

Status of Trelease's racemose milkvetch
(*Astragalus racemosus* Pursh var. *treleasei* Porter)
in Wyoming

Prepared for the Bureau of Land Management
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ABSTRACT

Trelease's racemose milkvetch (*Astragalus racemosus* var. *treleasei*) is a regional endemic of southwestern Wyoming and northeastern Utah. It is restricted mainly to outcrops deposited in the basins of Cenozoic lakes (Lake Gosiute and Lake Uinta), as represented in the Wasatch and Bridger Formations in Wyoming, and the Uinta and Duchesne River Formation in Utah. In Wyoming it occupies badlands outwashes and slopes along major river valleys, on sparsely-vegetated habitat with thickspike wheatgrass (*Elymus lanceolatus*), rubber rabbitbrush (*Ericameria nauseosa* var. *oreophila*), green rabbitbrush (*Chrysothamnus viscidiflorus*) and shadscale (*Atriplex confertifolia*).

Prior to this survey, Trelease's racemose milkvetch was known from 3 recent collections and 3 historic collections with sketchy information on habitat requirements and precise locations. It is currently known from 9 extant records and 1 historic record over a limited area of two counties. Individual colonies number typically less than 100 plants and occupy linear habitat of less than 1 acre. Only one population has over 200 plants. Based on surveys in 2002, and extrapolations from unsurveyed potential habitat, the current population numbers of Trelease's racemose milkvetch are conservatively estimated at 1,000-10,000 plants.

Trelease's racemose milkvetch is potentially threatened by oil and gas development and road construction within its limited range and specialized habitat. This species was designated as Sensitive by the Wyoming Office of the Bureau of Land Management (BLM) in 2001 and occurs primarily on BLM lands in the Pinedale and Kemmerer field offices. No populations currently receive formal protection. Trelease's racemose milkvetch qualifies as a BLM Sensitive species until sufficient habitat is afforded protection, determination made that populations in existing oil fields are secure, and/or management strategies are developed and implemented for this taxon in mineral extraction areas.

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Introduction

Trelease's racemose milkvetch (*Astragalus racemosus* var. *treleasei*) was first collected in 1937 by Reed C. Rollins, Harvard University botanist, near his hometown of Lyman, Wyoming (Uinta County). It was next collected in 1940 by O.A. Beath between Lyman and Carter. Three additional collections were made in the early 1940's from the area of Duchesne, Utah (Duchesne County). It was described as a new species by C.L. Porter (1945) and named in honor of Dr. Samuel F. Trelease, a collector of the taxon and authority on seleniferous vegetation from Columbia University, who included it in his research on selenium concentrations in the *Astragalus* genus. It was later collected in 1948 by H.F. Epson south of Big Piney (Sublette County) and collected again in 1949 at approximately the same locale by C.L. Porter of the Rocky Mountain Herbarium. Over the next four decades, it was collected at additional locales in Duchesne and Uintah counties, Utah but was not collected again in Wyoming until 1992. In the 1990's, three new collecting stations were documented by Ronald Hartman, curator, and Tom Cramer, graduate student, in the course of floristic surveys in the upper Green River basin by the Rocky Mountain Herbarium.

Astragalus racemosus var. *treleasei* was not included in the initial lists of rare species in Wyoming, as begun by Dorn (1977), because it was known from more than one county. It was added to the Wyoming plant species of concern list in 1993 (Fertig 1993). Due to its limited geographic range and scarcity of recent collections, it has remained a species of special concern in Wyoming and was listed as "Sensitive" by the Bureau of Land Management (BLM) Wyoming State Office in 2001 (USDI BLM 2001, 2002). In order to assess the conservation status of this taxon, the BLM contracted with the University of Wyoming – Wyoming Natural Diversity Database (WYNDD) to assemble information on the known distribution, abundance, life history, and threats to it on public lands in Wyoming. The results of this study are discussed in the following report.

Methods

Information on the habitat and distribution of *Astragalus racemosus* var. *treleasei* was obtained from scientific literature, and from specimens at the Rocky Mountain Herbarium (RM). Systematic efforts were made to relocate all extant and historic records and to further document precise location, population numbers, extent, habitat requirements, and potential threats. USGS topographic maps, geological maps and BLM land status maps were used to identify additional areas of potential habitat for ground survey. In addition, the literature was searched in the O.A. Beath Selenium Database of the UW Libraries (<http://www-lib.uwyo.edu/db/BSD/>) and in a bibliography on selenium (Case et al. 1990). Search topics included the name of the species and the variety, and the geological formations of southwestern Wyoming as pertains to this project.

Walter Fertig and Rob Thurston developed a potential habitat model for *Astragalus racemosus* var. *treleasei* using classification tree analysis and GIS (Fertig and Thurston 2003). The model was developed using 5 known locations of *Astragalus racemosus* var. *treleasei* obtained from WYNDD and RM and 960 absent points (locations where this species has not

been documented despite recent, systematic field sampling) derived from the RM's database of Wyoming collection sites. The classification tree analysis identified five environmental variables and two combinations of conditions that characterize potential habitat. July total shortwave radiation and surficial geology were the two most important variables. The analysis results were used in an ArcInfo GIS to build the model grid by determining those areas of the state that met each set of conditions. The model was validated with an independent dataset of 131 randomly selected absent points. No present points were used for validation since there were so few. The model predicted about 890 km² of potential habitat in Sublette, Lincoln, Uinta, and Sweetwater Counties (0.35% of Wyoming). This model was used in combination with known records, a surface geology map (Love and Christiansen 1985), and field observations for systematic surveys.

Project results reported in this document have also been used to update the state plant species abstract of *Astragalus racemosus* var. *treleasei* (Heidel and Fertig 2003) for posting on the WYNDD homepage (<http://www.uwyo.edu/wyndd>), to update all 10 of its element occurrence records in the Biological Conservation Database at WYNDD, and to offer preliminary review of the potential habitat model that was run prior to this survey.

Species Information

Classification

Scientific Name: *Astragalus racemosus* Pursh var. *treleasei* Porter (1945). Holotype: USA: Uinta Co., Wyoming: between Carter and Lyman, spring of 1940, Beath, O.A. 125 (RM holotype, GH, WTU isotype).

Common Name: Trelease's racemose milkvetch.

Family: Fabaceae or Leguminosae (Bean family).

Section: Current treatments place it in the Section *Bisulcati* (Barneby 1964), previously split out into the Section *Galegiformes*.

Synonyms: None.

Phylogenetic Relationships: The genus *Astragalus* contains app. 375 species in North America and app. 1600 worldwide (Barneby 1989). In Wyoming, Dorn (2001) recognizes 63 species and 16 additional varieties (79 total). *Astragalus racemosus* var. *treleasei* belongs to section *Bisulcati*, a group comprised of stout, selenium-scented perennials, with flowers in a densely racemose inflorescence, nodding at full anthesis, and a pendulous, stipitate pod, unilocular or nearly so, variably compressed (from Barneby 1964). It was initially considered to be an aberrant form of *Astragalus racemosus* or possibly a hybrid, but it is disjunct from the type variety and retains all distinctive characteristics when grown in a common garden (Porter 1945). Barneby (1964) characterized it as an "extremely well-marked variety" and stated:

"The discontinuous distribution of var. *Treleasei*, which is not only remote from the main range of *A. racemosus* but itself divided into two parts by the barrier of the Uintah Mountains, suggests comparatively great age and long isolation." (Barneby 1964)

Legal Status

Astragalus racemosus var. *treleasei* is designated a Sensitive species by the BLM Wyoming Office (USDI BLM 2001, 2002). It receives no legal protection under Wyoming state law.

Natural Heritage Rank: NatureServe (formerly the heritage division of The Nature Conservancy) and the network of state natural heritage programs give *Astragalus racemosus* var. *treleasei* a rank of G5T2, indicating that the species is “secure” but the variety is “imperiled because of rarity” throughout its geographic range (NatureServe 2002). The latter rank is usually assigned to taxa with a total of 6-20 extant populations worldwide.

It was previously ranked S1 in Wyoming (Fertig 2000, Fertig and Heidel 2002) based on three extant occurrences. The results of this survey provide basis for reassigning it an S2 rank. Its low population numbers and concentration in small geographic areas might be weighted in retaining the S1 rank, but the number of species’ occurrences and limited habitat vulnerability are consistent with it being re-assigned an S2 rank.

Description

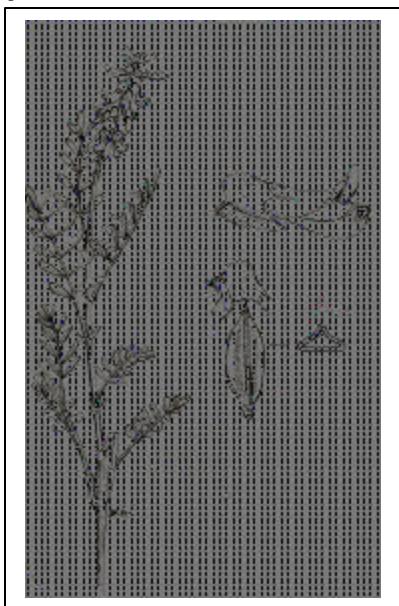


Figure 1. Illustration of *Astragalus racemosus* var. *treleasei* by B. Heidel



Figure 2. Close-up photograph of *Astragalus racemosus* var. *treleasei* by B. Heidel

Trelease's milkvetch is a stout, selenium-scented perennial herb, 2-5.5 dm tall, arising from a woody taproot and root-crown. Leaves are sparsely-hairy, light green, 6-15 cm long and pinnately divided, with 9-16 sharp-pointed ovate-elliptic leaflets. Lower stipules are papery and fused. The 20-60 pale yellow to white pea flowers have a banner 14-16.5 mm long and a purple dot at the tip of the keel. The calyx tube is 5-6 mm long and gibbous behind the pedicel. Flowers droop at anthesis in a densely racemose inflorescence 3-8(10) cm long of 20-70 flowers (Figures 1-3). Pods are 1-2 cm long, glabrous, sharply 3-angled, 1-celled, with 12-20 ovules per ovary and elevated on a conspicuous stipe (Barneby 1964, 1989; Dorn 2001).



Figure 3. Photograph of *Astragalus racemosus* var. *treleasei* by B. Heidel

Similar Species: *Astragalus bisulcatus* var. *bisulcatus* and var. *haydenianus* have purple flowers and pods that are 2-grooved rather than 3-angled. *Astragalus bisulcatus* var. *major* has light yellow flowers, but they are generally shorter (10-17.5 mm), and with only 4-10 ovules per ovary. *Astragalus canadensis* has rounded leaflets and hairs that attach at points near the middle, rather than at the base. Both *Astragalus racemosus* var. *racemosus* and var. *longisetus* (not recognized by Isely 1998) also occur in Wyoming, but they have pods 2-3 cm long, 17-31 leaflets, and are restricted to eastern Wyoming (Barneby 1964, 1989, Dorn 2001).

Barneby (1964) differentiated this variety from other varieties of *A. racemosus* in saying:

“Trelease’s alkali milk-vetch is an extremely well-marked variety, distinguished by its relatively few leaflets and short, plumply- proportioned fruit which is more abruptly contracted into the stipe than in other forms of *A. racemosus*...”

A summary of distinguishing characteristics is presented on the next page.

Table 1. Distinguishing characteristics of *Astragalus racemosus* var. *treleasei*

Species	Flower	Pod	Leaves	Distribution
<i>Astragalus racemosus</i> var. <i>treleasei</i>	Pale yellow to white flowers with a discrete purple spot at tip of keel, banner 14-16.5 mm	Pod deflexed, body of the pod trigonously compressed, 1-2 cm long; less than 4x as long as wide, 1-chambered	9-19 leaflets, acute or acuminate tips	West of the Continental Divide
<i>Astragalus racemosus</i> var. <i>racemosus</i> (Includes <i>A. r.</i> var. <i>longisetus</i>)	Whitish flowers sometimes with lilac-tipped keel and purple coloration, banner 16-20.5 mm	Pod deflexed, body of the pod trigonously compressed, 2-3 cm long; over 4x as long as wide, 1-chambered	(11) 17-31 leaflets	East of the Continental Divide
<i>Astragalus bisulcatus</i> var. <i>bisulcatus</i>	Purple flowers, banner 10-17.5 mm	Pod deflexed, body of the pod dorsiventrally compressed, 9-19 mm long,	(11) 17-31 leaflets, obtuse or rarely acute tips	East of the Continental Divide
<i>Astragalus bisulcatus</i> var. <i>haydenianus</i>	Pale yellow to white flowers, banner 8-11 mm	Pod deflexed, body of the pod dorsiventrally compressed, 6-9 mm long, 1-chambered,	(13) 15-35 leaflets obtuse or rarely acute tips	West of the Continental Divide
<i>Astragalus bisulcatus</i> var. <i>major</i>	Pale yellow to white flowers; banner 10-17.5 mm	Pod deflexed, body of the pod dorsiventrally compressed, 9-19 mm long, 1-chambered,	(13) 15-35 leaflets obtuse or rarely acute tips	East and west of the Continental Divide
<i>Astragalus canadensis</i> var. <i>canadensis</i>	Pale yellow to white flowers, sometimes purple-tinged, banner 12-17.5 mm	Pod erect or ascending, body of the pod round, 2-chambered	13-35 leaflets, obtuse sometimes mucronate tips	East and west of the Continental Divide
<i>Astragalus canadensis</i> var. <i>brevidens</i>	Pale yellow to white flowers, sometimes purple-tinged, banner 12-17.5 mm	Pod erect or ascending, body of the pod grooved on back, 2-chambered	13-35 leaflets, obtuse sometimes mucronate tips	East and west of the Continental Divide

Geographic Range

Astragalus racemosus var. *treleasei* is endemic to southwestern Wyoming in the Green River Basin and the foothills of the Wyoming Range (Sublette and Uinta counties) and to northeastern Utah in the Uinta Basin (Duchesne and Uintah counties). Its distribution is west of the Continental Divide and is disjunct from the type variety of *Astragalus racemosus* (Figure 4).

There is a major break between the distribution of *Astragalus racemosus* var. *treleasei* in Utah and Wyoming that is not indicated by the coarse distribution map of Isely (1998). They are separated by the Uintah Mountains. Barneby (1964) referred to this Utah and Wyoming distribution divided a mountain barrier as suggesting great age and long isolation.

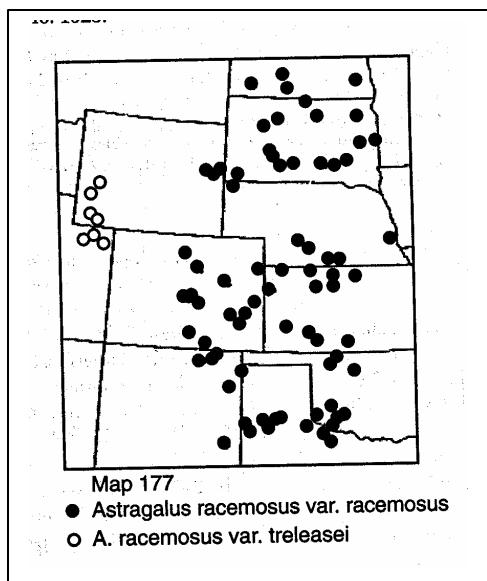


Figure 4; Rangewide distribution of *Astragalus racemosus* var. *treleasei* and *A. r. var. racemosus*, from Isely 1998

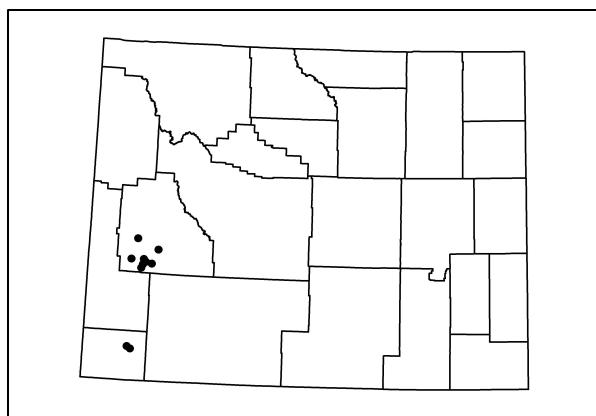


Figure 5. Distribution of *Astragalus racemosus* var. *treleasei* in Wyoming

Astragalus racemosus var. *treleasei* is known from at least 16 collection stations in Utah (Utah State University, 2002), widely scattered across the Uinta Basin (Welsh et al. 1987). In Wyoming it is known from 9 discrete collection stations, plus one historical station (Hartman and Nelson 1998, and this report; Figure 5). Its Wyoming distribution is concentrated in two limited areas of the Green River Basin, and the largest is along the upper Green River. Four of the 9 Wyoming records are on the west side of the Green River at the base of the valley slopes. Though this represents over 20 miles of Green River valley, its distribution is discontinuous and highly localized within this reach. Each element occurrence and its known distribution is presented in Table 1, next page. A complete record of survey sites with digitized maps is presented in Appendix B.

The map of predicted distribution of *Astragalus racemosus* var. *treleasei* that was used in conducting 2002 surveys (Figure 6) is documented in Appendix C, discussed on the next page.

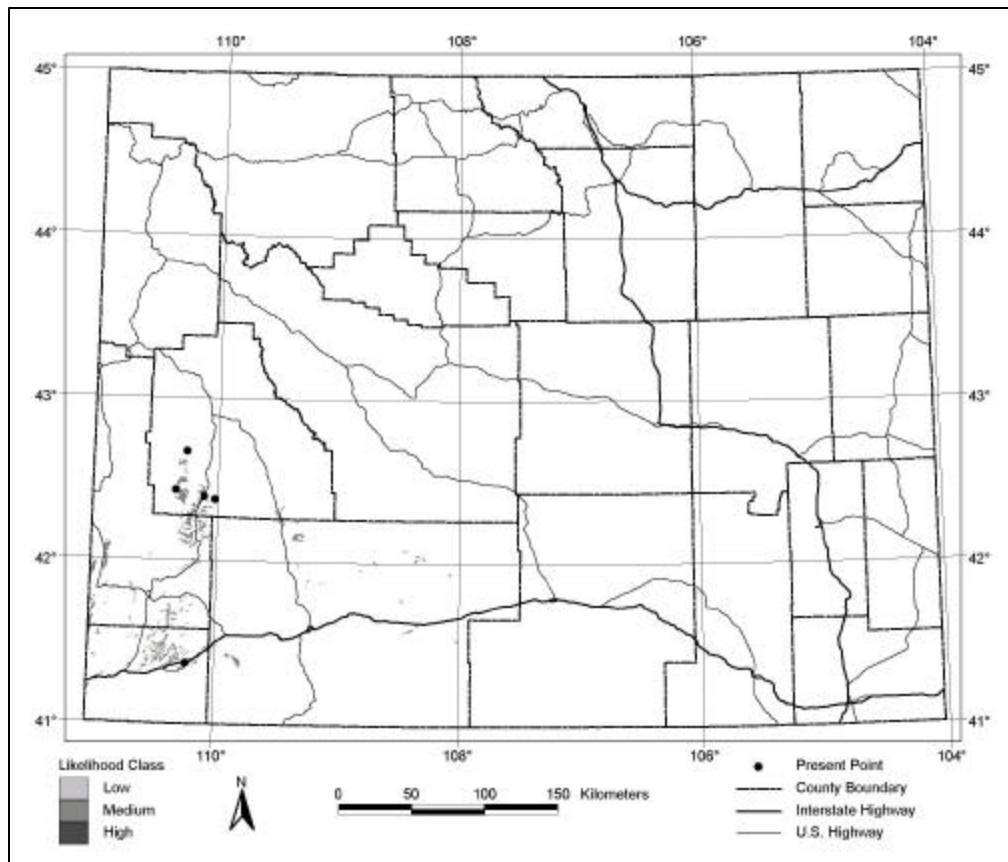


Figure 6. Predicted distribution of *Astragalus racemosus* var. *treleasei* in Wyoming

Prior to this status survey project, no population locations were precisely mapped within 1 square mile, or detailed as to their habitat. Relocating known populations was undertaken to get the most basic habitat and population data as well as to develop search images for expanded systematic survey. Fieldwork was undertaken in tandem with surveys of *Astragalus nelsonianus* en route. The task of developing a search image was challenged in Uinta County by the lack of undisturbed habitat at the relocated population, so a broad range of landscape settings and outwash features were considered. It was also challenged by the schism in habitat conditions between Cretaceous Mountain and all other population sites in Sublette County, so a broad range of landscape settings was considered in this area as well.

A systematic 3-pronged survey was conducted to expand on known distribution, considering outcrop similarity to the nearest known populations as determined from Love and Christiansen (1985), presence of badlands erosion features as determined on the ground, and public land access as determined from BLM surface management maps. Surveys were conducted on foot in over 40 sections (Appendix B) around known populations in Sublette and Uinta counties and between them. There were no new populations documented in Uinta County and the newly documented populations in Sublette County signified small range extensions.

Table 2. Locations of *Astragalus racemosus* var. *treleasei* in Wyoming

Occurrence # 001 County: Sublette USGS Quad: CHIMNEY BUTTE MILLESON DRAW Latitude: 422354N Longitude: 1100740W Map Accuracy: Precise; location is within a 75 foot radius of point on USGS topo map. Town/Range/Section: T28N R112W Sec. 23 NW 1/4 Location: Green River Basin, 10.1 mi south of Big Piney, along US Highway 189 and west of highway.	Occurrence # 005 County: Sublette USGS Quad : CRETACEOUS MOUNTAIN Latitude: 422538N Longitude: 1102131W Map Accuracy: Precise; location is within a 75 foot radius of point on USGS topo map. Town/Range/Section: T28N R114W Sec. 11 N 1/2 of SE 1/4, NW 1/4 of NE 1/4 Location: Green River Basin, northwest corner of Cretaceous Mountain, ca 15 air mi southwest of Big Piney.
Occurrence # 002 County: Uinta USGS Quad : AUSTIN RESERVOIR Latitude: 412330N Longitude: 1102057W South Lat: 411930N East Long: 1101730W North Lat: 412617N West Long: 1102550W Map Accuracy: General; location is within 5 mi of point on USGS topo map. Town/Range/Section: T16N R115W Sec. 2 (TRS approximate) Location: Green River Basin, between Carter and Lyman.	Occurrence # 006 County: Sublette USGS Quad: MILLESON DRAW Latitude: 422258N Longitude: 1100151W Map Accuracy: Precise; location is within a 75 foot radius of point on USGS topo map. Town/Range/Section: T28N R111W Sec. 27 N 1/2 of NW 1/4 Location: Green River Basin, lower part of Chapel Canyon, ca 11 air miles northeast of La Barge [ca 4 air miles east of the Green River].
Occurrence #004 County: Uinta USGS Quad : AUSTIN RESERVOIR MOUNTAIN VIEW Latitude: 412157N Longitude: 1101748W Town/Range/Section: T16N R114W Sec. 18 NE 1/4 of SE 1/4; Sec. 8 SE 1/4 of NW 1/4 Location: Green River Basin, bluffs of Blacks Fork River, 3 miles north of Lyman and immediately south of I-80, with outliers north of I-80.	Occurrence # 007 County: Sublette USGS Quad: MEADOW CANYON Latitude: 424014N Longitude: 1101627W Map Accuracy: Medium; location is within an approximately 1.5 mi radius from point on USGS topo map. Town/Range/Section: T31N R113W Sec. 14 Location: Wyoming/Salt River Ranges, west end of Dead Indian Dome at base of outcrops ca. 12.5 air miles northwest of Big Piney.

Occurrence # 009

County: Sublette
USGS Quad : LA BARGE
Latitude: 422205N
Longitude: 1101020W

Map Accuracy: Precise; location is within a 75 foot radius of point on USGS topo map.

Town/Range/Section: T28N R112W
Sec. 32 E 1/2 of NE 1/4

Location: Green River Basin, ca. 13 miles south of Big Piney near mouth of Yose Canyon.

Occurrence # 010

County: Sublette
USGS Quad : CHIMNEY BUTTE
Latitude: 422555N Longitude:
1100942W

Map Accuracy: Precise; location is within a 75 foot radius of point on USGS topo map.

Town/Range/Section: T.28N R112W
Sec. 9 NE 1/4 of NW 1/4

Location: Green River Basin, ca. 9 miles south and 1 mile west of Big Piney, along buttes north of Dry Basin and Dry Piney creeks.

Occurrence # 011

County: Sublette
USGS Quad : ROSS BUTTE
Latitude: 423305N
Longitude: 1095621W
Town/Range/Section: T30N R110W
Sec. 27 N 1/2

Location: 11.5 miles east of Big Piney, and at least 1.2 airmiles southwest of New Fork River bridge, north of BLM Rd. 5405.

Occurrence # 013

County: Sublette
USGS Quad : LA BARGE
Latitude: 421931N
Longitude: 1101150W
Map Accuracy: Precise; location is within a 75 foot radius of point on USGS topo map.

Town/Range/Section: T27N R112W
Sec. 18 SE 1/4 of NW 1/4, SW 1/4 of NE 1/4.

Location: 4 airmiles north of Le Barge at Red Hill, accessible 3.5 miles north of town on Hwy 189 and west 1 mile.



Figure 7. Typical habitat of *Astragalus racemosus* var. *treleasei* in Wyoming, EO#009, (foreground), by B. Heidel

Extent of Surveys in Wyoming

Astragalus racemosus var. *treleasei* was first collected in 1937 by Reed C. Rollins, Harvard University botanist, 3 miles north of Lyman, Wyoming (Uinta County). It was collected in 1940 by O.A. Beath between Lyman and Carter, possibly near the previous collection station of Rollins. It was collected for the first time in Sublette County in 1948 by H.F. Epson south of Big Piney and re-collected in what has been interpreted as the same locale in 1949 by C.L. Porter of the Rocky Mountain Herbarium. Both of the collection labels for these Sublette County specimens noted the taxon growing directly alongside the roadway, and though the location description differed by app. a mile in distance to Big Piney, there is only one place where the road intersects Badlands outcrop between Big Piney and LaBarge. It was not collected again in Wyoming until 1992. Three new collecting stations were documented by Ronald Hartman, curator, and Tom Cramer, graduate student, in the course of floristic surveys in the upper Green River basin by the Rocky Mountain Herbarium.

Systematic efforts were made in 2002 to relocate all recent and historic records and to expand known distribution. All recent collection stations and two of the three historic collection stations were relocated and surveyed. The collection station of the Beath holotype could not be relocated. The location was not described more precisely than a 10 mile distance between Lyman and Carter, and surveys in this area were not successful. It is possible that the Beath collection station coincided with the Rollins collection station, that it lies within the highway-widening project that was completed between Lyman and Carter in 2002, or that it persists outside the corridor. It remains in the database as a historic record, without knowing whether it is extant or extirpated.

Four new populations were documented along the Upper Green River in Sublette and Sweetwater counties among extensive surveys (Appendix B). Surveys to expand known distribution in Uinta County were unsuccessful. Survey work spanned the north-to-south breadth of predicted distribution in Wyoming, strongly supporting the break in distribution between Sublette and Uinta counties, but not otherwise expanding the known extent of geographic distribution. The small areas of predicted distribution ca. 50 miles to the east and west of known distribution were not surveyed.

The survey work also spanned the known range of elevations of the species, but did not extend it. There is only one known population that is outside of a valley setting, located on Cretaceous Mountain. The foothills setting and habitat of this one population are so fundamentally different from all others that it raised questions of whether the population is natural or if in turn whether foothills distribution has been circumscribed. It occurs on what appears to be Wasatch Formation immediately above outcrops of Whitewood Dolomite (Love and Christianson 1985), and the latter geological formation outcrops with interruptions for 15 miles to the south. Of all potential habitat that was not surveyed, presence/absence of *Astragalus racemosus* var. *treleasei* associated with these outcrop series in higher elevation foothills settings was the least complete and is the highest priority area for further status consideration. Survey work did not have the benefit of aerial photos, a limitation in delimiting populations and subpopulations. Thus, expanded survey of individual populations such as the Dry Creek population (EO#10) might also be considered.

Habitat

Astragalus racemosus var. *treleasei* occurs primarily in sparsely-vegetated outwash flats and fluted Badlands slopes at 6500-7500 ft. (Figure 7, p. 9). A foothills population on a ridge slope setting lies at 8,300 ft. Most populations are found on pale whitish or somber grey silty loams derived from shales, with a vesicular structure. In Utah, by contrast, the outcrops are often coarser, though occasionally include saline clay and silty soils (Welsh 1987). In both states, the taxon occupies Eocene-Oligocene outcrops in the basins of Cenozoic lakes (Lake Gosiute and Lake Uinta), as represented mainly by the Wasatch and Bridger Formations in Wyoming (from Love and Christianson 1985), and the Uinta and Duchesne River Formation in Utah (Welsh 1987). These basins formed at the north and south flanks of the Uinta Mountains that rose during Laramide orogeny (Hintze 1972).

The microhabitats are maintained by outcrop instability and outwash burial. It is interesting that the populations are primarily or exclusively on the outwash fan or on the outcrop slope above, but not well-represented in both topographic positions. It is usually present where the outwash fans are well-developed, with over 20 ft width. The settings vary considerably, ranging from sheltered “alcoves” of Badlands outcrop set back in the valley slopes where outwash fans coalesce, to isolated “spines” of Badlands outcrop that arise from the valley floor (Figure 8). While there are vast outcrops along the Green River valley, with conspicuous interbedded oxidized and unoxidized shale layers (“striped” bedding), the places with shale outcrop that erodes in fluted Badlands slopes are restricted, and those that support *Astragalus racemosus* var. *treleasei* are a smaller subset yet. The vertical and horizontal discontinuities of the particular Badlands outcrops that support *Astragalus racemosus* var. *treleasei* have not been explained and may correspond with localized deposition features such as inlets along Cenozoic lake shores, and periods of volcanic ash deposits as have been associated with high selenium concentrations (Trelease and Beath 1949).

Barren shale outwash flats and outcrops of river valleys appear to be its typical habitat in Wyoming, but there are at least three exceptions that don’t fit this generalization. One site appears to be a well-vegetated valley setting dominated by *Artemisia cana* with few *Astragalus racemosus* var. *treleasei* plants. It lies a short distance from outcrop but separated by a road and irrigation ditch. The setting appears to be an overgrown outwash flat, suggesting that the taxon may persist to some limited degree under successional change. It seems more likely to represent the longevity of individual plants rather than the ability of this taxon to become established in well-vegetated habitat.

The most common species in its sparsely-vegetated habitat include thickspike wheatgrass (*Elymus lanceolatus*), rubber rabbitbrush (*Ericameria nauseosa* var. *oreophila*), green rabbitbrush (*Chrysothamnus viscidiflorus*), and shadscale (*Atriplex confertifolia*). Frequently associated species in these communities include starveling milkvetch (*Astragalus jejunus* var. *jejunus*), indian ricegrass (*Achnatherum hymenoides*), bottlebrush squirreltail (*Elymus elymoides*), thrift mock goldenweed (*Stenotus armerioides*), rayless tansyaster (*Machaeranthera grindeliaoides*) and smooth two-whorl buckwheat (*Stenogonum salsuginosum*). Surrounding vegetation is dominated by Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*). Total vegetation cover in the immediate vicinity of *Astragalus racemosus* var. *treleasei* is usually less than 10%, most often in the 1-5% range. South of its known distribution in Sublette County, *Astragalus flavus* was found instead of *Astragalus racemosus* var. *treleasei* in similar habitats and

settings. The two taxa, *Astragalus racemosus* var. *treleasei* and *A. flavus*, occur together at the Uinta County population but not in the Sublette County populations.

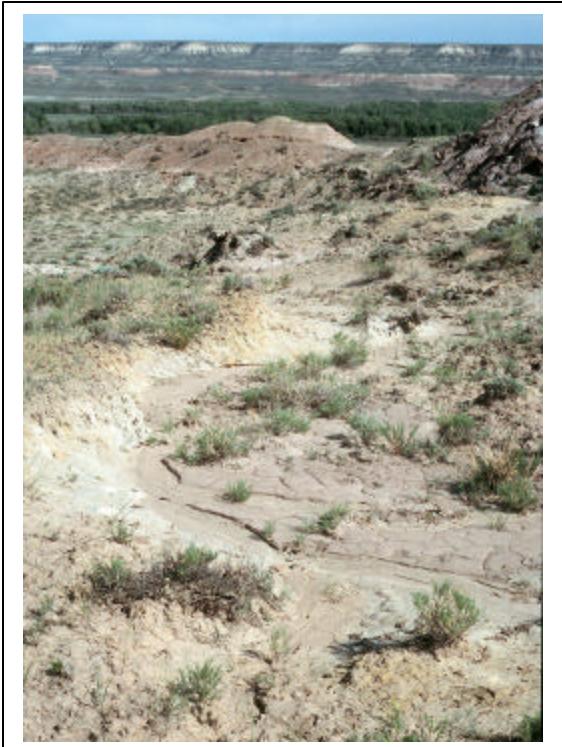


Figure 8. Typical habitat of *Astragalus racemosus* var. *treleasei* in Wyoming, EO#001, (foreground). Highway 189 lies behind ridge. By B. Heidel



Figure 9. Atypical habitat of *Astragalus racemosus* var. *treleasei* on Cretaceous Mountain, EO#005, (foreground), by B. Heidel

Another site was located on small barren flats on the top of ridge complexes, the only ridgeline setting among many that were surveyed. The small size and extent of the population may be more an indication of its ability to disperse and become established in marginal habitat than its habitat preferences.

Finally, a third site is located on Cretaceous Mountain on a gravelly silt loam on a ridge covered by Mountain big sagebrush steppe (*Artemisia tridentata* ssp. *vaseyana*). Soils are derived from LaBarge and Chappo members of the Wasatch Formation, located near striking outcrops of Whitewood Dolomite that may contribute to the gravel (Figure 9). Though it is only 1200 ft higher than the closest population, and occurs scarcely over 10 miles away, there is no semblance of Badlands habitat at or near the site. Other commonly associated species at the site of the Cretaceous Mountain population include dwarf sagebrush (*Artemisia arbuscula*), bluebunch wheatgrass (*Elymus spicatus*), sulphur Indian-paintbrush (*Castilleja sulphurea*), larch-leaved beardtongue (*Penstemon laricifolius*), Hooker's sandwort (*Eremogone hookeri*), and sulphur-flower wild buckwheat (*Eriogonum umbellatum*). This site represents a whole separate suite of landscape setting, elevation, and vegetation conditions than all other sites in Wyoming where the species occurs. The complete habitat differences at this third site are all the more puzzling because it is also the only population site that has numbers in excess of 200 plants. Almost all of them are on slopes of intact vegetation, but there are also 10 plants on one of the two oil pads in the area. Within the undisturbed areas, the taxon has much broader ecological amplitude than characterized in preceding paragraphs. It is highly unlikely that the taxon became established with the construction of oil wells, considering its concentration in intact habitat and the distance between these population segments and the oil wells. If it was introduced by man at this site, then it may have been introduced along the trail shown on old topographic maps that winds through the population. This foothills population represents an unsolved puzzle that might be examined further by consulting archeologists and by surveying similar habitat that extends interrupted for 15 miles to the south (as indicated by Love and Christiansen 1985).

The cold, dry intermontane climates are indicated by records from the nearest monitoring stations in Big Piney and Mountain View, respectively. Average annual precipitation values range from 7.5 – 9.3 inches (191 – 236 mm). The range of high and low monthly temperature values within months are similar to the differences of high and of low values between seasons (Table 3). Despite this limited differentiation between seasons, there are many cold temperature extremes. The mean length of the frost-free season is less than 30 days in Big Piney to over 80 days in Mountain View (USDI NOAA 2002).

Table 3. Climate data from monitoring stations nearest *Astragalus racemosus* var. *treleasei* populations in Wyoming

	Big Piney (6830 ft)	Mountain View (6800 ft)
Annual precipitation (in.)	7.5	9.3
January mean high temp (°F)	52.6	55.4
January mean low temp (°F)	25.5	32.5
July mean high temp (°F)	79.9	80.2
July mean low temp (°F)	39.7	47.3

Population Size and Trends

Individual colonies of *Astragalus racemosus* var. *treleasei* typically number less than 100 plants (less than 20 – 400+) and typically occupy linear bands of habitat totaling less than 1 acre. The slopes above such bands contribute to water erosion patterns that maintain species' habitat. The population with the largest numbers spans 10 acres. Aerial photographs were not available for systematic surveys of widely-scattered, potential habitat with subpopulations on adjoining sections. Based on surveys in 2002, however, in which documented populations are shown to have at least 900 plants, and extrapolations from unsurveyed potential habitat, the current population numbers are conservatively estimated at 1000-10,000 plants.

The species appears to be a long-lived perennial and there were no signs of mortality. Thus, the population numbers aren't expected to change greatly between years unless establishment is episodic. Long-term trend data are not available for any of the populations of *Astragalus racemosus* var. *treleasei*. Barneby (1964), however, characterized it as "abundant" at both the Sublette County site south of Big Piney and the Uinta County site on the "Black's Fork north of Lyman" that corresponds with the Rollins collection site if not the Beath collection site. At present, the Sublette County site has less than 70 individuals and may have been affected by road maintenance and by vegetation encroachment outside of the road corridor. The Uinta County site setting was highly altered with the construction of Interstate 80 and the Lyman rest stop. Less than 50 individuals persist in a portion of graded and recontoured valley slope. Even though the taxon has persisted at the two historical collection sites that can be relocated, it is likely that it has experienced significant decline at both sites.

Population Biology and Ecology

Astragalus racemosus var. *treleasei* flowered from the second week of June through the first week of July in 2002, a drought year, and there are no RM specimens collected in flower outside of this time period. There are 20-60 flowers per inflorescence, and they are indeterminate, flowering from the bottom to the top staggered over days and weeks. The photograph of a whole plant of *Astragalus racemosus* var. *treleasei* was taken on June 8, 2002 (Figure 3, p. 7), and shows the flowers at the bottom of the inflorescence just beginning to open.

The taxon is also identifiable by the pods, which persist through August. The flowers and inflorescences are relatively large, and despite the drought, it appeared that most individuals had multiple flowering stems and numerous flowers. The flowers in the *Astragalus* genus are insect-pollinated, but pollinators were generally not observed during the relatively cold days of the work conducted in June. Fruits were noted in low numbers in early July. It is possible that the rate of flower abortion increases or fruit set decreases with drought, or else that they are just shed at different times as pods ripen and fall. The majority of plants in all populations were in flower, and most non-flowering plants were distinctly smaller or had fewer stems (Figure 10), suggesting that they may be younger or that their growth was impeded by burial.

Germination information is available from the selenium research of Trelease and Beath (1949). They propagated the type variety from seed by treating seed coats for 20 minutes with concentrated sulfuric acid to soften them, then soaking in water for three hours, and allowing seeds to germinate in pots of quartz sand. The potted plant seedlings were treated with culture solutions that contained selenium as selenite or as selenate at three concentrations ranging from

3 – 27 ppm plus a control. The seedlings that were given no selenium in the culture solution made slow growth in comparison with those that received this element and were stunted at the end of a three month growth period. No seedlings were observed in the 2002 surveys, and few small vegetative plants were noted. It is not known whether the taxon has a seed bank.



Figure 10. Vegetative plant of *Astragalus racemosus* var. *treleasei*, by B. Heidel
(Compare stature of the plant in this photo with that in Figure 3; p.8)

Astragalus racemosus var. *treleasei* was locally common within a small portion of the two largest populations, as well as on a small roadcut. In these settings, numbers approaching 1 plant per 2 m². The robust, multi-stemmed plants were conspicuous and gave false impressions of being common. In these three settings, the highest densities of plants were found at three different aspects (mainly east and west aspects, and to a lesser extent, south). Plants are distributed unevenly by topographic position and aspect, perhaps reflecting the suitable erosion conditions for establishment and persistence. At any given site, they may be restricted to a single aspect, though between sites they are present on all aspects.

Due to its concentration of selenium, it does not appear to be favored for browse by livestock or native herbivores. Predation of flower heads and pods was not observed, nor were leaves browsed or grazed. It is most often found in sites with vegetative cover under 10%, suggesting that it does not compete well with other species on less severe habitats.

Although it frequently occurs in the same area with other species in the *Astragalus* genus, species in the *Bisulcati* group were not documented at the same locale and this taxon does not appear to hybridize in the wild.

Current Management

Almost all known occurrences of *Astragalus racemosus* var. *treleasei* are on lands managed by the BLM Pinedale Field Office on lands managed for multiple-use. The exception is the Uinta County occurrence where the taxon persists within lands managed by the Wyoming Department of Transportation south of Interstate 80, and there are a few scattered plants north of Interstate 80 on lands managed by the BLM Kemmerer Field Office that appear to be accidentally introduced along the roadbed. No populations are currently found within protected lands.

Existing and Potential Threats

The taxon has been affected by road construction and road maintenance activities. Habitat was eliminated by construction of Interstate 80, which was accompanied by grading and re-contouring of Blacks Fork River valley slopes. The roadcut through Badlands outcrop on Hwy 189 may have reduced or degraded outcrop habitat. It may also have created habitat on the embankment and beside the road shoulders. Those plants on the embankment above the roadbed are secure unless the highway is widened. Those few plants growing beside the road shoulders were directly sprayed with herbicide in 2002 and apparently killed.

Oil, gas, and coalbed methane developments are potential impacts. The placement of exploration wells, oil roads, oil pads, and pipelines avoided the *Astragalus racemosus* var. *treleasei* population on Cretaceous Mountain to date. Further information needs to be gathered whether this site is slated for any further development and the nature and scope of rehabilitation. The highly localized distribution pattern of the taxon means that there can be major losses in its numbers from such developments. Furthermore, the full range of exploration activities and rehabilitation activities may have potential affects, not just oil field development.

Off-road recreational use was not observed at any of the sites, but the unconsolidated substrate conditions and uneven topography of species' habitat may be favored by recreationists.

There were no signs of livestock grazing the taxon or indirectly damaging it, though all BLM populations are part of livestock allotments. Most populations and subpopulations are readily accessible to livestock but occupy habitat that corresponds with secondary range, receiving little use. One of the small populations is in an allotment with poor range condition, and it is possible but not proven that its small size reflects trampling activity, changes in erosion patterns, and/or exotic species encroachment in areas of suitable habitat (EO#013). Placement of salt blocks and stock ponds may concentrate livestock use, and one population recently had a stock pond excavated within 300 feet (EO#010).

Astragalus racemosus var. *treleasei* is an accumulator of selenium, and destruction of seleniferous vegetation has been practiced as a range management technique in some situations. Selenium (Se) is among the few elements that plants absorb in sufficient amounts that can be toxic to livestock. It has a similar atomic structure to sulfur, and is incorporated into cellular components in its place (sulfur-containing amino acids, for example). This substitution of Se for sulfur can cause chronic selenium toxicity resulting in deformity or mortality in birds, fish and mammals. There is no evidence that the taxon has been affected by eradication efforts. In fact,

the species has low selenium concentrations relative to the type variety (Trelease and Beath 1945) and may hold clues to the evolutionary development of this adaptation.

Summary

Astragalus racemosus var. *treleasei* has a narrow distribution and narrow habitat requirements. Survey was conducted throughout valley habitat in Sublette and Uinta counties but included little of the 15 miles of foothills habitat north of LaBarge. At present, this taxon qualifies as a BLM Sensitive species until sufficient habitat is afforded protection, determination is made that populations in existing oil fields are secure, and/or management strategies are developed and implemented for this taxon in oil extraction areas.

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