Status of Nelson's milkvetch (*Astragalus nelsonianus* Barneby) In Wyoming

Prepared for the Bureau of Land Management
Wyoming State Office

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ABSTRACT

Nelson's milkvetch (*Astragalus nelsonianus*) is endemic to Fremont, Natrona and Sweetwater counties of southcentral and eastcentral Wyoming and immediately adjoining northern Daggett County, Utah and northern Moffatt County, Colorado. It occurs on alkaline, seleniferous erodible slopes, shale bluffs, ridgetops, gullies and flats. The poorly-developed soils are silty or less often fine sand, sometimes with a pebble surface, and derived from lacustrine deposits as well as loess deposits, and even from volcanic cinders. The known Wyoming occurrences are found in sparsely vegetated sagebrush plant communities at elevations of 5200-7600 feet. The most common species in its sparsely-vegetated habitat include Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), rubber rabbitbrush (*Ericameria nauseosa* var. *nauseosa*), and shadscale (*Atriplex confertifolia*).

Prior to this survey, Nelson's milkvetch was reported from 22 recent collections and 7 historic collections with sketchy information on habitat requirements. It is currently known from 28 extant records and 4 historic records. Many individual colonies number in the 100's and there are 6 populations of over 300 plants. Of the 12 occurrences that were surveyed in 2002, 5 were restricted to or had their largest numbers in bladed roadside right-of-way or, in one case, a pipeline corridor. These included 3 of the 6 large populations, suggesting an increasing trend. Based on surveys in 2002 and extrapolations from unsurveyed potential habitat and other recent collections, the current population numbers of Nelson's milkvetch are roughly estimated at 4,000-40,000 plants with caveats.

Nelson's milkvetch 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 Casper, Lander, Rawlins and Rock Springs field offices. No populations currently receive formal protection. Nelson's milkvetch is now known to be more widespread and less vulnerable in Wyoming than previously documented, supporting a change in state rank and downlisting to a "watch species" of potential concern. It qualifies for removal from the Sensitive species list of the Wyoming BLM.

ACKNOWLEDGEMENTS

Scott Laursen of Wyoming Natural Diversity Database (WYNDD) digitized element occurrence locations in ArcView. Jim Glennon and Frank Blomquist of the Bureau of Land Management (BLM) reviewed an earlier draft of this report. The support of Jim Glennon, Frank Blomquist and Jeff Carroll, BLM, is also gratefully acknowledged.

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Introduction

Nelson's milkvetch (*Astragalus nelsonianus*) was first collected at Bitter Creek, Sweetwater County in 1897 by Aven Nelson in his pioneering botanical work in the Red Desert. It was also collected by Nelson near Bush Rim in 1900. It was described as a new variety of *Astragalus pectinatus* Dougl. by Marcus Jones (1902), It was not collected again until the 1940's when five collections were made by O.A. Beath, H.F. Eppson and G.F. Freytag in researching seleniferous species of *Astragalus*. They included the first collection from Fremont County, made by O.A. Beath in 1944. It was also collected in 1951 by C.L. Porter and R.C. Rollins near McKinnon in Sweetwater County, and by Barneby in Daggett County, Utah. It was elevated to a full species by Rupert Barneby (1964). Beginning in 1979, many new collections were added in the course of floristic surveys, and collections were made in the vicinity of historical ones. This was the work of students under Ronald Hartman, including Beth Ward Burkhart, Keith Dueholm, Charmaine Refsdal, Amy Roderick Taylor, and Laura Welp. The first collection from Natrona County was made by Ronald Hartman in 1993. Before this study, it was reported from 7 historical and 17 recent collection stations (Fertig 2000).

Astragalus nelsonianus 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 and 8 collection records. It was recognized as a species of special concern in Colorado and Utah, where it was assigned a state rank of "S1" indicating that it is critically imperiled. 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 (Fertig and Heidel 2002) and was designated "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 nelsonianus* was obtained from scientific literature and from specimens at the Rocky Mountain Herbarium (RM). Systematic efforts were made to relocate extant and historic records and to further document precise location, population numbers, extent, habitat requirements, and potential threats. Review of specimens at RM revealed an additional 5 recent collections that were added in preparation for survey. 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, 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 nelsonianus* using classification tree analysis and a GIS (Fertig and Thurston 2003). The model was developed using 21 known locations of *Astragalus nelsonianus* obtained from WYNDD and RM and 954 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 eight environmental variables and three combinations of conditions that characterize potential habitat. July total shortwave radiation, surficial geology and annual number of wet days were the three 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 173 randomly selected absent points and 10 present points. The model predicted about 8,509 km² of potential habitat in Sweetwater, Fremont, Natrona, Converse, Uinta, Lincoln, Washakie, Big Horn, Hot Springs, and Johnson counties (3.4% of Wyoming). This map was used in combination with known records, a surface geology map (Love and Christiansen 1985), and field observations for systematic survey.

Project results reported in this document have also been used to update the state plant species abstract of *Astragalus nelsonianus* (Heidel and Fertig 2003) for posting on the WYNDD homepage (http://www.uwyo.edu/wyndd), to update most of the 34 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 nelsonianus* Barneby (1964). Lectotypes: USA, Sweetwater Co., Wyoming: Bitter Creek, (1897) *Nelson, A. 3115* (POM, MO, NY, RM, UTC); paratypes from same locality (POM, RM).

Common Name: Nelson's milkvetch.

Family: Fabaceae or Leguminosae (Bean family).

Section: Current treatments place it in the Section *Pectinati* (Barneby 1964), previously under Section *Podo-sclerocarpi*

Synonyms: *Astragalus pectinatus* Dougl. var. *platyphyllus* Jones

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 nelsonianus* belongs to section *Pectinati*, a group comprised of 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).

Barneby (1964) characterized it as "rather poorly distinguished from *A. pectinatus* by its ampler foliage, longer flower, and broader and more tumid calyx-tube." He also notes a difference in the color of fresh flowers, with *A. pectinatus* having a cream-colored flower

compared to the pure white flower color of *A. nelsonianus*. This is a distinction that is blurred in herbarium specimens. He goes on to note that "the semblance in foliage to *A gray*i and the size of the leaf-stomata suggest that *A. nelsonianus* is polyploid or has polyploid populations."

Legal Status

Astragalus nelsonianus is listed as Sensitive by the BLM Wyoming State Office (USDI BLM 2001, 2002). The goals of the USDI Bureau of Land Management (BLM) Wyoming policy for sensitive species are to:

- Maintain vulnerable species and habitat components in functional BLM ecosystems
- Ensure sensitive species are considered in land management decisions
- Prevent a need for species listing under the Endangered Species Act
- Prioritize needed conservation work with an emphasis on habitat

The information provided in this report provides the basis for re-examining the vulnerability of this species, recommending its removal from the Sensitive species list of the Wyoming BLM. It is also listed as Sensitive by the BLM Colorado State Office. This species 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 gave *Astragalus nelsonianus* a rank of G2, indicating that it 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. The compiled and expanded information in Wyoming, the center of its distribution, provides basis for reassigning it a global rank of G3, indicating that it is more common than previously known, while it remains vulnerable because of rarity throughout its geographic range.

It was previously ranked S2 in Wyoming (Fertig and Heidel 2002) based on 17 extant occurrences. The results of this survey provide basis for reassigning it an S3 rank. The current number of extant records (30), habitat breadth, and lack of immediate threats also support a downlisting to a "watch species" of potential concern.

In Colorado and Utah it is known from a single record in each state, and is assigned a state rank of "S1" indicating that it is critically imperiled.

Description

Nelson's milkvetch is a selenium-scented perennial herb with 1-many flowering stems 10-30 (40) cm tall arising from a woody rhizome (Figure 1). Lower stipules are papery and fused, while the upper stipules may be free or fused only at the base. Leaves are 4-9 cm long, nearly sessile, and divided into 5-11 linear to oblong leaflets. The leaflets are firm, green, equally pubescent above and below with short, appressed, basally attached hairs. Individual leaflets are attached directly to the grooved rachis without a distinct joint. The inflorescence is a raceme of 6-20 large white flowers with banners over 20 mm long. The calyx tube is 7-9 mm long. Fruits are oblong to elliptical, 15-33 mm long, semi-woody at maturity, 2-grooved, and borne on downward-curved stalks (Barneby 1964, 1989; Dorn 2001).

Previous descriptions of this species characterized it as having a "shallowly buried rootcrown" (Barneby 1989). When specimens were collected in the field during this study, it was documented that the species has a stout, woody rhizome. A horizontal woody rhizome of 1 m length with several separate shoots was unearthed in the field. A vegetative plant that was tallied as 5 separate shoots which proved to be connected by a stout woody rhizome is photographed in Figure 7. Segments of rhizomes have been collected among the voucher specimens produced in this study, and rhizomes are evident among other RM specimens (e.g., *Dueholm 10512*).

Figure 1. Photograph of *Astragalus nelsonianus* by B. Heidel

Similar Species: *Astragalus grayi* has erect to ascending fruits, calyx tubes shorter than 6 mm, and cream-colored flowers. *Astragalus pectinatus* var. *pectinatus* has smaller fruits and extremely narrow leaflets with strongly inrolled margins and pale yellow flowers. There are three varieties of *A. bisulcatus*, some which may have white flowers, but they are often bi-colored, and in any case, leaflets are jointed to the rachis, and there is a 2-grooved fruit (Barneby 1964, Dorn 2001).

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

Table 1. Distinguishing characteristics of *Astragalus nelsonianus*

Species	**Flower**	**Pod**	**Leaves**	**Distribution**
Astragalus nelsonianus	White flowers, banner 22-30 mm	Pod deflexed, becoming a little compressed laterally or dorsiventrally, 15-33 mm long	5-11 (13) linear-oblong or oblanceolate leaflets, decurrent at rachis, acute or obtuse tips	East and west of Continental Divide
Astragalus pectinatus	Pale yellow flowers, banner 21-24 mm	Pod deflexed, body of the pod rounded, 15-25 mm long	9-21 linear leaflets, decurrent at rachis	East of Continental Divide
Astragalus grayi	Cream color flowers, banner 15-23 mm	Pod erect or ascending, body of the pod rounded, 9-18 mm long	5-11 linear oblong or oblanceolate leaflets, decurrent at rachis	East and west of Continental Divide
Astragalus bisulcatus var. *bisulcatus*	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
Astragalus bisulcatus var. *haydenianus*	Pale yellow to white flowers, banner 8-11 m	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
Astragalus bisulcatus var. *major*	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

Geographic Range

Astragalus nelsonianus is endemic to southwest and central Wyoming, northeast Utah, and northwest Colorado. It is widely scattered across a distribution area that is almost 200 miles long and centered in Wyoming. This distribution pattern is shown in Figure 2 (from Barneby 1964). This pattern is more or less complete with exception of the northwestern Colorado population that lies within the boundaries drawn, and the Natrona County populations, an eastward lobe that extends at the north end.

In Wyoming, it is known from the Wind River, Green River, Washakie, southern Powder River, and Great Divide basins, Owl Creek Mountains, and the Rock Springs Uplift in Fremont, Natrona, and Sweetwater counties (Figure 3.)

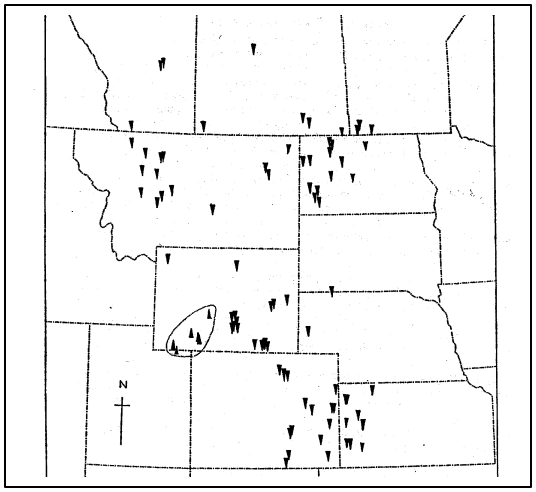

Figure 2. Rangewide distribution of *Astragalus nelsonianus* (circled) and *A. pectinatus,* from Barneby (1964)

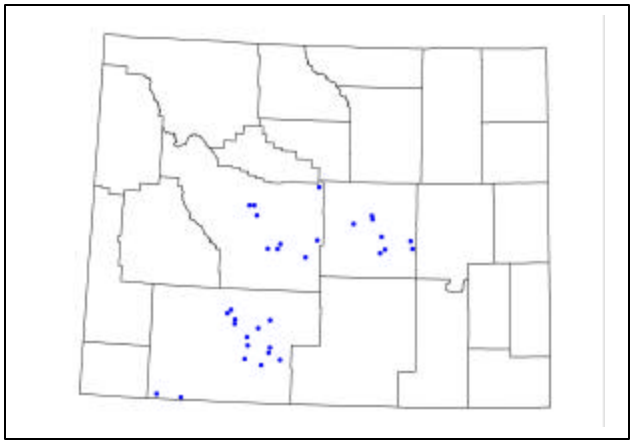

Figure 3. Distribution of *Astragalus nelsonianus* in Wyoming

Each element occurrence and its known distribution summarized in Table 2 and presented in Appendix A. A complete record of survey sites with digitized maps is presented in Appendix A. The complete list of places that were surveyed in 2002 is presented in Appendix B.

The map of predicted distribution of *Astragalus nelsonianus* that was used in conducting 2002 surveys is presented on the following page (Figure 4), documented in Appendix C, and discussed below.

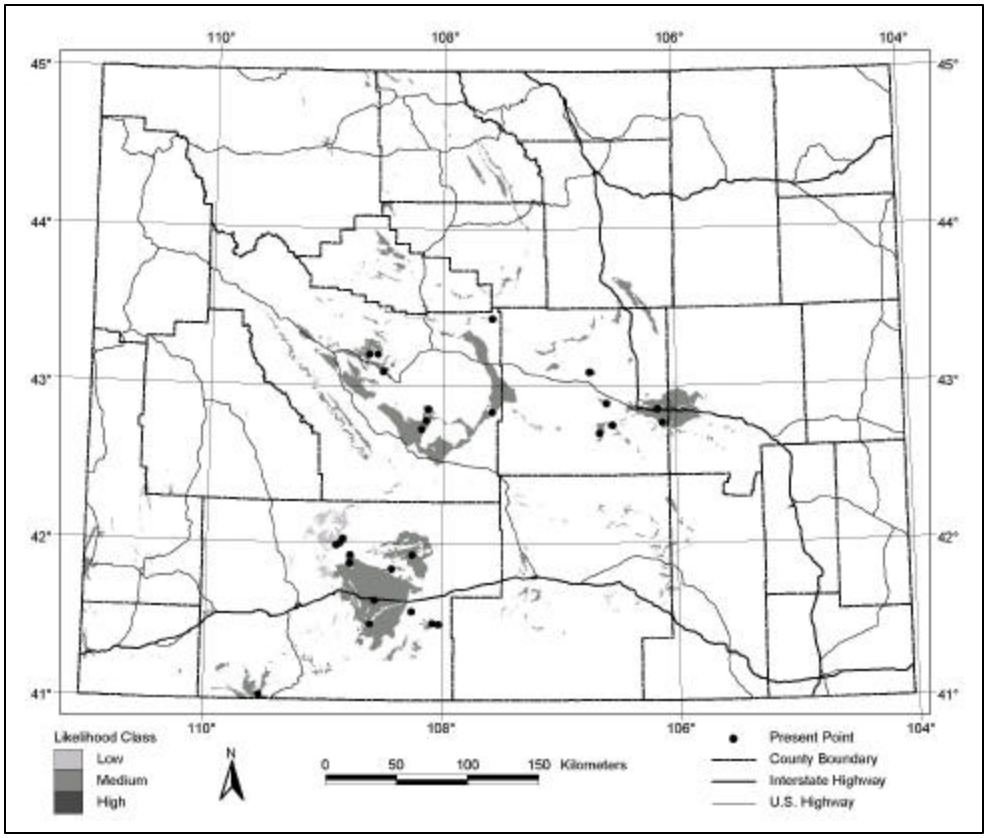

Figure 4. Predicted distribution of *Astragalus nelsonianus* in Wyoming

Extent of Surveys in Wyoming

Astragalus nelsonianus was first collected at Bitter Creek, Sweetwater County in 1897 by Aven Nelson, in his pioneering botanical work in the Red Desert (Williams 1984). It was also collected by Nelson near Bush Rim in 1900. It was described as a new variety of *Astragalus pectinatus* Dougl. by Marcus Jones (1902). It was not collected again until the 1940's when five collections were made by O.A. Beath, H.F. Eppson and G.F. Freytag in the course of concerted researching seleniferous species of *Astragalus.* This included the first collection from Fremont County by O.A. Beath in 1944. It was also collected in 1951 by C.L. Porter and R.C. Rollins near McKinnon in Sweetwater County and by R. Barneby in Daggett County, Utah as a state record. It was elevated to a full species by Rupert Barneby (1964). Beginning in 1979, many new collections were added in the course of floristic surveys and collections were made in the vicinity of historical ones (Welp et al. 1996, Welp 1997, Refsdahl 1996, Ward et al. 1998, Ward 1998, Roderick et al 1999, Taylor 2000). The first collection from Natrona County was made by Ronald Hartman in 1993. Before this study, it was reported from 7 historical and 17 recent collection stations (Fertig 2000). Review of specimens at RM revealed an additional 5 recent collections that were added in preparation for survey.

Systematic efforts were made in 2002 to relocate recent and historic records throughout the known range of the species and to document their extent. It was found in two of the six historic records that had not been relocated in recent years, where it was only present in

small numbers on disturbed roadcuts as they crossed ridge rims. Seven of the 24 recent collections were relocated. Three new populations were documented among the new locations that were surveyed to expand species distribution. Over 60 sections were surveyed in relocating known populations and surveying new ones. Three recent collections were surveyed and could not be relocated. The locations where survey was conducted are summarized in Appendix B.

Habitat

Astragalus nelsonianus occurs on alkaline, seleniferous erodible slopes, shale bluffs, ridgetops, gullies and flats. The poorly-developed soils are silty sometimes mixed with fine sand, sometimes with a pebble surface, and derived from lacustrine deposits as well as loess deposits, and even from volcanic cinders. The known Wyoming occurrences are found in sparsely vegetated sagebrush plant communities at elevations of 5200-7600 feet. In Colorado, it occupies gullies and flats in seleniferous soil (Spackman et al. 1997). In Utah, it occupies saline soils in desert shrub communities (Welsh et al. 1987).

The one thing that is consistent about species' habitat between sites is that it is restricted to discrete zones or patches of topography and substrate at each site. The Sweetwater County sites are on silty soils developed from lacustrine deposits associated with Lake Gosiute, including members of the Green River Formation and the Wasatch Formation. Soils are derived from both oxidized and unoxidized deposits, and the former contain high calcium carbonate concentration. It is variously found at rim crests and bluffs, upper slopes, mid slopes. Most of them are sparsely vegetated, and some slopes show signs of slumping. In Fremont County, it occurs mainly on the Wind River Formation (Figures 5, 6). It also occurs in unique settings that are not known elsewhere in its distribution like the low shale ridges beside a lake created out of irrigation waters (Figure 8) and a site near Lysite in the area of some of the highest reported selenium concentrations known in the western United States (Trelease and Beath 1949; possibly on the Gros Ventre Formation.) In western Natrona County, occurrences are on outcrops that include the Mesaverde Formation capped by powdery silt that may be derived from loess. Soil tests were not run, but the vegetation patterns and soil structure characteristics are consistent with soils containing high volcanic ash content. Volcanic ash has been described as a major source of selenium and constituent of many sedimentary Cretaceous formations as found in the study area (Trelease and Beath 1949).

All of these settings have little soil development, and some are clearly maintained by erosion with active slumping, gullying at the heads of active gullies, or wind-scouring. In settings where there is unstable habitat side-by-side with stable habitat, *Astragalus nelsonianus* is restricted to unstable habitat. The photograph in Figure 7 shows five vegetative shoots running horizontally across the middle of the foreground. With digging, it was determined that they are all part of a single plant connected by a stout, woody rhizome that showed signs of deformation and shifts in growth with slumping. A schematic diagram of the range of topographic positions where it was documented in the 2002 survey is presented in Figure 9. In some settings, it is restricted to benches and bluff edges of 0-5% slope, while in others, it may only be found on steep slopes of 20-45%, while in a few places it occupies more than one natural setting and range of slopes.

Table 2. Locations of *Astragalus nelsonianus* in Wyoming

Occurrence Number: 001
County: Sweetwater
USGS Quad Name: ANTELOPE FLATS
Latitude: 412912N
Longitude: 1083717W
Town/Range/Section: T18N R100W S36 NE 1/4
Location: Great Divide Basin, Red Desert, badland slopes and draws ca 2.5 air miles northwest of Sixmile Rim, ca 0.5 air miles southeast of Patrick Draw, and ca 16 air miles southeast of Point of Rocks.

Occurrence Number: 002
County: Fremont
USGS Quad Name: PAVILLION SE
Latitude: 430523N
Longitude: 1083137W
Town/Range/Section: T1N R3E sensitive
Location: Wind River Basin, across US Highway 26, ca 9 miles west of Riverton.

Occurrence Number: 003
County: Sweetwater
USGS Quad Name: J O DUGWAY
Latitude: 413350N
Longitude: 1081604W
Town/Range/Section: T18N R96W S6
Location: Great Divide Basin, Delaney Rim, ca 4 air miles south of Tipton, restricted to ridgecrest on east side of road.

Occurrence Number: 004
County: Sweetwater
USGS Quad Name: J O DUGWAY, TIPTON
Latitude: 413717N
Longitude: 1081505W
Town/Range/Section: T19N R96W S17 NE4 of SW4, S18 NW4
Location: Great Divide Basin, Red Desert in Tipton area, originally collected "1 mile west of Tipton" and "7 miles east of Table Rock Station." Also ca. 0.7 miles southeast of Tipton railroad crossing along BLM Rd 3313.

Occurrence Number: 005
County: Fremont
USGS Quad Name: GAS HILLS
Latitude: 425004N
Longitude: 1073521W
Town/Range/Section: T33N R90W S14
Location: Wind River Basin, Gas Hills, vicinity of Lucky Mac Mine, "north of main road (Dry Creek Road), east of the anticline in Hog Heaven".

Occurrence Number: 006
County: Sweetwater
USGS Quad Name: BLACK ROCK SOUTH
Latitude: 415223N
Longitude: 1084736W
Town/Range/Section: T22N R101W S24
Location: Great Divide Basin, Black Rock [ca 13 air mile north of Point of Rocks on Interstate 80].

Occurrence Number: 007
County: Sweetwater
USGS Quad Name: BARREL SPRINGS
Latitude: 412927N
Longitude: 1080533W
South Lat: 412857N
North Lat: 412927N
East Long: 1080334W
West Long: 1080533W
Town/Range/Section: T18N R95W S34, T17N R94W S6 NW4
Location: Washakie Basin, North Barrel Springs Draw at south end of Delaney Rim, ca 6 air miles east of Man and Boy Buttes and ca 13-14 air miles south-southwest of Wamsutter.

Occurrence Number: 009
County: Fremont
USGS Quad Name: SAND DRAW
Latitude: 424647N
Longitude: 1080904W
South Lat: 424647N
North Lat: 425115N
East Long: 1080800W
West Long: 1080904W
Town/Range/Section: T32N R95W S2, T33N R94W S7
Location: Wind River Basin, ca 2 air miles northeast of Big Sand Draw oil and gas field, and open ridgetops west of Roger's Mountain.

Occurrence Number: 010
County: Fremont
USGS Quad Name: PAVILLION
Latitude: 431155N
Longitude: 1083847W
Town/Range/Section: T3N R2E S33 NW ¼ of NE 1/4
Location: Wind River Basin, just west of Ocean Lake, ca 16 air miles northwest of Riverton, ca 5 air miles southeast of Pavillion.

Occurrence Number: 011
County: Fremont
USGS Quad Name: OCEAN LAKE
Latitude: 431205N
Longitude: 1083424W
Map Accuracy: Precise; location is within a 75 foot radius of point on USGS topo map.
Town/Range/Section: T3N R3E S30 SW ¼, S31 NE4 of NW 1/4
Location: Wind River Basin, on the east side of Ocean Lake, just north of Ocean Drain.

Occurrence Number: 012
County: Sweetwater
USGS Quad Name: MCKINNON
Latitude: 410303N
Longitude: 1095428W
Map Accuracy: General; location is within 5 mi of point on USGS topo map.
Town/Range/Section: T12N R111W S3
Location: Green River Basin, "Henry's Fork, near McKinnon".

Occurrence Number: 013
County: Fremont
USGS Quad Name: DISHPAN BUTTE
Latitude: 424324N
Longitude: 1081131W
Map Accuracy: Precise; location is within a 75 foot radius of point on USGS topo map.
Town/Range/Section: T32N R95W S28 NE 1/4, NE 1/4 of NW 1/4
Location: Wind River Basin, "road over Beaver Rim" (along Highway 135).

Occurrence Number: 014
County: Sweetwater
USGS Quad Name: FREIGHTER GAP
Latitude: 420132N
Longitude: 1085123W
Map Accuracy: Medium; location is within an approximately 1.5 mi radius from point on USGS topo map.
Town/Range/Section: T24N R101W S28
Location: Great Divide Basin, ca 6 air miles northeast of Steamboat Mountain, in vicinity of Bush Rim.

Occurrence Number: 015
County: Sweetwater
USGS Quad Name: STEAMBOAT MOUNTAIN
Latitude: 415910N
Longitude: 1085438W
South Lat: 415910N
East Long: 1085242W
North Lat: 415955N
West Long: 1085438W
Map Accuracy: Medium; location is within an approximately 1.5 mi radius from point on USGS topo map.

Town/Range/Section: T23N R102W S1, 11-12; T23N R101W S5 NW 1/4; S6 E 1/2

Location: Great Divide Basin, ridge south of Split Rock Canyon, ca 4-5 air miles northeast of Steamboat Mountain and ca 2-2.5 air miles south of Freighter Spring.

Occurrence Number: 017

County: Sweetwater

USGS Quad Name: BLACK ROCK NORTH

Latitude: 415517N

Longitude: 1084727W

South Lat: 415503N

East Long: 1084713W

North Lat: 415527N

West Long: 1084740W

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

Town/Range/Section: T23N R101W S36 S 1/2

Location: Great Divide Basin, Greasewood Wash, ca 2 miles north of County Road 15, ca 3.25 air mi north of Black Rock.

Occurrence Number: 018

County: Sweetwater

USGS Quad Name: BITTER CREEK NE

Latitude: 413814N

Longitude: 1083501W

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

Town/Range/Section: T19N R99W S8 S ½ of NE ¼, NW ¼ of SE ¼.

Location: Rock Springs Uplift, west-facing draws and slopes of a tributary of Bitter Creek, ca 8.5 air miles northwest of Table Rock and ca 10.5 air miles east-southeast of Point of Rocks [ca 0.25-1 air mile south of Interstate 80].

Occurrence Number: 019

County: Sweetwater

USGS Quad Name: RED LAKE SW

Latitude: 415003N Longitude: 1082619W

Map Accuracy: Medium; location is within an approximately 1.5 mi radius from point on USGS topo map.

Town/Range/Section: T22N R98W S36 E ½.

Location: Great Divide Basin, along Dugout Draw at the west edge of Red Desert Basin, ca 1.5-2.5 air miles south of Black Rock Creek, ca 27 air miles west-northwest of Wamsutter, and ca 44 air miles east-northeast of Rock Springs.

Occurrence Number: 020

County: Sweetwater

USGS Quad Name: RED LAKE NE

Latitude: 415539N

Longitude: 1081543W

Map Accuracy: Medium; location is within an approximately 1.5 mile radius from point on USGS topo map.

Town/Range/Section: T23N R96W S33 NE 1/4

Location: Great Divide Basin, Horseshoe Bend, ca 0.2 miles east of County Road 20, ca 25 air miles northwest of Wamsutter, and ca 55 air miles east-northeast of Rock Springs.

Occurrence Number: 021

County: Natrona

USGS Quad Name: BROOKHURST

Latitude: 425100N

Longitude: 1060948W

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

Town/Range/Section: T33N R78W S11 N ½ of NE ¼.

Location: Southern Powder River Basin, along U.S Highway 20-26-87, ca 8 air miles east of Casper.

Occurrence Number: 022

County: Natrona

USGS Quad Name: BROOKHURST

Latitude: 424547N
Longitude: 1060754W
Map Accuracy: Medium; location is within an approximately 1.5 mi radius from point on USGS topo map.
Town/Range/Section: T32N R78W S12 NW ¼.
Location: Western plains, southern Powder River Basin, ca. 0.1-0.25 air mile northeast of Highway 253, ca 9 air miles southeast of Casper.

Occurrence Number: 023
County: Fremont
USGS Quad Name: COTTONWOOD PASS
Latitude: 432547N
Longitude: 1073510W
Map Accuracy: Medium; location is within an approximately 1.5 mile radius from point on USGS topo map.
Town/Range/Section: T40N R90W S24
Location: Owl Creek Mountains, slopes near Cottonwood Creek.

Occurrence Number: 024
County: Fremont
USGS Quad Name: MUSKRAT BASIN
Latitude: 423833N
Longitude: 1074538W
Map Accuracy: General; location is within 5 mi of point on USGS topo map.
Town/Range/Section: T31N R91W S19 TRS estimated by RM
Location: Sweetwater River Uplift, ca 15 miles northwest of Split Rock.

Occurrence Number: 025
County: Natrona
USGS Quad Name: HELLS HALF ACRE
Latitude: 430142N
Longitude: 1070227W
Map Accuracy: General; location is within 5 mi of point on USGS topo map.
Town/Range/Section: T35N R85W S4
Location: Casper Arch, ca 40 miles west of Casper.

Occurrence Number: 026
County: Sweetwater
USGS Quad Name: HAYSTACK BUTTES SOUTH
Latitude: 410135N
Longitude: 1093237W
Map Accuracy: Medium; location is within an approximately 1.5 mile radius from point on USGS topo map.
Town/Range/Section: T12N R107W S14
Location: Green River Basin, ridge on east side of Flaming Gorge Reservoir ca 8 air miles northwest of Dutch John and 2.1 miles west of the Ashley NF boundary.

Occurrence Number: 027
County: Natrona
USGS Quad Name: BURLINGTON LAKE, NATRONA
Latitude: 430513N
Longitude: 1064500W
South Lat: 430455N
East Long: 1064345W
North Lat: 430608N
West Long: 1064543W
Map Accuracy: Precise; location is within a 75 foot radius of point on USGS topo map.
Town/Range/Section: T36N R82W S7 W 1/2 of NW 1/4 of SW ¼; T36N R83W S12 E 1/2 of NE 1/4 of SE4, and SE 1/4 of NW 1/4; Sec 13 W 1/2 of SW 1/4; Sec 14 SE 1/4 of SE 1/4 of SW 1/4.
Location: Casper Arch, ridge system 4-5 miles north-northeast of Natrona and US Highway 20/26 and ca 5 miles north of Burlington Lake.

Occurrence Number: 028
County: Sweetwater
USGS Quad Name: FORT LA CLEDE
FORT LA CLEDE NE
Latitude: 412530N
Longitude: 1082215W
Map Accuracy: Medium; location is within an approximately 1.5 mile radius from point on USGS topo map.
Town/Range/Section: T17N R97W S29 N 1/2; Sec. 30 N 1/2 of NW 1/4; S19 SE 1/4 of SW 1/4
Location: Washakie Basin, plains and low ridges north of Laney Wash ca. 2 miles east-northeast of Fort La Clede ruins and ca. 9.5 miles east of Co. Hwy. 19 via BLM Rd. 4409 and 4410.

Occurrence Number: 029
County: Natrona
USGS Quad Name: CLARKSON HILL
Latitude: 424230N
Longitude: 1063740W
Map Accuracy: Precise; location is within a 75 foot radius of point on USGS topo map.
Town/Range/Section: T32N R82W S26 N 1/2 of SW 1/4; S27 SE ¼ of SE 1/4; S34
Location: Upper North Platte and Laramie River drainages; ca. 4 air miles northwest of junction of Wyoming Hwy. 487 and Wyoming Hwy 220.

Occurrence Number: 030
County: Natrona
USGS Quad Name: EMIGRANT GAP NE
Latitude: 425327N
Longitude: 1063630W
Map Accuracy: Precise; location is within a 75 foot radius of point on USGS topo map.
Town/Range/Section: T34N R81W S30 NW 1/4 of NW 1/4, NW 1/4 of NE 1/4
Location: Upper North Platte and Laramie River drainages; Emigrant Gap Ridge ca. 3.5 airmiles south of US Hwy 20 (26), ca. 14.8 airmiles WSW of Caspar.

Occurrence Number: 031
County: Natrona
USGS Quad Name: BESSEMER MOUNTAIN, EMIGRANT GAP
Latitude: 424501N
Longitude: 1063316W
Map Accuracy: Medium; location is within an approximately 1.5 mile radius from point on USGS topo map.
Town/Range/Section: T32N R81W S9 SW 1/4
Location: Upper North Platte and Laramie River drainages; north side of Bessemer Mountain, ca. 13.7 air miles southwest of Casper.

Occurrence Number: 032
County: Sweetwater
USGS Quad Name: BITTER CREEK NE
Latitude: 414347N
Longitude: 1083552W
Map Accuracy: Precise; location is within a 75 foot radius of point on USGS topo map.
Town/Range/Section: T20N R99W S8 W 1/2
Location: Rock Springs Uplift; West-facing slopes of Tenmile Rim, 5.5 miles north of Bitter Creek exit from I-80.

Occurrence Number: 033

County: Natrona

USGS Quad Name: NATRONA

Latitude: 430728N

Longitude: 1064542W

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

Town/Range/Section: T37N R83W S35 SE 1/4 of SE 1/4

Location: Casper Arch, ca. 8 miles north of Natrona on North Natrona Road, and north ca. 0.5 miles on Divide Road, and north ca. 0.3 miles to the head of the second east-west gully.

Occurrence Number: 034

County: Fremont

USGS Quad Name: YELLOWSTONE RANCH

Latitude: 424321N

Longitude: 1082030W

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

Town/Range/Section: T32N R96W S30 NE 1/4; S29 NW 1/4 of NW ¼.

Location: Wind River Basin, app. 14 miles northwest of Sweetwater Junction, and app. 0.5 miles north of mouth of Del Monte Draw on Beaver Creek on either side of Beaver Creek Road.

Figure 5. Typical habitat of *Astragalus nelsonianus* in Wyoming (EO#34 on Beaver Creek valley, Fremont County); view perpendicular to slope, by B. Heidel

Figure 6. Typical habitat of *Astragalus nelsonianus* habitat (same area as Figure 5; upslope view), by B. Heidel

Figure 7. Slumping of *Astragalus nelsonianus* habitat (EO#032 in Sweetwater County) (Note the 5 vegetative shoots across the middle, all ramets of one genet connected by a stout woody rhizome), by B. Heidel

Figure 8. Habitat of *Astragalus nelsonianus* on low shale ridge, (EO# 011 in Fremont County) By B. Heidel

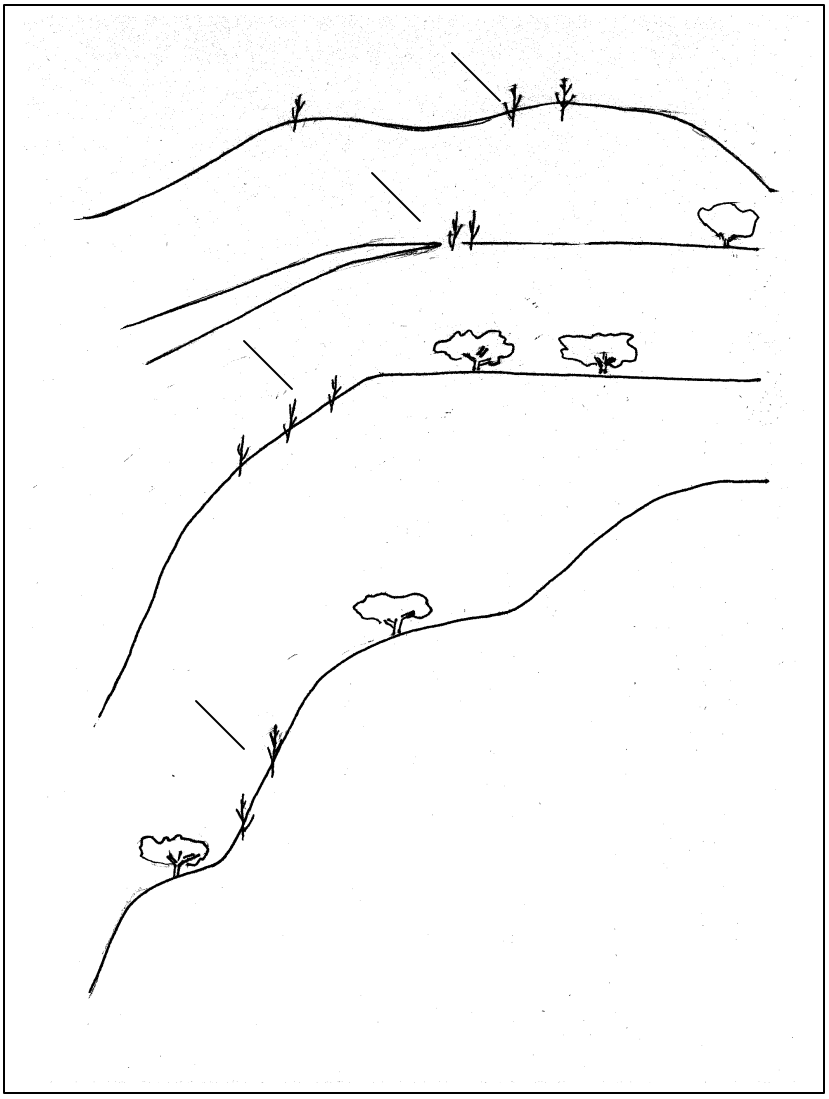

Figure 9. Range of topographic settings for *Astragalus nelsonianus* in Wyoming

The most common species in its sparsely-vegetated habitat include Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), rubber rabbitbrush (*Ericameria nauseosa* var. *nauseosa*), and shadscale (*Atriplex confertifolia*). Species composition varies considerably with substrate and topographic position across its range, but in general, the associated species in the occurrences of Sweetwater and Fremont counties include thickspike wheatgrass (*Elymus lanceolatus*), western wheatgrass (*Elymus smithii*), Canby bluegrass (*Poa secunda*), Nuttall's saltbush (*Atriplex gardneri*), Hooker's sandwort (Eremogene hookeri), spreading wild buckwheat (*Eriogonum microthecum*), cushion wild buckwheat (*Eriogonum ovalifolium*), granite prickly-phlox (*Linanthus pungens*), thrift mock goldenweed (*Stenotus armerioides*),), indian ricegrass (*Achnatherum hymenoides*), contracted indian ricegrass (*Achnatherum contracta*), Nuttall's desert-parsely (*Lomatium nuttallii*), Payson's beardtongue (*Penstemon paysoniorum*), basin daisy (*Platyschkuhria integrifolia*), and bastard toadflax (*Comandra umbellata*). The associated species in Natrona County include rayless tansyaster (*Machaeranthera grindelioides*), thread-leaved sedge (*Carex filifolia*), shadscale (*Atriplex argentea*), moss phlox (*Phlox*

bryoides), shortstem wild buckwheat (*Eriogonum brevicaule*), broom snakeweed (*Gutierrezia sarothrae*), leafy wild parsley (*Musineon divaricatum*), needle-and-thread (*Stipa comata*), big bluegrass (*Poa juncifolia*), and winterfat (*Krascheninnikovia lanata*). Total vegetation cover in the immediate vicinity of *Astragalus nelsonianus* is uneven and usually in the 5-20% range. Other species of *Astragalus* were not noted in the same habitat. In Natrona County, its range overlaps with that of *Astragalus pectinatus* though they have not been reported growing together.

The cold, high plains climate is indicated by climate monitoring data from Rock Springs, Riverton and Casper (Table 3).

Table 3. Climate data from monitoring stations nearest *Astragalus nelsonianus* populations in Wyoming (from USDI NOAA 2002).

	Casper Airport (5340 ft)	**Riverton (4950 ft)**	**Rock Springs (6370 ft)**
Mean annual ppt. (in.)	11.92	8.61	8.57
Jan. av. high temp (F)	33.52	29.15	31.66
Jan. av. low temp. (F)	12.67	-0.25	10.61
Jul. av. high temp (F)	87.43	88.76	86.35
Jul. av. low temp (F)	54.22	51.61	51.76
Av. frost free days	May 20- Sept. 20	May 20-Sept. 15	May 25- Sept. 10

Population Size and Trends

Astragalus nelsonianus is known from at least 28 recent collection stations in Wyoming, one in Colorado and at least one in Utah, in addition to 4 collection stations known only from historical records in Wyoming (Hartman and Nelson 1998, Colorado Natural Heritage Program 2003, Welsh 1987, and this report). Many individual colonies number in the 100's and there are 6 populations of over 300 plants. One site observed in 1995 was found to consist of relatively few, widely scattered individuals over 20 + acres. Population estimates were made at 12 of 29 recent collection stations in 2002 and are in the range of 2,500-6,250 individuals. An extrapolation of these numbers puts total species numbers in the range of 4,000-40,000 individuals.

There are fundamental difficulties in estimating numbers for this species in general and from 2002 data in particular. First, the species produces a stout, woody rhizome. This was not reported before in the literature, and rhizome lengths of greater than a meter were observed in the field with several separate shoots. Stems that are grouped in an area, whether flowering or nonflowering, may all be part of the same plant, i.e., ramets of the same genet (see Figure 7). For this reason, tallies of individual shoots are likely to be overestimates of the actual number of genetically distinct individuals. Second, very few plants of *Astragalus nelsonianus* flowered within natural habitat in 2002 (flowering is discussed further in the following section on species biology). A vegetative plant is shown in Figure 10. For this reason, tallies of the shorter, more inconspicuous vegetative plants are likely to be underestimates of actual population size. No

efforts were made to compensate for these factors that confound population census. Detailed monitoring over consecutive years would help evaluate these phenomena.

Many of the populations in natural habitat occur across extensive slope faces but are associated with slope microhabitat conditions as dictated by topographic position, slope, and aspect. Many populations are also in checkerboard land ownership where the full extent of species' distribution was not possible to evaluate, or where the access to recent collection sites was not possible to arrange during the limited fieldwork time. Therefore, the extent of populations is only a first approximation. .

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 nelsonianus*. Of the 9 historic collections, 4 have been relocated, an indication of persistence and stability.

It is possible that the species' numbers have increased at some populations under recent disturbance. In three cases where disturbance nears or crosses natural populations, it appears as though the species numbers have increased under disturbance and in some cases have dispersed into otherwise unsuitable habitat because of disturbance. First, a pipeline passes near a Sweetwater County population north of Bitter Creek (EO #018) and the numbers of plants in the broad, disked pipeline corridor were over a magnitude greater in the corridor than in the intact species' habitat, suggesting an increase under disturbance. Second, a county road was widened within the past 1-2 years passes near the slope of the Tenmile Rim population (EO #032). The occupied right-of-way habitat is a very broad, shallow trough that was excavated and bulldozed out of level or gently-rolling uplands in 2001 or 2002. There are few plants in the road right-of-way above the population where it occurs on the slopes of the rim. There are, however, numerous plants in the bulldozed road right-of-way at scattered intervals. In total, there are app. 1.6 miles of right-of-way population, at 3 intervals within a 15 mile distance north of the population where the road veers from the rim habitat. Third, a county road right-of-way near the historic site of Fort La Clede in Sweetwater County was the site of a 1999 collection (Dorn #7966; EO # 028). It was revisited, and the largest numbers of plants were in the bulldozed road right-of-way. The only individuals of *Astragalus nelsonianus* that could be found in intact habitat were on breaks overlooking the occupied road right-of way habitat as it crosses gentler terrain. Precise stem counts were taken in the right-of-way because it offers a basis for evaluating species' response to bulldozers if counts are taken in the future. The road was in the process of being bladed and widened at the time of visit in July. The largest numbers of plants were in the segment that had yet to be widened. Almost no surviving plants were visible in the segment that had been bladed in prior days. It is possible that this bulldozing activity will result in an increase in local species' numbers within the next year or more.

This pattern of species' response to disturbance is supported even in populations that occupy intact habitat. Populations that have two-track roads running through them tend to have highest plant densities in the road tracks (e.g., EO# 27, 30).

The mechanism by which the species increases under disturbance is not known. The examples above may reflect dispersal of the hard, semi-woody fruits, or breakage and re-rooting of the woody rhizomes. None of the collection labels prior to this study mentioned disturbed habitat, with the exception of one roadside collection in Natrona County where the species could not be relocated. It is possible but not proven that the species' adaptations to its unstable habitat confer resilience or benefit under other disturbances.

Population Biology and Ecology

Astragalus nelsonianus flowers from early to late June, and there is also one specimen in flower at RM that was collected at the end of May (*Haines 856*). Fruits are present from late June-August, and may persist on the stem over winter. Flowering activity appears to be affected by the drought. Many populations in 2002 had few or no flowering or fruiting plants, represented only by small vegetative plants (Figure 10). The showy flowering plants are conspicuous, usually taller and with multiple stems. At the onset of this survey, it was evaluated whether the species could be surveyed in vegetative condition, based on specimen reviews and notes taken in populations that had both flowering and nonflowering individuals. It was deemed feasible to verify species' presence, but it is likely that population counts and aerial extent are low. In cases where the population spanned both disturbed and intact habitat, the flowering activity was usually restricted to the disturbed habitat.

Figure 10. Vegetative plant of *Astragalus nelsonianus* (EO#011 on Ocean Lake, Fremont County). Compare this with the robust flowering plant shown in Figure 1 (p. 4), by B. Heidel

In general, the flowers in the *Astragalus* genus are insect-pollinated. The flowers of *Astragalus nelsonianus* are large and showy for the genus, with a banner up to 3 cm long. The most abundant as well as the most conspicuous insect visitor encountered was a very large wasp species observed visiting flowers in the evening in early June (EO# 018).

Few fruits were noted in the limited fieldwork that was conducted in early July, but this did not include revisits to plants that were known to produce flowers in June. It is possible that the rate of flower abortion increases or fruit set decreases with drought. The fruits are tough and semi-woody, not readily rupturing. They may require mechanical treatment (scarification or other abrasion) to germinate. They are so short and wide as to easily roll on sloping terrain. There are no known dispersal vectors.

Vegetative and reproductive shoots arise from woody rhizomes singly or in groups, and break easily at the junction between the herbaceous shoot and woody rhizome. The woody rhizome was excavated on one steeply-sloping site that was slumping, and the rhizome helped hold the slope intact. It is not known whether slumping and gullying could fragment the rhizome but if this happens on occasion, it may be an extreme form of vegetation reproduction.

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 30-60 minutes with concentrated sulfuric acid to soften them, then soaking in water for three hours, and allowing seeds to germinate on covered glass dishes with moist filter paper. The filter paper was moistened with culture solutions that did and did not contain selenium as sodium selenite (20 ppm). The addition of selenium to the culture solution had no effect on the growth of *Astragalus nelsonianus* seedlings due to the presence of stored selenium in the seeds, while it inhibited those species that do not accumulate selenium (Rosenfeld and Beath 1964). No seedlings were observed in the 2002 surveys, but many small vegetative plants were noted that could have been stunted in the drought or represent new plants. Considering that the species has a hard, semi-woody fruit that does not rupture, it seems likely that the taxon has a seed bank.

Astragalus nelsonianus was nowhere common, with the possible exception of disturbed habitats. In its natural habitat, plants are distributed unevenly by topographic position, slope and aspect, perhaps reflecting the suitable erosion conditions for establishment and persistence.

Due to its concentration of selenium, it does not appear to be favored for browse by livestock, wild horses, or native herbivores. Predation of flower heads and pods was not observed. It is most often found in sites with vegetative cover under 20%, suggesting that it does not compete well with other species on less severe habitats. It may occur in the same area with other species in the *Astragalus* genus, but species in the *Pectinati* group were not documented at the same locale and these species do not appear to hybridize in the wild.

Current Management

Almost all known occurrences of *Astragalus nelsonianus* are on lands managed by the BLM Casper, Lander, Rawlins and Rock Springs field offices. It is also on lands managed by the Ashley National Forest (Flaming Gorge National Recreation Area) and by the State of Wyoming. No populations are found within protected lands, and almost all are on lands managed for multiple-use.

Existing and Potential Threats

The potential threats to the species that were identified included habitat disturbance associated with oil and gas development and off-road vehicle recreation (Fertig 2000). However, the 2002 survey results indicate that there is no evidence that species numbers have declined under these influences, and they may have increased (see previous text on trends). The plants growing in disturbance settings are not necessarily secure but can evidently disperse and expand. Re-census of the population segment that was bulldozed (EO #028) after the time of the 2002 survey would help confirm or refute this. Recreational use was not observed to affect the species at any of the sites. Furthermore, most of the species' natural habitat is on rugged slopes where disturbances are few and localized.

There were no signs of livestock or wild horses grazing the species or indirectly damaging it. The species habitat generally represents secondary range, receiving little use. *Astragalus nelsonianus* 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.

The majority of populations in intact habitat are on slopes or gullies that are unsuited for development. The populations that have low levels of disturbance present, i.e., two-track roads running through them, tend to have highest plant densities within the road tracks (e.g., EORs #027, #030). A quarter of the species populations that could be located in 2002 appeared to be restricted to or concentrated in disturbance settings. This could mean either a loss of habitat by the natural population or an adventive capacity of the species to become established in disturbed habitats. In any case, the populations that are exclusively or primarily in disturbed settings are not considered to represent a direct contribution to species' viability but an indication of species biology and the possibility of potential habitat in the area. Only four large populations are known from natural habitat. At present, this taxon qualifies as a Wyoming species of potential concern until sufficient habitat is afforded protection or additional large populations in natural habitat are documented. This is the basis for retaining *Astragalus nelsonianus* on the list of species of potential concern in Wyoming in the center of its range.

Summary

Astragalus nelsonianus has a limited geographic distribution and set of habitat requirements. Survey was conducted that spanned the extent of species' distribution in Wyoming across Sweetwater, Fremont and Natrona counties. At present, this species does not appear to qualify as a BLM Sensitive species because of the number of occurrences and apparent increase of species numbers and extent under disturbance. Wyoming is the center of its range, and it recognized as a Wyoming species of potential concern until sufficient habitat is afforded protection or additional large populations in natural habitat are documented.

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