BIOLOGICAL EVALUATION OF ASTRAGALUS BARRII POPULATIONS FOR 1995 GRAZNG PERMIT REISSUANCE ANALYSIS AREAS 1-3 ASHLAND RANGER DISTRICT, CUSTER NATIONAL FOREST

INTRODUCTION

In 1995 and 1996 a number of permits for livestock grazing on the Ashland Ranger District of the Custer National Forest are due to expire. The National Environmental Policy Act and the Endangered Species Act require that an Environmental Assessment is provided prior to issuance of livestock grazing permits. To comply with the Environmental Assessment, all populations of Threatened and Endangered plants that intersected allotments of the Ashland Ranger District of the Custer National Forest that had livestock grazing permits that would expire within 1995 and 1996 were given a Biological Evaluation. Where populations showed moderate or high vulnerability to livestock grazing and trampling, these Biological Evaluations included a complete Effects Analysis. The Effects Analysis addressed the effects of livestock grazing upon the Threatened and Endangered plant populations.

Furthermore, an Environmental Assessment is required to determine whether proposed management practices will establish the desired future condition of Threatened and Endangered plants. This condition is defined within the Custer National Forest Management Plan as 'maintained or improved existing habitat for Threatened and Endangered plants and recovery of the species wherever possible.'

Plants that are listed as Category 2 or Category 3 with the U.S. Fish and Wildlife Service or are listed as Sensitive with the U.S. Forest Service are managed as though they were Threatened or Endangered. Thus, species listed as Category 2 Category 3, or Sensitive and that intersect allotments with expiring permits were also given a Biological Evaluation.

STUDY AREA

The grazing allotments to be surveyed within the Ashland Ranger District were grouped into three analysis areas. Analysis Area 1, the Ashland Southwest Area, was composed of five allotments and covered 61,806 acres. Analysis Area 2 the Ashland Southeast Area, was composed of eight allotments and covered 58,157 acres. Analysis Area 3, the Ashland North Area, was composed of eight allotments and covered 62,642 acres.

METHODS

As the first step in the Biological Evaluation, a review of available information was conducted. A list was compiled of all plants defined as Threatened, Endangered, Category 2, Category 3, or Sensitive that occurred in the Custer National Forest. This involved a search of the occurrence records for these plants on a rangewide, regional, Custer National Forest, Ashland Ranger District, and Analysis Area level. Populations of these rare plant species were defined. Populations of rare plants that intersected any Analysis Areas were identified. Suitable habitat for rare plant populations that intersected any Analysis Areas was identified. Where populations of a rare species were not known to intersect an Analysis Area, and where adequate survey work had been performed in and near the Analysis Area without the discovery of any populations, it was concluded that no populations existed in the Analysis Area and were thus in no risk from livestock activity. As a result, in this case, no further Biological Evaluation was necessary. Where the populations were present in an Analysis Area, or where suitable habitat for populations existed in an Analysis Area and no adequate survey work had been performed in the area, further Biological Evaluation was conducted.

As the second step in the Biological Evaluation, these species were rated as to vulnerability to grazing in terms of geography, phenology, palatability, disturbance sensitivity, and grazing intensity. Species that were assessed as having high or medium vulnerability to grazing with respect to one or more of these characteristics underwent the third step of the Biological Evaluation.

The third step of the Biological Evaluation, known as the Effects Analysis, involved **1)** determining and prioritizing cause and effect components, **2)** determination of spatial and temporal limits of the analysis, **3)** description of the existing condition, **4)** predicting effects, and **5)** documentation. Documentation included field surveys and identification of researchers and authority. Field surveys involved the location of the populations, description of the habitat and biology, population counts, photographs, specimen collection establishment of plots, and observation of grazing effects. The intensity level of the field surveys was determined by the density of the vegetation within the survey area, the ability of the plant community to support rare species, the visibility of the rare plant, and the degree of physical impact of the grazing regime in the analysis area. All of this data was recorded on field data sheets entitled ”Species of Special Concern Survey Form” and topographic maps.

BIOLOGICAL EVALUATION

Review of Available Information

The only rare species listed with the Custer National Forest that has a history of occurring on the Ashland Ranger District is Astragalus barrii, or Barr's milkvetch. It is listed as Sensitive with the Forest Service and Category 3-C with the Fish and Wildlife Service. Species listed as Sensitive are defined as 'species for which population viability Is a concern as evidenced by significant current or downward trends In population or habitat.' Species listed as Category 3-C are defined as ‘taxa that have proven to be more abundant or widespread than previously believed and/or those that are not subject to any identifiable threat, but remain under research and may be reevaluated.' A search of the occurrence records of A. barrii revealed that only one population at A. barrii has been observed within any of the Analysis Areas, that being in Analysis Area 1. These occurrence records were based on intensive surveys of southeastern Montana In 1986 (Shelly, 1986), Custer National Forest In 1988 (Schassberger, 1988), and the Ashland Ranger District in 1995 (Marriott, 1995). A summary of the occurrence records for A. barrii is contained in the section “Spatial and Temporal Analysis.”

Habitat preferences of A. barrii are gullied knolls or buttes, or barren hills or cliff tops with soils derived from claystones, siltstones, or sandstones that are low in organic matter, have high pH, fine texture, and low fertility. Often these soils are strongly calcareous. It favors open light conditions with high percentages of bare ground and dry sites where the rate of surface runoff is high. Sites containing A. barrii tend to be highly erodable and steeply sloped. Associated species of A. barrii are *Artemesia tridentata, Eriogonum pauciflorum, Musineon divaricatum, Atriplex confertifolia, Yucca glauca, Comandra umbellata, Andropogan scoparius, Gutierrezia sarothrae, and Phlox hoodii.* Astragalus barrii will be found within mixed grass and short grass vegetation communities, and on the edges of *Pinus ponderosa or Juniperus scopulorum* vegetation communities.

A consideration of habitat present within the Analysis Areas revealed that many *potential* sites for A. barrii existed. However, the historical records and the recent adequate survey work demonstrated that in reality only one A. barrii population in any of the Analysis Areas, that being in Analysis Area 1. As a result, a Biological Evaluation was necessary for the A. barrel population within Analysis Area 1, but no further Biological Evaluation was necessary for within Analysis Areas 2 and 3.

Species Vulnerability Rating

Astragalus barrii was rated as having moderate vulnerability to grazing with respect to one of the vulnerability criteria. These criteria with the respective ratings are listed below.

1) Geographic Criteria: Regional/Edaphic Endemic
2) Critical Successional Stage: Early and Mid, during flowering and fruiting
3) Phenology: Moderate vulnerability during flowering and fruiting
4) Palatability: Low throughout
5) Disturbance Sensitivity: Low

6) Grazing Intensity: Low

As a consequence of this rating, an Effects Analysis was initiated and the lone A. barrii site within the Analysis Area 1 was surveyed.

Effects Analysis

1) Cause and Effect Components: Livestock grazing and trampling is the only project activity that has the *potential* to affect the habitat and populations of A. barrii. This affect could be *direct* in the form of grazing or trampling of the plants. This could be most adverse during the flowering and fruiting stages where trampling or grazing could remove the reproductive plants or damage the reproductive structures. Or the cattle could serve to disperse the seeds, establishing now or expanded populations. Flowering occurs in April, May and June, most commonly in May. Fruiting pods appear In June and July. This could be *indirect* in the disruption of critical habitat corn by grazing and trampling. These components are: 1) Associated species. There may be sensitive biological relationships between A. barrii and other plant species. These could be altered by grazing or trampling of these other species. Also, the alteration of communities of associated species may change the successional stage of the site in which A. barrii has a niche. 2) Structure. Astragalus barrii tends to areas with high percentages of bare ground. Grazing or trampling could increase the amount of bare ground through the removal of vegetation and increased erosion, or it could decrease the amount of bare ground by creating conditions favorable for the introduction of weedy annuals. 3) Topography. Astragalus barrii thrives in open light conditions and on relatively steep slopes. Grazing or trampling could, in their extreme, bring about an increase in erosion sufficient to change slope shape, declination, and light exposure. 4) Geography. Astragalus barrii typically inhabits dry sites where the rate of surface runoff is high. Cattle grazing and trampling has the potential to alter the surface and subsurface hydrology. Astragalus barrii tends inhabit soils with low fertility, little organic matter, high pH, and fine texture. Cattle grazing and trampling could increase soil erosion, altering soil fertility, chemistry, and texture. 5) Geology. Astragalus barrii seems to thrive under conditions of relatively high erosion and deposition. Cattle activity could increase erosion and deposition.

2) Spatial and Temporal Analysis:
a) Spatial Analysis: A summary of the geographic distribution of A. barrii based on data from the Montana Natural Heritage Program (MTNHP) is presented below:

- Rangewide Distribution: Astragalus barrii is found in three states of the Northern Great Plains. In Wyoming it is found in Johnson county, and reported as endemic in the area. In South Dakota it is found in Fall River, Shannon, and Pennington counties. In Pennington county a population is reported to number an estimated 12,527,214 plants (Schmoller 1993). In Montana it is found in Bighorn, Carter, Powder River, and Rosebud counties.
- Statewide Distribution: Bighorn County had two populations of indefinite number. Carter County had one site with an indefinite number of plants. Powder River County had 19 populations with a total of 14,000 plants. Rosebud County had six sites with a total of 2,400 plants.
- Custer National Forest Populations: Within Custer National Forest there were nine sites with a total estimated population of 14,200 to 14,250 plants. All sites were within Powder River County. A breakdown of the populations at each site is below:

MTNHP Occurrence Number	Population Size	Year Observed
PDFABOF150.010	1250	1988
PDFABOF150.011	600	1988
PDFABOF150.012	2000	1988
PDFABOF150.013	1750	1988
PDFABOF150.014	2400	1988
PDFABOF150.016	2000	1988
PDFABOF150.016	950	1988
PDFABOF150.017	3050	1988
PDFABOF150.020	200-250	1988

- Analysis Area 1 Populations: One population, number PDFABOF150.015, intersected Analysis Area 1. It was located within the north end of the King Creek allotment, within the King Mountain Hiking and Riding Area. The legal description was T—R—S— 1/4. It was reported to have a population of 2000 plants.

b) Temporal Analysis:

- Expected Short Term Effects: Cattle grazing and trampling has the *potential* to have adverse and beneficial effects upon populations of A. barrii in the short term. The adverse effects would be by the direct removal or destruction of plants through grazing and trampling. This would be most critical during the flowering and fruiting periods from April through July. Yet, the trampling and grazing may also serve to benefit the species by dispersing the seeds and impressing them into the soil.

  In reality, there is a lack of evidence that cattle grazing has any significant adverse or beneficial effect upon the populations of A. barrii over the short term. The level of grazing observed in A. barrii habitats is minimal. Four factors appear to contribute to this. First, A. barrii will grow on slopes of a steepness that is avoided by cattle. A rule of thumb is that cattle avoid slopes greater than 40 degrees. Astragalus barrii will be found on slopes of 35 to 45 degrees. Second, it grows in areas with a high percentage of bare ground, lacking good quantities of forage. Third, it does not appear to be selected by cattle (Schmoller, 1993). Fourth, it is associated with species that, in the main, are not selected by cattle (Johnson and Nichols, 1982) (USDA, 1937). Only five of the twenty-eight MTNHP sites recorded evidence of cattle grazing on or near the A. barrii populations, and the grazing was generally light (MTNHP, 1995). No evidence of cattle grazing of A. barrii plants was seen in the entire Pennington county, South Dakota survey. (Schmollor 1993).

  Similarly, the reality is that there is a lack of evidence that cattle trampling has any signfflcant adverse or beneficial effect upon the populations of A. barrii over the short term. The level of trampling observed in A. barrii habitats is minimal. Again, this appears to be the result of the fact that A. barrii will grow on steep slopes and in areas with a high parcerdage of bare ground cover, does not appear to be selected by cattle, and is associated with species that, in the main, are not selected by cattle. An occasional plant has been seen that has been compressed by hooves. At many sites *Odocoileus hemionus* (Mule deer) tracks were more common than cattle, leading to speculation that more grazing and trampling were accomplished in A. barrii populations by Mule deer than cattle (Schmoller, 1993).

  Thus, over the short term, common levels of cattle grazing and trampling are not expected to have any significant adverse or beneficial impact on the populations of A. barrii.

- Expected Long Term Effects: Cattle grazing and trampling has the *potential* for adverse and beneficial long term effects. Cattle grazing and trampling could benefit A. barrii populations in two ways. First, cattle activity could produce and maintain habitat conditions beneficial to A. barrii such as open light, dry soil, nearly bare ground, and high erosion gradients. Second, livestock grazing and trampling could aid in the dispersal and sowing of A. barrii seeds amidst the present population and into other locations with suitable habitats. Thus, it is suspected that the present levels of cattle grazing and trampling on the A. barrii site could, in the long term, serve to maintain habitat conditions and disperse populations of A. barrii. Conversely, cattle grazing and trampling could prove to be adverse to populations of A. barrii in two ways. First, cattle grazing and trampling could maintain habitat conditions adverse to A. barrii. These habitat conditions would include unfavorable successional stage and associated species, structure with limited bare ground and open light, and increased erosion that would bury plants, uproot plants, change slopes, or alter runoff gradients. Second, cattle grazing and trampling could result in the loss of significant numbers of flowers, fruits, or the plants themselves, thus reducing the capacity of the population to sustain itself through reproduction.

In reality, there is a lack of evidence that cattle grazing or trampling results in any benefit or detriment to populations of A. barrii over the long term. It has been observed with regularity that cattle activity In A. barrii habitat is minimal. Again, this appears to be the result of the fact that A. barrii will grow on steep slopes and in areas with a high percentage of bare ground, does not appear to be selected by cattle, and is associated with species that, in the main, are not selected by cattle. Moreover, in the 1993 study of A. barrii in Pennington county, South Dakota it was found to be thriving in the open light, bare ground, and high erosion of certain old road beds, ditches and cattle trails (Schmoller, 1993). This suggests that the levels of cattle grazing and trampling commonly seen in A. barrii may have a slight tendency to maintain A. barrii populations rather than destroy them. However, many sites that are grazed and trampled by animals, even overgrazed to the point that the habitat resembles that which is suitable for A. barrii, do not have A. barrii populations. Astragalus barrii appears to be an *edaphic* endemic. Indeed, the primary habitat factors appear to be: 1) Parent rock. Badland formations composed of claystones and siltstones are the rock of choice. 2) Soil type. These soils tend to be derivatives of the parent rock or alluvium composed of the parent rock. They are alkaline, low in organic matter, of fine textures, and low fertility. 3) Vegetation structure. All sites with A. barrii have high percentages of bare ground, usually 60 to 90%. 4) Associated vegetation. In sites from Montana and South Dakota A. barrii was regularly in association with *Eriogonum pauciflorum, Phlox hoodii,* and *Gutierrezia sarothrae.* Livestock are not a habitat factor. They are, at best, a minor factor in the creation and maintenance of A. barrii. There is no evidence that the species depends upon cattle activity for survival.

Thus, over the long term, it is expected that common levels of cattle grazing and trampling will have no significant adverse or beneficial impact upon the populations of A. barrii, or may have a slightly beneficial impact.

3) The Existing Condition:

a) General: On July 5, 1995 Target Surveys were performed for a population of Astragalus barrii on MTNHP site PDFABOF150.015 in the Long Creek allotment In Analysis Area 1 in the Ashland District of Custer National Forest. The objective was to verify the presence of A. barrii, gather population data, and observe the effects, if any, of cattle grazing and trampling. In view of the history of sensitive plant populations on the site and the potentially moderate vulnerability of these populations to livestock grazing during the critical flowering and fruiting periods, a Complete Survey Intensity Level was selected. All surveys were done on foot. The surveyors were David Schmollor and Amy Schmoller.

b) Population Size and Geographic Structure: The survey of the area rediscovered the A. barrii population. It consisted of one distinct population with an estimated 5,250 individuals on approximately 1.88 acres (.76 ha) of land. The entire population lay within Analysis Area 1. The areal extent of the population is described on the topographic map that follows this report. ***[map not included in this webversion]***

c) Population Biology: There was no clear evidence of disease, predation, or injury. Occasionally a dead plant was observed, but there was no evidence of grazing or trampling on any of the plants. Thus, it was not clear whether the demise of these individual plants was caused by cattle grazing or some other factor such as drought, disease, erosion, or other herbivore. Mule deer tracks were in greater abundance than cattle tracks, and would seem to be more of a factor in the death of the plants than cattle. In addition, the full number of the dead plants amounted to less than one percent of the total, suggesting that the mortality of these individuals was a minor event. There was no clear evidence of symbiosis or parasitic relationships. However, as was the case In many of the other sites at which A. barrii had been located, *Comandra umbellata* plants were growing in the midst of A. barrii. *Comandra umbellata* is a hemi-parasite, with roots that attach to other plants. There were three evidences of reproductive success. First, there were numerous seedlings and juvenile plants. These comprised approximately three to five percent of the total. Second, an estimated 98% of the plants were in fruit. Those plants in fruit had numerous peduncles, most peduncles carrying three fruits. This represented a

tremendous potential for maintenance and dispersion of the species. All remaining plants were in the vegetative stage; no plants were in flower. Third, the population count of this survey found an estimated 5,250 plants. The survey of 1988 found an estimated 2000 plants (Schassberger, 1988). By these estimates, the population saw a 163% increase in the past seven years. Overall, a healthy, vigorous population of A. barrii plants was observed with little or no evidence of an impact from cattle grazing or trampling.

d) Habitat Description: Astragalus barrii was found growing in the *Pinus ponderosa/Agropyron spicatum* Forest Habitat Type. This zone had components of *Rhus aromatica/Carex filifolia, Artemesia tridentata/Agropyron spicatum, and Sarcobatus vermiculatus*l*Agropyron spicatum* Shrub-Steppe Habitat Types (Hansen, 1985). Common associated species were, in order of dominance, *Eriogonum pauciflorum, Agropyron spicatum, Sarcobatus vermiculatus,* and *Artemesia tridentata.* Astragalus barrii was found in open light conditions only. It was not found beneath the forest canopy. The density of this species would diminish as vegetative cover increased in density. It was found in vegetation structures showing 50 to 70 percent bare ground. The majority of the shading this species experienced was from its location on western exposures of the steep sided slopes which provided some early morning shading. It was growing on all slope positions except the bottom of the slope.The degree of slope varied from 0 to 50 degrees, but most commonly was 35 degrees.

The soils were of the Entisol order, Ustic Torriorthents subgroup, and the Midway and Elso soil series (Mw). Entisols are recent mineral soils that lack genetic horizons or have the beginning of such horizons. Midway and Elso soils are medium to medium-fine textured, steeply sloped, shallow soils that are low in organic matter content and fertility, are well drained, have moderate to slow permeability, and very rapid runoff. These soils are strongly calcareous and alkaline, with a pH in all horizons between 8.0 and 8.4. The Midway soils are rocky clay loams and are sticky and plastic when wet. The Elso soils are rocky silt loams and are non-sticky and non-plastic when wet. Some sandy textures are found in both soil types. All three textures are represented due to the variety of sedimentary materials that comprise the parent rock.

The parent rocks at the A. barrii site were Badlands sedimentary deposits. These were nearly level bedded, weakly consolidated soft sandstones, silty sandstones, clayey shales, and lignite beds. Where the lignite beds had burned, adjacent shale beds had been converted into porcelainite. The landform was an eroding sedimentary butte or table. The population lay along two arms of the butte that ran to the northwest. The surface stability at the A. barrii site was weak and erodability was high due to the degree of slope, poor soil structure, and the poor consolidation of the parent rocks. The dominant erosion process was sheetwash. Cattle did not appear to figure Into the erosion process in any large way as there was no evidence of significant cattle activity in the way of trampling, trails, grazing, or manure. As noted, Mule deer were in greater evidence than cattle, and would appear to be a larger factor in the erosion process than cattle.

4) Effects Prediction

Two courses of action are considered in this Effects Prediction: a) Continue livestock grazing on King Creek allotment where MTNHP site PDFABOF150.015 is located, or b) suspend livestock grazing on the long Creek allotment altogether. The following effects are predicted:

a) Continue livestock grazing

- Direct Effects: The direct effect of this action alternative would be by cattle grazing or trampling of A. barrii plants themselves. However, historical records at MTNHP site PDFABOF150.015 show no decline under grazing, and direct grazing and trampling of A. barrii plants is not commonly observed. Thus, no adverse or beneficial direct effects upon the populations of A. barrii at this site are predicted to occur under this alternative.

- Indirect Effects: The indirect effect of this action alternative would be by the alteration of critical habitat components such as associated species, vegetation structure, topography, geography, and geology through cattle grazing and trampling. However, while grazing and trampling by

animals may be factors in the creation and maintenance of A. barrii habitat, the evidence is that they are minor factors. There is no evidence that the species is actually dependent upon cattle for survival. Conversely, there is a lack of evidence that cattle grazing and trampling adversely impact A. barrii habitat to any signfflcard degree. Thus, no adverse or beneficial indirect effects upon the population of A. barrii are predicted to occur under this action aftemative.

- Cumulative Effects: The cumulative effects of this action alternative are not expected to be adverse or beneficial to the population of A. barrii found on this site. Astragalus barrii inhabits a site that presents few options for future activity and has little activity in the past, whether the activity be logging, mining, grazing, recreation, or prescribed burning.

b) Suspend livestock grazing entirely

- Direct Effects: The direct effect of this action altemative would be by the elimination of cattle grazing or trampling of A. barrii plants themselves. However, historical records at MTNHP site PDFABOF150.015 show no decline under grazing; present stocking levels seem to accommodate the species. Additionally, direct grazing and trampling of A. barrii plants is not commonly observed. Thus, elimination of all livestock grazing would not serve to eliminate a significant factor in opposition to the species. Thus, no adverse or be direct effects upon the populations of A. barrii at this site are predicted to occur under this action alternative.
- Indirect Effects: The indirect effects of this action altemative would be by the elimination of factors that may after alter critical habitat components such as associated species, vegetation structure, topography, geography, and geology. These factors would be cattle grazing and trampling. However, while grazing and trampling by animals may be, factors in the creation and maintenance of A. barrii habitat, the evidence is that they are minor factors. Thus, elimination of all livestock grazing would not halt the creation and maintenance of A. barrii habitat nor allow for significant increases in habitat not favorable to A. barrii. Conversely, there is a lack of evidence that cattle grazing and trampling adversely impact A. barrii habitat to any significant degree. Thus, elimination of all livestock grazing would not serve to eliminate a significant factor in opposition to the species. Thus, no adverse or beneficial indirect effects upon the populations of A. barrii are predicted to occur under this action alternative.,
- Cumulative Effects: The cumulative effects of this action alternative are not expected to be adverse or beneficial to the populations of A. barrii found on this site. Astragalus barrii inhabits a site that presents few options for future activity and has experienced little activity in the past, whether the activity be logging, mining, grazing, recreation, or prescribed burning.

  A word of caution: Cattle activity being a minor factor in the creation and maintenance of A. barrii habitat does imply an *increase* in stocking levels would result in a proliferation of the species. The relative lack of cattle activity is the prime reason that cattle grazing and trampling do not have adverse impacts upon populations of A. barrii. But under an increase of stocking levels there is an increased potential for adverse impacts upon A. barrii plants and habitat. Eventually, prime forage declines and less palatable forage is selected. Favored pastures are exhausted and less favored are invaded. Many of the potential effects discussed in section 2b could be realized. It is expected that a linear increase in stocking levels would eventually result in an accelerating increase in adverse impacts. This potential for adverse impacts would be even greater where the stocking levels are increased in the critical flowering and fruiting period of April through June. On the other hand, it is expected that a *decrease* in stocking levels overall or during the critical flowering and fruiting period would have no significant adverse or beneficial impact. Again, direct grazing and trampling of plants is uncommon; present stocking levels seem to accommodate the species. Thus, reduction of stocking levels would not serve to reduce a significant factor in opposition to the species. While grazing and trampling by animals may be a factor in the creation and maintenance of A. barrii habitat, it appears to be a minor factor. There is no evidence that the species is dependent upon cattle for survival. Thus, reduction of stocking levels would not reduce the creation and maintenance of A. barrii habitat nor allow for significant increases in habitat not favorable to A. barrii.

Documentation

This Biological Evaluation was prepared by David Schmoller, Biological Technician, Ashland Ranger District, Custer National Forest. Field surveys, maps, and photographs were the work of David Schmoller and Amy Schmoller, Biological Aid, Ashland Ranger District Custer National ForesL Two specimens were collected by David Schmoller.

A copy of this report was sent to the Montana Natural Heritage Program in Helena, Montana. Photographs are on file at the Ashland Ranger District. One specimen is in the Morvtana State University Herbarium, the other is in the Ashland Ranger District Herbarium. Field data forms, entitled "Plant Species of Special Concern Survey Forms" and maps are attached. ***[not included in this webversion]***

A Selected Bibliography

Barkley, T.M. (ed.). 1986. **Flora of the Great Plains.** University of Kansas Press, Manhattan, KS.

Dorn, Robert D. 1977. **Flora of the Black Hills.** Mountain West Publishing, Cheyenne, WY.

Elias, T. S. (ed.). 1987. **Conservation and Management of Rare and Endangered Plants.** California Native Plant Society, Sacramento, CA.

Hansen, Paul L. and George R. Hoffman. 1985. **An Ecological Study of the Vegetation of the Grand River/Cedar River, Sioux and Ashland Districts of the Custer National Forest: A Habitat Type Classification.** USDA Forest Setvice.

Hitchcock, C. Leo and Arthur Cronquist. 1973. **Flora of, the Pacific Northwest.** University of Washington Press, Seattle, WA.

Johnson, James R. and James T. Nichols. 1982. **Plants of South Dakota Grasslands.** South Dakota State University, Brookings, SD.

Marriott, Hollis. 1995. **Status Survey of** Astragalus barrii **on the Ashland Ranger District of the Custer National Forest.** MTNHP, Helena, MT.

Schassborger, LA. 1988. **Status Review of** Astragalus barrii**.** USDA Forest Service - Region 1, Custer National Forest, Billings, MT.

Schmoller, David. 1993. **Status Survey for** Astragalus barrii**.** USDA Forest Service - Region 2 Nebraska National Forest, Wall, SD.

Shelly, J.S. 1986. **Field Survey of Southeastern Montana**. USDA Forest Service.

USDA Forest Service. 1988. **Range Plant Handbook.** Dover Publications, Inc., New York, NY.

Van Bruggen, Theodore. 1976. **The Vascular Plants of South Dakota.** The Iowa State University Press, Ames, IA.

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