i>	Black sage	Y
<i>Artemisia tridentata</i> var. <i>vaseyana</i>	Mountain big sage	Y
<i>Astragalus gilviflorus</i>	Tufted milkvetch	Y
<i>Astragalus kentrophyta</i>	Spiny milkvetch	N
<i>Astragalus sericoleucus</i>	Cushion milkvetch	N
<i>Astragalus spathulata</i>	Tufted milkvetch	Y
<i>Bupleurum americanum</i>	American thorn wax	Y
<i>Campanula rotundifolia</i>	Harebell	Y
<i>Carex rupestris</i>	Curly sedge	Y
<i>Carex filifolia</i>	Threadleaved sedge	Y
<i>Carex stenophylla</i>	Spire-rush sedge	Y
<i>Castilleja nivea</i> *	Snow Indian-paintbrush	N
<i>Clematis columbiana</i> var. <i>tenuiloba</i>	Columbian virgin's-bower	Y
<i>Cryptantha spiculifera</i>	Snake River cat's-eye	Y
<i>Cymopterus longilobus</i>	Henderson's wavewing	Y
<i>Draba oligosperma</i>	Few-seed whitlow-grass	Y
<i>Elymus spicatus</i>	Bluebunch wheatgrass	Y
<i>Eremogone hookeri</i>	Hooker's sandwort	Y
<i>Erigeron ochroleucus</i>	Buff fleabane	Y
<i>Eritrichum howardii</i> *	Howard's forget-me-not	N
<i>Eritrichum nanum</i>	Alpine forget-me-not	N
<i>Festuca hallii</i> *	Hall's fescue	N
<i>Gutierrezia sarothrae</i>	Broom snakeweed	Y
<i>Helictotrichon hookeri</i>	Hooker's alpine oatgrass	N
<i>Heterotheca villosa</i>	Hairy false golden-aster	Y
<i>Juniperus communis</i>	Common juniper	Y
<i>Juniperus scopulorum</i>	Rocky Mountain juniper	Y
<i>Kelseyia uniflora</i>	Kelseyia	Y
<i>Koeleria macrathera</i>	Junegrass	Y
<i>Leucopoa kingii</i>	False fescue	Y
<i>Linum perenne</i>	Wild blue flax	Y
<i>Lomatium attenuatum</i> *	Tapertip biscuitroot	Y
<i>Machaeranthera grindelioides</i>	Rayless tansy-aster	Y
<i>Minuartia nuttallii</i>	Brittle stitchwort	Y
<i>Minuartia obtusiloba</i>	Alpine stitchwort	N

² Associated species that are tracked as species of concern or watch species in Wyoming are marked by an asterisk.

<i>Oxytropis parryi</i>	Parry's locoweed	Y
<i>Packera cana</i>	Woolly ragwort	Y
<i>Paronychia depressa</i>	Spreading nailwort	Y
<i>Pentaphylloides floribunda (Potentilla fruticosa)</i>	Shrubby cinquefoil	N
<i>Petrophyron caespitosum</i>	Rocky Mountain rockmat	Y
<i>Phlox hoodii</i>	Hood's phlox	Y
<i>Pinus flexilis</i>	Limber pine	Y
<i>Pseudotsuga menziesii</i>	Douglas-fir	Y
<i>Pyrrocoma carthamoides</i> var. <i>subsquarrosa</i> *	Absaroka goldenweed	Y
<i>Ribes cereum</i>	White squaw currant	Y
<i>Sedum lanceolatum</i>	Stonecrop	Y
<i>Selaginella densa</i>	Dense spikemoss	Y
<i>Stenotus acaulis</i>	Stemless mock goldenweed	Y
<i>Stephanomeria runcinata</i>	Desert wirelettuce	Y
<i>Telesonix heucheriformis</i>	False saxifrage	Y
<i>Tetranneuris acaulis</i> var. <i>acaulis</i>	Stemless four-nerve-daisy	Y
<i>Trifolium haydenii</i>	Hayden's clover	N

Of special interest are other plant species of concern that grow with *Shoshonea pulvinata* (marked by an asterisk in Table 3). During the course of this survey, new or expanded records were documented for *Cymopterus evertii* (Evert's spring-parsley) and *Pyrrocoma carthamoides* ssp. *squarrosa* (Absaroka goldenweed). There is also an undescribed species of *Astragalus* reportedly growing with it on Cedar Mountain (#010; Dorn 1989); also referenced in Dorn (2001).

Topography: *Shoshonea pulvinata* is found in prominent, exposed settings, most often at or near breaks in topography like rims and ridge crests.

Soil relationships: Soils are poorly developed and derived directly from the parent material, which is usually limestone (Dorn 1989). The soils are very shallow and well-drained in all cases. The bare soil at the surface has high reflectance, and aerial photographs were found to be highly effective in targeting and prioritizing the most suitable habitat in an area (Figure 6).

Regional climate: The Cody, Wyoming weather station (481840) provides the nearest portrayal of the climate in the adjoining Absaroka Mountains, presenting data from 1915-2006 posted by the Western Regional Climate Center data (USDI NOAA 2010). The annual precipitation is 25.3 cm (9.97 in), with peak rainfall in June at 4.2 cm (1.64 in) but spread out widely over the growing season. Five months (April-July and September) all average over 2.5 cm (1 in) mean monthly precipitation. The driest month is February, with 0.7 cm (0.29 in) mean monthly precipitation. Mean annual temperatures at Cody are 7.7 °C (45.8 °F), ranging from -4.3 °C (24.3 °F) in January to 20.9 °C (69.6 °F) in July.

The Cody weather station is at 1530 m (5020 ft) elevation in a foothills setting, and would be expected to have a warmer but possibly drier climate than the montane settings of *Shoshonea pulvinata* habitat. Average wind speeds may be an important climate factor, as suggested by Dorn (1989), but such data are not available.

Local microclimate: *Shoshonea pulvinata* occupies areas where exposure to wind minimizes snow accumulation, and where subsequent soil and vegetation development are inhibited so that competition is minimal (Dorn 1989). Despite exposed conditions, the whitish gravelly surface has high albedo and reduces evaporation from underlying soils. Therefore, this seemingly arid microclimate retains subsurface moisture for taprooted perennials such as *S. pulvinata*. The 2010 growing season was exceptionally dry leading up to the August surveys. Dying plants were present at a Logan Mountain setting (#005; Figure 14) in a setting that had the highest vegetation cover and gentlest slope. It may be that this locale had relatively high competition, or that the moisture in the soil horizon dropped below rooting depth.

Population biology and demography

Phenology: *Shoshonea pulvinata* flowers from mid May-mid June, depending on elevation and climate conditions of the year. It produces fruit from early June-mid August.

The 2010 surveys were conducted when *Shoshonea pulvinata* was in fruit. The species is easiest to detect from a distance when it is in flower, but the deep green vegetation and low mat are different from most other plants growing in the same habitat.

Population size and condition: Dorn (1989) estimated total population numbers at ca 210,000 based on surveys at the Wyoming populations as they were mapped at the time, estimating that there were 200,000 plants west of Cody in the combined populations on Cedar Mountain (#010), Logan Mountain (#005), Rattlesnake Mountain (#003) and Sheep Mountain (#001). In 2010 surveys, roughly 5000 plants were surveyed in newly-added subpopulations. The tallies presented in Table 4 are conservative estimates and are not split between BLM and USFS lands. Approximately 12,000 plants, total, have been reported in Montana (Lesica and Shelly 1988). Total occupied habitat covers less than 5 km² (2 mi²) even though there are individual populations that extend for over 21 km (13 mi).

Trend data are not available for Wyoming populations. Demographic monitoring was conducted in three different settings of *Shoshonea pulvinata* in Montana over an 8-year period that provides insights into species' life history (Heidel 2001). Two of the three transects had a decline in total number of plants, and the third transect had an increase. Seed germination or recruitment appeared to be the limiting life history stages for *S. pulvinata* at the most exposed site, which also had the highest flower production. The low mortality rates indicate that *S. pulvinata* is a long-lived perennial of typically stable numbers, consistent with its cushion-plant growth form. Plants

in two of the three transect settings got smaller on the average rather than larger, and this was particularly apparent among plants in the transect located in a shady setting, suggesting that plant sizes can fluctuate over time and independent of numbers.

Type of reproduction: *Shoshonea pulvinata* reproduces sexually, by seed. There is no indication that caudex branches break apart in nature for vegetative reproduction.

Table 4. Size and extent of *Shoshonea pulvinata* populations in Wyoming

EO#	Population size ³	Extent ha (ac)	Trend
001	Inferred to be at least in 1000's (2010); currently known from 9 subpopulations. Part of "Absaroka population" in Dorn (1989) estimated at 200,000.	18 (44)	Unknown
002	Unknown	Unknown	Unknown
003	Inferred to be at least in 10,000's (1986); currently known from 14 subpopulations. Part of "Absaroka population" in Dorn (1989) estimated at 200,000.	176 (436)	Unknown
004	Est. over 10,000 plants (1989); currently known from three subpopulations	101 (249)	The species survived fire that burned open woodland across much of occupied habitat in 1996, but net effects are unknown.
005	Est. over 20,000 plants (2004); currently known from 12 subpopulations. Part of "Absaroka population" in Dorn (1989) estimated at 200,000.	61 (151)	Small decline with low levels of mortality observed in 2010, possibly due to long-term drought.
007	Est. 5000-8000 plants (1997); currently known from 2 subpopulations. Part of "Absaroka population" in Dorn (1989) estimated at 200,000.	23 (56)	Unknown
009	Est. 600-1100 (1992); currently known from 3 subpopulations	17 (42)	Unknown
010	Est. 500-1000 plants total (2010); currently known from 4 subpopulations. Part of "Absaroka population" in Dorn (1989) estimated at 200,000.	10 (25)	Unknown
TOTAL	Estimated over 215,000 (Dorn 1989), assuming stable trend and adding 2010 survey results	406 (1003)	

Pollination biology: Members of the family Apiaceae have relative uniformity in the flower and inflorescence structure, in which most pollen transfer is carried out by insects (Koul et al. 1993). The flowers offer nectar and pollen attractive to a variety of insects, generally including flies, bees, wasps, ants, beetles and some hemipteran insects. Flies of the family Syrphidae were observed by Dorn (1989) on the flowers. Visitation is affected by environmental conditions, particularly light and temperature. The members exhibit diverse breeding systems ranging from completely selfing to obligately outcrossing. Generally speaking, many exhibit a blend of self-

³ The year in parentheses refers to that of the most complete survey or survey of the largest subpopulation.

and cross-pollination. The small, less conspicuous inflorescences tend to have greater degrees of self-pollination (Koul et al. 1993).

Each inflorescence of *Shoshonea pulvinata* has a combination of sessile perfect flowers and stalked staminate flowers. It is not known if the ratio between the two flower types differs between populations or between years. If it takes less energy to produce staminate flowers, then it may be that the plants in the harshest settings put disproportionate amounts of their energy into pollen production.

In the first status report (Dorn 1989), all populations west of Cody were treated as part of a single population. They are on different landforms separated by valleys, but there is some chance of pollen exchange between them.

Seed dispersal and biology: Each fruit of *Shoshonea pulvinata* produces two seeds (schizocarps). There are often many umbels per plant, but a limited number of the inner flowers are perfect, i.e., with the capacity to produce seeds. The number of seeds may be reduced further in the absence of pollinators or under environmental stress that causes seeds to abort. Based on field observations, it is possible to come up with ballpark figures for fecundity. If we assume that every umbel produces 1-10 fruits, and every plant has 1-20+ umbels, then seed production would range from 2-400+ seeds per plant. The seeds are wingless and have no appendages for wind or animal dispersal (Figures 1, 2). The woody-ribbed fruits may not be attractive as a food source. Gravity appears to be a primary agent of dispersal. The mature flowering stalks are usually lie prostrate on gravel pavement and seeds may disperse no farther than falling down between gravel surrounding the parent plant.

Population ecology:

General summary: *Shoshonea pulvinata* is a polycarpic perennial that can live for almost a decade as a single-stalked plant (Heidel 2001), and plants can grow to a diameter of almost 0.5 m (16 in) across (Dorn 1989; Figure 13). There are many *S. pulvinata* plants that are inferred to be many decades old (Heidel 2001), and though their ages have not been analyzed, parallels might be drawn with well-documented cases of cushion plants in arctic latitudes that live for centuries (Morris and Doak 1998).

One of the challenges in characterizing the life history of *Shoshonea pulvinata* is that critical rates like mortality and recruitment rates seem to have episodic spikes. There was much higher mortality and recruitment among different population segments in comparing data from a two-year interval (1991-1993), which encompassed a drought year, than there was in comparing data from a six-year interval (1993-1999; Heidel 2001).

Competition: *Shoshonea pulvinata* is consistently found in low vegetation cover. This is the basis for inferring that it favors low competition conditions, also based on microclimate conditions and monitoring data (Heidel 2001).

Herbivory: No signs of herbivory have been noted. A rust has been observed on some plants in Montana, with no apparent affect on vigor (Heidel 2001).

Hybridization: There are no signs of hybridization.



Figure 13. Large *Shoshonea pulvinata* plant. Logan Mountain. By B. Heidel.



Figure 14. Dying *Shoshonea pulvinata* plant. Logan Mountain. By B. Heidel.



Figure 15. *Shoshonea pulvinata* in fire line, Bald Ridge. By Kent Houston (USFS)



Figure 16. Surface erosion around *Shoshonea pulvinata* within part of 1996 burn area. By B. Heidel.

ASSESSMENT AND MANAGEMENT RECOMMENDATIONS

Potential threats to currently known populations:

Grazing: *Shoshonea pulvinata* habitat supports little grazing because it has low forage value and is usually in settings that constitute secondary range. Signs of grazing or trampling have not been observed. Habitat is usually far from water, and no grazing developments were found beside occupied habitat.

Logging: *Shoshonea pulvinata* occurs in or near dry forests that have limited timber value. It is possible that stands might become salvage logging targets if they were infested by beetles or burned in a wildfire. Reduction of forest canopy would not be likely to affect *S. pulvinata*, but direct mechanical damage from logging equipment or accelerated soil erosion are potential threats. Any practice associated with logging or salvage logging, like seeding non-native species, could also potentially affect *S. pulvinata*.

Pine beetle damage or dead trees were noted at all four of the *Shoshonea pulvinata* populations that were surveyed (Bald Ridge - #004, Cedar Mountain - #010, Logan Mountain - #005, Sheep Mountain - #001).

Roads: There are no *Shoshonea pulvinata* populations located beside roads. One of the most accessible populations is on the summit of Cedar Mountain (#010), but the road to the summit crosses private land where access is controlled by the landowner, and access is only regularly permitted for radio tower maintenance.

There is a Forest Service spur road that dead-ends on a flat knoll below Bald Ridge (#004) that is used to turn vehicles around, and which has a small subpopulation of *S. pulvinata* that could be affected by heavy use. A cut in the fenceline was also observed below this spot with ORV tracks running through the opening.

In general, ORV traffic is absent from the vicinity of *Shoshonea pulvinata* populations even though there is heavy use below Sheep Mountain. The top of Sheep Mountain has relatively gentle terrain that provides ease of access to most *S. pulvinata* subpopulations, so ORV use could become a major threat if any ORV access were developed to the top. The existing trail system is used by horseback riders and hikers. The potential impacts warrant consideration if any changes are made to the travel plans in the area of *S. pulvinata* populations

Weeds: Non-native species are absent from *Shoshonea pulvinata* habitat at present. There are low numbers of *Carduus nutans* (musk thistle) along trails and roadways leading to the Rattlesnake Mountain and Sheep Mountain populations. They are unlikely to establish in *S.*

pulvinata habitat, but early intervention may be warranted to keep them in check on the landscape.

Fire: Fire may be the most widespread and intense of natural disturbances in habitat of *Shoshonea pulvinata*. Survival of *S. pulvinata* was evident when a crown fire burned large portions of the whitebark pine and limber pine woodlands on Bald Ridge (#004) in 1996 in the Dano Fire. Vigorous plants of *S. pulvinata* were observed in the fire lane (Figure 15) when the site was revisited by the U.S. Forest Service some years later. Also at Bald Ridge (#004), some *Shoshonea pulvinata* plants looked like they were subject to erosion, appearing as though perched on pedestals (Figure 16). There did not appear to be plants that had been killed by fire or lost habitat from it, although its response to fire in open woodland habitat may not be the same as in dense woodland that encompasses or adjoins occupied habitat. It was determined that the burn stopped near the northern boundary between BLM lands and national forest.

The exposed summit positions of *Shoshonea pulvinata* habitat are apt to have frequent lightning strikes and high fire return intervals. It is not known whether the appearance of pine bark beetle infestation in its habitat and possibility of synchronous tree mortality could produce a fire intensity that *S. pulvinata* could not survive. Dead and dying trees were noted at or adjoining *S. pulvinata* populations on Bald Ridge (#004), Cedar Mountain (#010), Logan Mountain (#005) and Sheep Mountain (#001), and possibly Rattlesnake Mountain (#003). There are dense stands present in or adjoining occupied habitat at least at the first two of the above-mentioned sites.

Other: Radio towers are built on the Cedar Mountain summit on both private land and BLM-administered lands. Private land was not surveyed, but there are towers adjoining *Shoshonea pulvinata* habitat on BLM land. There is potential that any future tower construction could impact occupied habitat, though a new tower was constructed literally in the middle of a small subpopulation where a large, old *S. pulvinata* plant is situated directly beside a tower post that was put in place without disturbing it.

There are no quarrying or mining activities occurring in *Shoshonea pulvinata* habitat at present, and there are generally more accessible sources of limestone.

The lowest elevation subpopulations or collecting stations of *Shoshonea pulvinata* on Logan Mountain, north of U.S. Hwy 14-16-20, are on private lands that have housing developments. One of the new subpopulations is on BLM lands within about 1 km (0.6 mi) of a house on private property. This has limited affects unless developments foster the spread of noxious weeds, or unless access provisions are changed in travel plans.

Management practices and response

There is preliminary information to indicate that *Shoshonea pulvinata* is resilient to some level of fire intensity, based on observations at Bald Ridge (#004). It may be appropriate to set up monitoring right away if wildfire burns through any subpopulation. Likewise, any prescribed burn treatments proposed near *Shoshonea pulvinata* habitat warrant advance surveys for the species. If occupied habitat is considered as part of the treatment, then pre- and post-treatment monitoring is warranted, ideally with a treatment control, to document species' response. Permanent belt transects (Lesica 1987, Heidel 2001) are one possible experimental design for producing stage-based demographic results.

Conservation recommendations

Recommendations regarding present or anticipated activities: There are no immediate threats to *Shoshonea pulvinata* identified in 2010 surveys. Current access restrictions and near-absence of exotic species from the landscape contribute to this interpretation. Access oversight and weed control vigilance could become increasingly important management activities for this species in the future.

Notification of BLM personnel of locations on BLM lands: To prevent inadvertent impacts to known populations, all appropriate BLM personnel involved in on-the-ground management activities that include grazing, weed control, prescribed burn and travel planning should be provided with location data for *Shoshonea pulvinata*. Toward this end, the updated state species abstract (Appendix C) is provided as part of project products, accompanied by GIS files of all known populations in the state.

Status recommendations: *Shoshonea pulvinata* is a regional endemic that is designated sensitive by all four federal land managing agencies where it occurs in Montana and Wyoming. It is a habitat specialist on the landscape, and one of many rare plant species that are poor competitors. There is no evidence to suspect that populations of *S. pulvinata* are at risk on lands managed by the BLM Cody Field Office, although these low elevation populations and population segments of the species could become the frontlines for management needs in the future.

Summary: Systematic surveys were conducted for *Shoshonea pulvinata* that garnered new subpopulations and expanded known population extent onto BLM lands. However, there were no new populations found. The surveys covered most unsurveyed areas of potential habitat on BLM lands. What is perhaps more significant in updating results is the near absence of threats to the species and its habitat. Questions are raised about its potential vulnerability to intense fire in the wake of timber die-offs due to pine beetle infestations for those populations with dense stands of timber in or adjoining occupied habitat. Travel management and weed management may also have bearing on the status of *S. pulvinata* in the future.

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