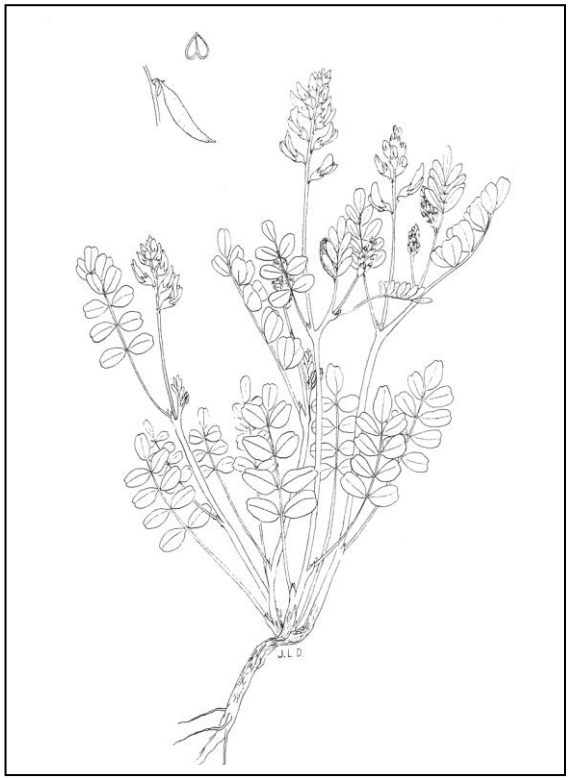
Status of *Astragalus paysonii* (Payson's milkvetch) in the Salt River and Wyoming Ranges, Bridger-Teton National Forest



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ABSTRACT

Payson's milkvetch (*Astragalus paysonii*), is designated as a Sensitive species in the U.S. Forest Service – Intermountain Region. It occurs in Salt River and Wyoming Ranges of Wyoming on the Bridger-Teton National Forest. Results of 2011-2012 fieldwork are presented to update the 1993 status report 20 years later. Persistence is documented under instances of natural disturbance, man-made disturbance and no known disturbance. However, declines or disappearances that may represent extirpation are more common than persistence and only one of the populations reported to be large (100+ plants) in 1992 remained so in 2011-12. The later was a population at a natural ecotone setting rather than a disturbance setting. There are currently six large populations (with 100+ plants), and three of the six are in man-made disturbance settings. Data needs are spelled out for agency management and conservation ranking alike.

ACKNOWLEDGEMENTS

Field surveys of Payson's milkvetch (*Astragalus paysonii*) were conducted in 2011 by Klara Varga and in 2012 with the assistance of Michael Kirkpatrick. Orval Harrison kindly revisited his 1991 collection site and took the author there for surveys. The 2011-12 surveys build on the 1993 status report reflecting surveys of Walter Fertig and Hollis Marriott (Wyoming Natural Diversity Database; WYNDD). Maps of current distribution and survey routes, printouts of survey results, and tables of species' data were constructed with the help of Victoria Pennington (WYNDD).

The project began at the initiation of Faith Ryan (Bridger-Teton National Forest; BTNF), more recently overseen by Gary Hanvey. Lara Oles provided a Geographic Information System (GIS) layer of wildfires mapped on Bridger-Teton National Forest. The interest and support of Teresa Prendusi (Intermountain Region of U.S. Forest Service), Tyler Johnson (BTNF) and all BTNF staff are acknowledged with appreciation. An earlier draft of this report was reviewed by Teresa Prendusi and comments are gratefully appreciated. This project was conducted as a challenge cost-share between the Bridger-Teton National Forest and WYNDD, under Cooperative Agreement No. 07-CS-11040300-019.

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Cover picture: *Astragalus paysonii* illustration by Jane Dorn. From: Dorn and Dorn (1980).

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Introduction

The purpose of the project was to systematically survey Payson's milkvetch (*Astragalus paysonii*), a Sensitive species in the Wyoming and Salt River Ranges, on the Big Piney, Kemmerer and parts of the Greys River Districts of the Bridger-Teton National Forest (BTNF). The Sensitive plant list of the U.S. Forest Service – Intermountain Region (U.S.D.A. Forest Service 1991, 1994) has been developed to address management needs for plant species that might qualify for listing under the Endangered Species Act in order to prevent agency actions from leading to the further endangerment and subsequent need for listing them under the Act. The 2012 work culminated recent Sensitive species and Species of Local Concern surveys (Heidel 2012), and built upon all earlier botanical work.

Astragalus paysonii was first discovered as a new species to science in the Wyoming Range, collected on the North Horse Creek in 1922 "from burned areas in forest" as recorded by Edwin and Lois Payson on the collection label. Surveys for it were conducted in 1978 as part of the first work on rare species for BTNF (Shultz and Shultz 1978) that included the first status report narrative and reported a total of three Wyoming sites, including a population made up of nine clearcuts. It was followed by an *A. paysonii* status report prepared for the U.S. Fish and Wildlife Service by Robert Dorn (1979) reporting a total of Wyoming four sites, also continued incidental to a more general floristic survey (Shultz and Shultz 1979). Surveys and collections added five more sites in the 1980s. Surveys at 19 Wyoming sites of *A. paysonii* (including revisits) were conducted in 1992 in the Salt River and Wyoming Ranges and other 1993 specimen data incorporated, documenting that it was widespread but in extremely low numbers at all but a few places, in an array of disturbed habitat most consistently on logging roads (Fertig and Marriott 1993). A total of 30 population records were reported by Fertig and Marriott (1993). Seven were subsequently documented, including the first record in the Gros Ventre Range and the first two records in the Snake River Canyon, for a total of 37 population records. The additions represented specimen collections at Rocky Mountain Herbarium, a natural areas survey (Fertig 1996), and a highway project survey by Jim Ozenberger (BTNF) on U.S. Hwy. 26/89 in the Snake River Canyon. All rare plant records including those of *A. paysonii* were later compiled in a general rare species tabulation (Fertig 1999), and Snake River Canyon populations were re-surveyed in 2007 (Mancuso and Heidel 2008). Of the 37 population records, 35 are on the BTNF and the other two are administered by the BTNF but on the Targhee National Forest.

Astragalus paysonii was targeted for inventory because it is a Sensitive species, it is almost restricted to the Wyoming-Salt River Ranges (34 of 37 records), it is seral, and it had almost no repeated surveys to provide census data or population size estimates over time. This study represents the results of re-survey at 23 of the 34 study area sites in addition to new surveys at one extensive wildfire area where populations are known from the vicinity but not in the burn perimeter. The report also presents records added since the Fertig and Marriott (1993) report. As a successional species, *A. paysonii* might be adapted to natural disturbances such as wildfire, in which case its viability hinges on fire regime or on the interchangeability of man-made disturbance for natural fire disturbance.

Study Area

The Salt River and Wyoming Ranges are in Lincoln and Sublette counties in west-central Wyoming (Figure 1). They are major landforms in the Thrust Belt, part of the North American Overthrust Belt. The stratigraphy, structural style of deformation, and geologic history of the Thrust Belt differs from other mountains in the state. The mountains of the Thrust Belt were not formed as major uplifts in Precambrian basement core. Instead, the Thrust Belt contains a thick (more than 40,000 feet) sequence of Precambrian, Paleozoic, and Mesozoic sedimentary rocks with no crystalline basement involved in the deformation. Essentially, the Belt was formed "…during an episode of mountain building called the Sevier Orogeny, from 150 to about 55 million years ago. In it, continental crust on the westward-moving North American plate collided with oceanic crust of the eastward-moving Pacific plate forcing large sheets of rock eastward, deforming and uplifting them in a series of overlapping, low-angle thrust faults, arranged much like shingles on a roof. The resulting series north-south trending landforms comprised of resistant Paleozoic rocks, mainly shallow-water marine limestone, dolomite, and fine-grained sandstone, that are the dominant structural component of all major thrust sheets (Royse 1993). These are generally thrust over less resistant Mesozoic marine shales and sandstones

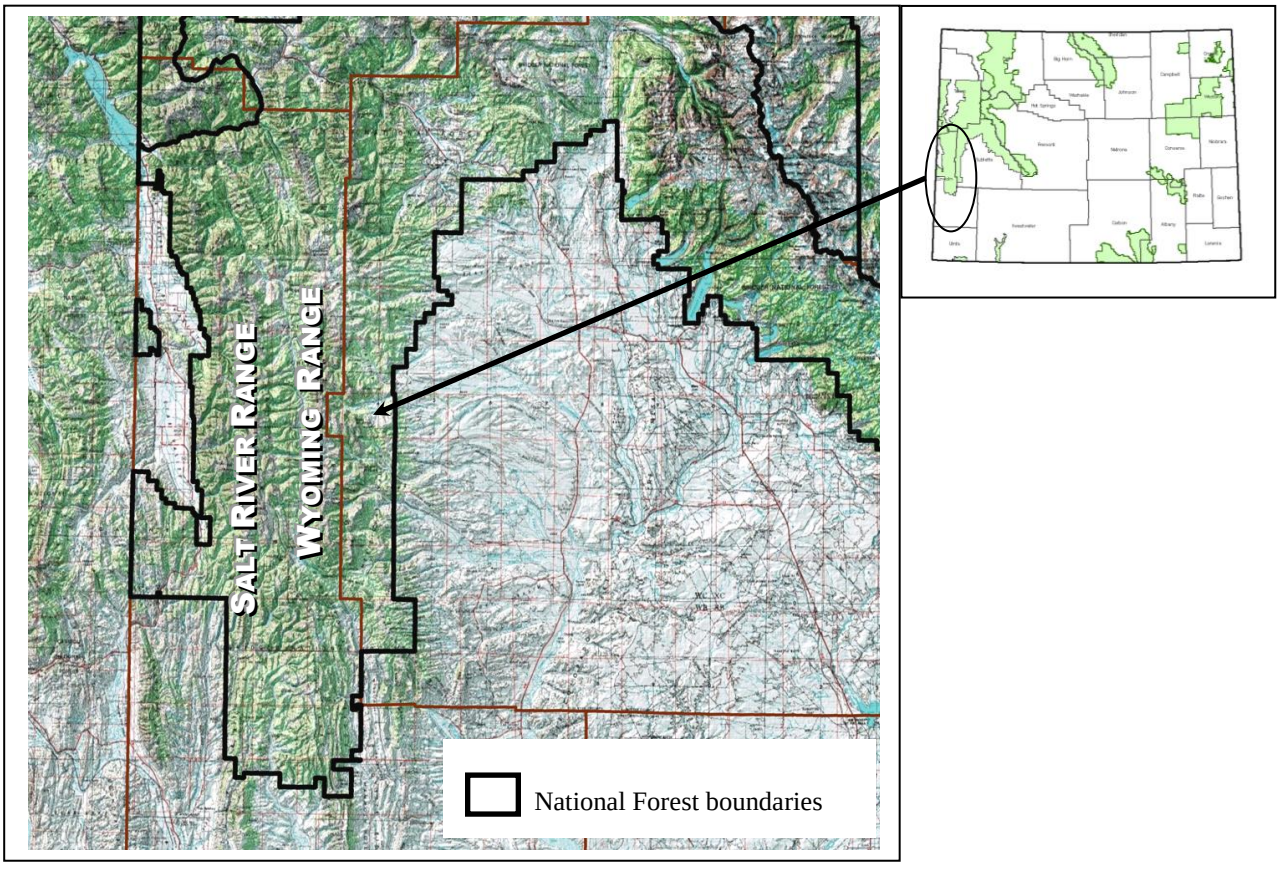


Figure 1. Study area in the Salt River and Wyoming Ranges, Bridger-Teton National Forest in west-central Wyoming

in the footwall by the thrusts (Royse 1993). The Thrust Belt is comprised of five major thrust fault systems, and the three easternmost thrust fault systems, including the Darby, Absaroka and Crawford (east to west, youngest to older) make up the Wyoming and Salt River Ranges. A geologic map of the Afton Quadrangle (1:62,500; Rubey 1973) and the bedrock geology of Wyoming (Love and Christiansen 1985) represent the geology of both ranges. The Wyoming and Salt River Ranges extend as far north as the Snake River Canyon and Hoback Canyon, respectively; though for purposes of this project, the latter was excluded.

The prevailing vegetation types are dominated by lodgepole pine (*Pinus contorta*) spanning much of the montane zone (7000-9000 ft). An overview of disturbance regimes in lodgepole pine systems of Wyoming is presented by Knight (1994). There are no studies available on fire return intervals in the study area but wildfire boundaries have been digitized by the Forest (U.S.D.A. Forest Service 2011), and major recent fires (1991-2010) cover ca. 5 % of the study area as mapped. The history of fire suppression on one hand and the current spread of bark beetles and blister rust on the other potentially alter the natural disturbance regime.

The annual hydrologic budget of lodgepole pine systems in Wyoming is strongly influenced by snowfall, as also presented by Knight (1994). The mean annual precipitation ranges from 30.5-152.5 cm (12-60 in), increasing with elevation and in moving northward. There are very steep precipitation gradients and lower values on the east side of the Wyoming Range compared to the west side of the Salt River Range. There are no National Oceanic and Atmospheric Administration (NOAA) climate stations within the ranges, but there are ten standard SNOTEL sensors with the ranges, and the nearest NOAA stations at Afton and Big Piney provide an overview of foothills conditions and east-west contrasts (Table 1; U.S.D.I. NOAA 2005). Prevailing winds are out of the west. In general, there is a rain shadow effect and the Wyoming Range has less rainfall than the Salt River Range.

Table 1. Climate conditions east and west of the Wyoming and Salt River Ranges

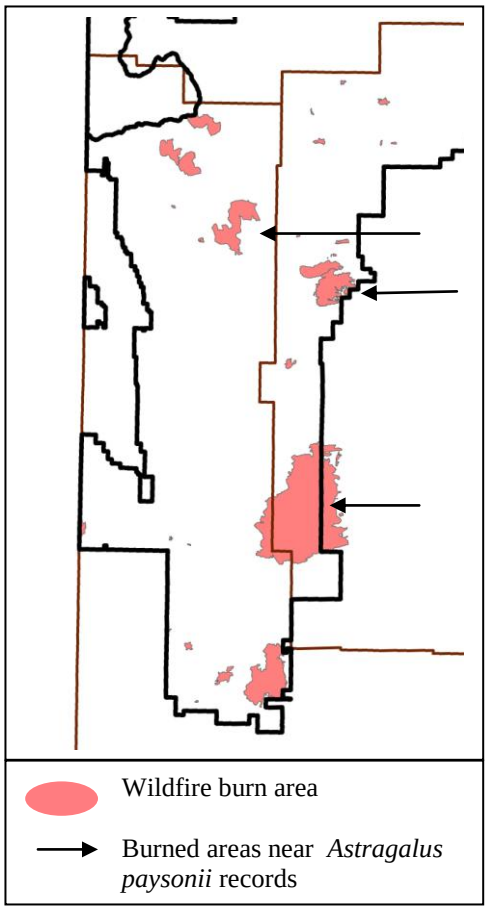
Climate variable	**Afton (1957-2005)**	**Big Piney (1948-2005)**
Mean annual precipitation cm (in)	50.5 (19.9)	19.1 (7.5)
Average total snowfall cm (in)	293.1 (115.4)	72.6 (28.6)
Mean % contribution of snowfall to total annual ppt.	94.5%	64.3%
Mean monthly temperature Cº (Fº)	3.9 (39.0)	1.7 (35.1)
January mean minimum temperature Cº (Fº)	-15.3 (4.5)	-20.7 (-5.3)
July mean maximum temperature Cº (Fº)	27.4 (81.4)	26.7 (80.0)

Methods

Surveys for Payson's milkvetch (*Astragalus paysonii*) were conducted to relocate populations documented by earlier collections or surveys. They were conducted by three botanists working independently or in tandem for a total of about 20 days in July 2011 and July - August 2012.

In 2011, surveys targeted all of the largest reported *Astragalus paysonii* populations, i.e., those having more than 100 plants (Fertig and Marriott 1993). In 2012, surveys targeted the next-largest set, those reported as having more than 10 plants, and as many of others as practical. In addition, new surveys were conducted in wildfire areas that had burned since the time of the 1992 surveys. A digital layer of wildfires on the Bridger-Teton NF since 1992 was provided by the Forest, showing six large fires including the largest of these, the Fontenelle Fire of 2012 (Figure 2). Of the large fires, three overlapped or were near known *A. paysonii* populations, all three in the Wyoming Range.

Figure 2. Wildfire boundaries on the Salt River and Wyoming Ranges, 1991-2012



In preparation for fieldwork, the known distribution of *Astragalus paysonii* was superimposed on digital orthophotographs and printed out as quarter-quads at about the same scale as U.S.G.S. topographic maps, along with other information (wildfire and geology mapping) for reference in field surveys. In the field, every effort was made to relocate the original population site using all original location information, mapping interpretations of

original location information, and habitat descriptions. In cases where there were inconsistencies between original location information (e.g., TRS and elevation) or between the original location and mapping interpretation, effort was made to consider all possible locations on the ground.

Many of the original habitat descriptions for *Astragalus paysonii* referred to linear features such as margins of roads or clearings. Thus, many of the recent surveys followed linear survey routes. In current conditions, most previous linear features were recognizable, sometimes with conditions that may have changed little and other times heavily overgrown. In the field, legumes in the same habitat were recorded. Any other rare species on the Wyoming plant species of concern list (Heidel 2012) were recorded as encountered.

After the field season, all 1992 and 2011-12 survey routes were digitized, are represented in a table, and conveyed electronically. The 1992 survey routes also included those for *Draba borealis*, which does not occupy the same habitat. All prior routes were digitized without attempt to distinguish those routes directed toward *D. borealis* vs. *Astragalus paysonii*.

Results

Astragalus paysonii survey results were almost equally split between populations that persist (10 of 34), and those that are possibly extirpated or could not be found (13 of 34) (Table 2). Eleven population records were not surveyed, representing small populations or vague collection locations. Among those populations that persist (including two outside the Wyoming-Salt River Range study area), there are six with over 100 plants, only one of which was known to have numbers of similar magnitude in 1992 and the other five had no prior census or estimates. Three of the six are in man-made disturbance (logging, campground, utility corridor), two are in natural disturbance (wildfire), and the one with high numbers persists at an ecotone.

Six *Astragalus paysonii* populations are considered extirpated (five in the Wyoming – Salt River Range study area), in cases where the original site was relocated with certainty or else all potential habitat in the area was covered with certainty and the species was not found. We failed to find seven additional populations that were searched throughout the given section(s), but there was some element of uncertainty about the original location or whether all potential habitat was covered.

Of the surveyed *Astragalus paysonii* populations, four were in or near wildfires that burned in 2012, without relocating any populations. Two populations were relocated in areas where wildfires had recently burned between 1991-2010. Only one had a large population size, in the Horse Creek/Mule Fires. An additional area of recently burned landscape was surveyed with no known populations, and no new populations were found in it.

Astragalus paysonii survey results are presented in Table 2, detailed with printouts of all population records in Appendix B, summarized a population data table (Appendix C), and highlighted in the *Astragalus paysonii* State Species Abstract (Appendix D).

Table 2. Overview of *Astragalus paysonii* survey results (2011-12)

No.	Place	First Visit	Last Visit	Setting	2011-12 Status
001	Darby Cr	1978	2011	Clearcut/burned/2012 wildfire	Extant; one order of magnitude decline.
002	Edwards Cr	1979	2011	Clearcut/burned/road	Extant; two orders of magnitude decline.
003	Middle Fk Cr	1978	1978	Forest edge	Unknown; vague location.
004	N Horse, Pass Cr	1922	2011	Repeated wildfires, including recent	Extant. Rebounding or persisting in high numbers. Type locality.
005	Clear Cr	1980	2012	Clearcut	Failed to find. Vague location.
006	Thompson Pass	1980	2012	Clearcut; 2012 wildfire	Possibly extirpated.
007	Coal Cr	1980	2012	Clearcut; 2012 wildfire	Failed to find.
008	Bailey Cr	1979	2011	Wildfire	Extant. Persisting in low numbers.
009	Murphy Lks	1992	2012	Logging road	Possibly extirpated.
010	Waterdog Lk	1979	2011	Forest edge	Extant. Persisting in high numbers, absent from old locations but present in new locations.
011	Bailey Lk	1979	1992	Trailside disturbance	Unknown.
012	Smith Fk Rd	1986	1986	Roadside?	Unknown.
013	Bear Cr	1982	2012	Logging road	Failed to find.
014	Blind Bull Cr	1992	2012	Logging road; recent wildfier	Possibly extirpated.
015	S 3 Fks Cr	1992	2012	Roadcut	Possibly extirpated.
016	Prospect Canyon	1992	2012	Forest interior? roadbank?; 2012 wildfire	Possibly extirpated.
017	Dutch Dans Gulch Rd	1992	1992	Clearcut, young lodgepole stand	Unknown.
018	Irene Cr	1992	2012	Logging road	Extant; one order of magnitude decline.
019	Maki Cr	1992	1992	Wildfire, timber salvage	Unknown.
020	Nugent Park Rd	1992	1992	Wildfire	Unknown.
021	Corral Cr	1992	2012	Clearcut/burned	Failed to find
022	Box Canyon Cr	1992	2012	Clearcut/burned	Failed to find
023	Scaler Gd Stn	1992	1992	Roadcut near clearcut	Unknown.
024	S Beaver Cr	1992	2011	Roadcut	Failed to find at old location, but present in new nearby location.
025	Deadman Mtn Trail	1989	2011	Logging road	Failed to find. Vague location.
026	Deadman Mtn Trail	1992	1992	Forest trail	Unknown. Vague location.
027	The Rim	1992	2012	Utility corridor, logging road	Extant. The most recent data show high numbers.
028	Stump Lk	1992	2012	Forest interior? Forest edge?	Failed to find.
029	Clark Draw	1992	2012	Forest edge	Failed to find.
030	Buck Ridge	1991	2012	Logging road	Extant. The most recent data show high numbers.
031	Tunp	1993	1993	Logged areas	Unknown; vague location.
032	Commissary Ridge	1993	1993	Natural openings?	Unknown; vague location.
033	Little Granite Cr	1994	2003	Wildfire	Extant. The most recent data show high numbers.
034	Big Fall Cr	1995	2012	Clearcut; logging road	Extant. Persisting in fair numbers.
035	US Hwy 26/89	1995	2007	Old campground, hwy corridor	Extant. Persisting in high numbers.
036	US Wy 26/89	1995	2007	Hwy corridor	Possibly extirpated
037	Cliff Cr	1977	1977	Unknown	Unknown. Vague location.

PAYSON'S MILKVETCH
Astragalus paysonii (Rydb.) Barneby

Classification
Scientific name: *Astragalus paysonii* (Rydb.) Barneby
First described as *Hamosa paysonii* by Rydberg (1927) and transferred to the *Astragalus* genus by Barneby (1944).
Synonyms: none
Common name: Payson's milkvetch
Family: Fabaceae
Size of genus: There are 62 species of *Astragalus* reported for Wyoming in Dorn (2001), not including distinctions at the variety level. The *Astragalus* genus is comprised of 375 species (Barneby 1964) plus at least 20 more recent additions (Isely 1998). This does not include taxa below the species level.
Phylogenetic relationships: A member of sect. Miselli (Barneby 1964), most closely related to *A. umbraticus* of California and Oregon.

Present legal or other formal status
U.S. Fish & Wildlife Service: None (Formerly 3C)
U.S. Forest Service – Intermountain Region: sensitive. It was first designated by the Intermountain Region in 1988 (U.S.D.A. Forest Service 1991).
Global Heritage rank: G3
State Legal status: none
State Heritage rank: The more recent list update (Heidel 2012) reported a state rank of S2 based on a median between conservative and liberal estimates of extant population numbers.
Wyoming contribution rank: Conservation of Payson's milkvetch as a regional endemic in a core part of its distribution is High.

Description
Technical description: Payson's milkvetch is an upright, few- to multi-stemmed perennial herb growing to 50 cm tall. Stem leaves are 4-9 cm long and pinnately compound with 7-15 oval to wedge-shaped leaflets. Stipules are free to the base. The small, pea-like flowers are white sometimes with a tinge of lilac or else just on the veins. They are borne in numerous, loose, axillary racemes. Fruit pods are crescent-shaped, 10-17 mm long, and glabrous or white-hairy. Each fruit has a distinct groove on the upper side and has two separate locules. At maturity, fruits are straw-colored or brownish and deflexed (Hitchcock and Cronquist 1961, Dorn 1979, Clark and Dorn 1981, Dorn and Dorn 1980, Dorn 2001, U.S.D.A. Forest Service 1991, Fertig and Marriott 1993, Fertig et al. 1994; Figures 3-9).

Similar species: *Astragalus miser* var. *hylophilus* has a single-cell pod and connate stipules. *A. agrestis* has a congested inflorescence and ascending fruits. *A. canadensis* has cream or pale yellow flowers, a congested inflorescence, and erect fruits. *A. alpinus* has black-haired fruit and fused stipules. In the absence of fruits or flowers, *Hedysarum* spp. can be distinguished by their united stipules and conspicuously veiny leaflets (Dorn 2001; Fertig and Marriott 1993; Fertig et al. 1994, Heidel 2013).

Local field characteristics: *Astragalus paysonii* can be discerned by a combination of traits that include thin textured leaflets often with notched tips, white flowers and black hairs on the calyx, and crescent-shaped pendulous pods on slender stipes (Shultz and Shultz 1978, Dorn 1979). The pods are almost flat-sided, even though they are triquetrous in cross-section.

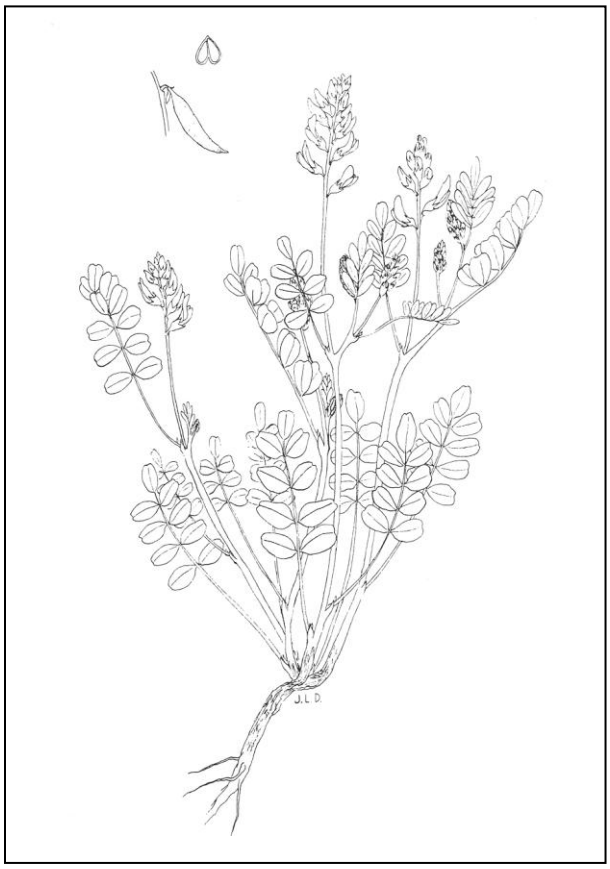


Figure 3. *Astragalus paysonii*, illustration by Jane Dorn, from Dorn & Dorn (1980)

Figure 4: *Astragalus paysonii* in flower, by B. Heidel

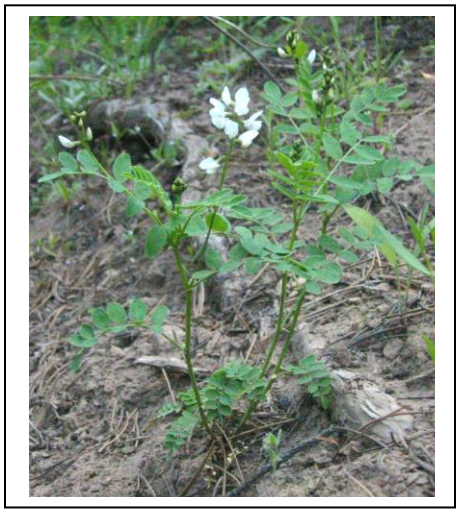


Figure 5. (right) *Astragalus paysonii* in flower, by K. Varga

Figure 6. (below) *Astragalus paysonii* in flower and fruit, by B. Heidel

Figure 7. (above) *Astragalus paysonii* flowers may have a tinge of lilac. By M. Kirkpatrick.
Figure 8 (right). Some small populations of *Astragalus paysonii* had only vegetative plants. By B. Heidel

Figure 9. Occasionally, individual plants of *Astragalus paysonii* are almost bush-like. By B. Heidel.

Phenology: Flowers from late June to early August. Fruits produced from July-October. The plant is most readily located when in flower. Fruits sometimes fall to the ground when they dry out and plants sometimes completely desiccate in the latter part of the growing season, turning brown and brittle.

The phenology of *Astragalus paysonii* varies with setting and climate. In 2011, a particularly wet year, only flowering plants were found during the first half of July. Most were in bud except plants in the North Horse Creek population, a wildfire site. By comparison, in 2007, all plants in a Snake River Canyon population had finished fruiting and were senescing during the first week of July (Mancuso and Heidel 2008). Even though 2012 seemed like a particularly dry year, many plants were found in both fruiting and flowering from the second week of July into the fourth week of August. A review of specimens at the Rocky Mountain Herbarium suggests that the indeterminate flowering is very opportunistic such that healthy plants in late July may have 8 inflorescences at staggered phenological stages, and with 4-6

more inflorescences in different immature bud stage (e.g., *Fertig 13201*). In addition, different stems of the same plant and different plants of the same population may be in very different stages of phenology. This flowering opportunism may be adaptive in a variable environment.

Geographical distribution

Range: *Astragalus paysonii* is a regional endemic of the Clearwater Mountains of north-central Idaho, historically from the Palisades Reservoir area of east-central Idaho, and from western Wyoming, including the Wyoming and Salt River ranges, and the adjoining Gros Ventre ranges (Lincoln, Teton, and Sublette counties; Barneby 1964, Rocky Mountain Herbarium 2011).

The Salt River and the Wyoming Ranges harbor 34 of 37 *Astragalus paysonii* populations in Wyoming (Figure 10). Its discovery on the Gros Ventre Range was made in 1994, where it was found along Little Granite Creek. It might also be considered as extending to the Snake River Range because it is known from the Snake River corridor, where it was recently surveyed in 2007. There it appears to be completely restricted to roadsides and other zones of human disturbance. It may have been an upstream extension of the historic population records around the Palisades Reservoir area of Idaho. There has been limited more recent work on the species in Idaho since the Lorain (1990) study. Idaho currently has three records that pre-date 1970 and 21 that are more recent (Idaho Natural Heritage Program 2008, Kinter personal communication).

All known Wyoming populations of *Astragalus paysonii* are on the Bridger-Teton National Forest, except for those that are located in a unit of the Targhee National Forest that is under management of Bridger-Teton National Forest, or extend into the federal highway corridor of U.S. Hwy. 26/89 in the Snake River Canyon. One population is protected within the proposed Fall Creek Special Botanical Area (Bridger-Teton NF). All other population records are on National Forest lands managed for multiple use. In Idaho, Payson's milkvetch has been documented from Nez Perce National Forest (Idaho Co.), Challis National Forest (Custer Co.) and Targhee National Forest (Bonneville Co.) as well as lands managed by the Couer d'Alene District of the BLM and the state (Lorain 1990; Idaho Natural Heritage Program 2008). The Clearwater National Forest has most records and is in Region 1 of the U.S. Forest Service whereas Challis and Targhee National Forests are in Region 4 of the U.S. Forest Service.

Extant sites: *Astragalus paysonii* is now known from 31 records in Wyoming documented since 1970 (Figure 10, Table 2), excluding six that appear to be extirpated. This successional species may be prone to local extirpation where present in low numbers, and 11 of the 30 populations have not been surveyed since the 1990's, and originally had low numbers or no estimate of numbers when originally documented. If the 2012 survey results are any indication, it is likely that the majority of these 11 are no longer extant. It is likely they have low viability, but not certain without more information about the seed bank and lifespan.

Of the two *Astragalus paysonii* population records on the Targhee National Forest in Wyoming, one is a large population estimated over 200 plants in right-of-way and abandoned

campground, while the other was a small population in an area that has since had recontouring and it is considered extirpated (Mancuso and Heidel 2008).

In 2011, surveys targeted six of the largest *Astragalus paysonii* population records and one historic record. Two of the six could not be relocated and may be extirpated, but the historic record was relocated. In 2012, surveys targeted 16 more population records. Only four were relocated, five could not be relocated and are probably extirpated, and seven were not relocated but ambiguity in the original location information left room to question whether or not they are extirpated. This leaves the status of eleven population records unknown.

Historical sites: Prior to 2011, there was one record (#004) of *Astragalus paysonii* known only from a historical collection, representing the 1922 discovery and type locality collected by Edwin and Lois Payson. The location was described as North Horse Creek, about 7 miles west of Merna. The setting was described as "burned areas in forest" as recorded on the collection label. The first attempt to search for it was made in 1978 by John and Leila Shultz, who reported:

> "In searching for the very place where Payson collected *Astragalus paysonii* in 1922, we were guided by the type description itself. Early on we realized that the road crossing of North Horse Creek had been changed and in fact the fill for the new road might possibly have over-covered the exact site. However, we were able to find the traces of the old road as it approached the river. Following the type description and focusing on the granitic soil and burned site description, we devoted three days to searching the general area but with no success. We concluded with considerable confidence that this locality was no longer a site for *Astragalus paysonii*" (Shultz and Shultz 1978).

In 2011, a GIS layer mapping of recent wildfires (1991-2010; U.S.D.A. Forest Service 2011) was provided by the Forest and it was determined that part of the North Horse Creek landscape had burned (Mule Fire of 2003 and Horse Creek Fire of 2007). The area was therefore included among those targeted for 2011 survey, where *Astragalus paysonii* was successfully documented at scattered North Horse Creek drainage locations within areas that had recently burned. The information from the 1978 and 2011 surveys suggest that *A. paysonii* has a seed bank that can revive the local population under fire disturbance.

Unverified/Undocumented reports: None known.

Sites where present status not known: There are 11 *Astragalus paysonii* population records in Wyoming that have not been visited since 1992 to know whether they persist.

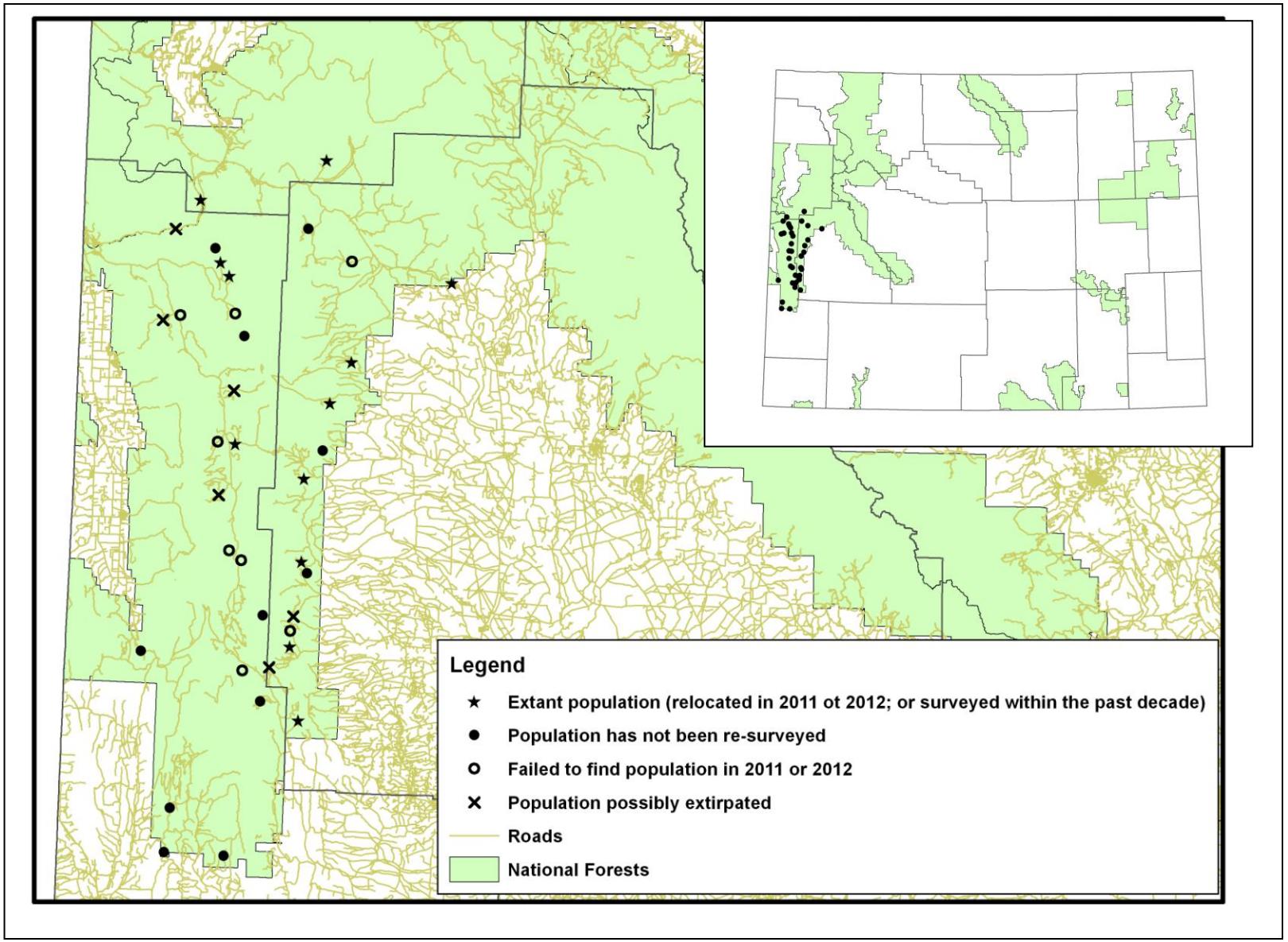
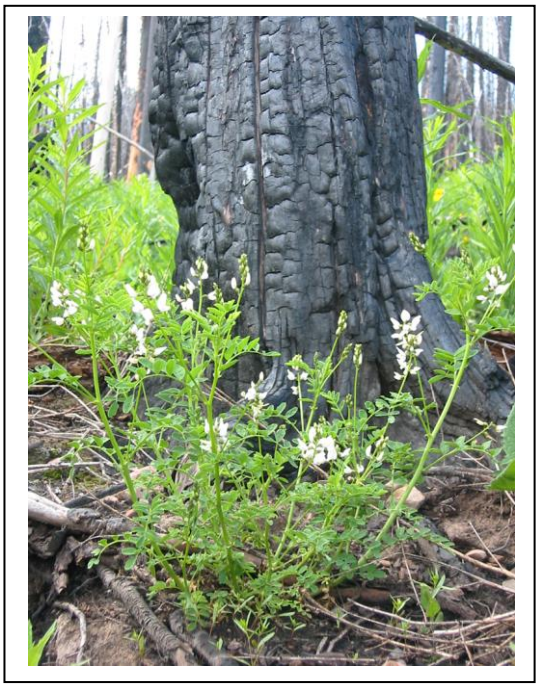


Figure 10. Distribution of Payson's milkvetch (*Astragalus paysonii*) in Wyoming

Habitat

Settings and associated vegetation: *Astragalus paysonii* occurs primarily in disturbed areas such as recovering burns, clear cuts, road cuts, and blow downs. Usually found on sandy soils with low cover of forbs and grasses. Elevation 5850-9600 feet (Fertig and Marriott 1993, Mancuso and Heidel 2008).

Astragalus paysonii may be a nitrogen-fixer in burned over communities (Clark and Dorn 1981). Most of the past Wyoming surveys for this species have focused on man-made disturbance (Shultz and Shultz 1978, Dorn 1979, Fertig and Marriott 1993). All Idaho surveys for this species found it only in man-made disturbance (Lorain 1990). More recently in Wyoming, a 2003 collection record and the 2011-12 surveys provide evidence of three major populations under natural conditions that include wildfire (Figures 11 and 12) and natural ecotones.



Figures 11-12. Wildfire habitat of *Astragalus paysonii* on North Horse Creek, by K. Varga

Figure 13. Clearcut habitat of *Astragalus paysonii*, by Jane & Robert Dorn, from Fertig et al. (1994)

Note: *Astragalus paysonii* plants in dense patches in foreground

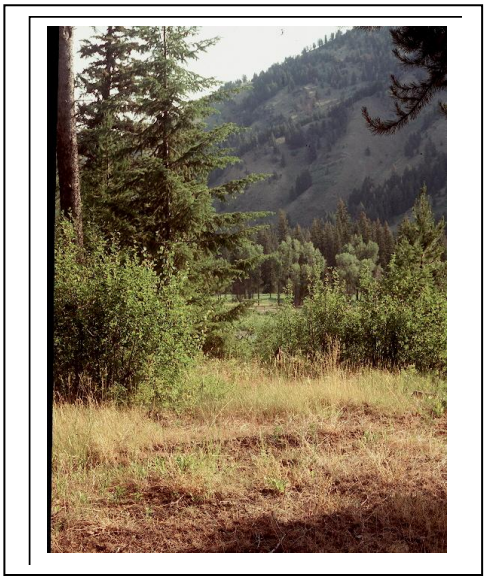
Figure 14. *Astragalus paysonii* is not found in dense *Calamagrostis* cover of lodgepole pine stands, except at roadsides. By B. Heidel.

Figure 15. Sandy or gravel loams and sparse recolonization are evident at most roadcut sites. By M. Kirkpatrick.

Figure 16. A roadcut with occasional ORV traffic harbors one of the six large extant populations. By B. Heidel.

Figure 17. A seeded utility corridor harbors one of the six large extant populations. By B. Heidel.

Figure 18 (right). Sandy opening in abandoned campground on Snake River. By B. Heidel



Astragalus paysonii is also found where man-made disturbances simulate natural disturbance in reducing competition and soil duff, as seen in clearcut logging followed by broadcast burning (Figure 13), the edges of roadcuts or utility corridors (Figures 14-17), and similar settings (Figure 18).

Geology of *Astragalus paysonii* habitats vary widely within the study area. Soils generally have coarse sediment, often sandy, but were earlier described as silty and ashy (Dorn 1979). They appear to derive from the following mapping units as parent materials:

- Ankareh Formation, Thaynes Limestone, Woodside Shale and Dinwoody Formation
- Aspen Shale Formation
- Blind Bull Formation
- Gannet Group
- Nugget sandstone, Chugwater and Dinwoody Formations
- Stump Formation, Preuss Sandstone or redbeds, and Twin Creek Limestone
- Wasatch Formation
- Quaternary deposits including: Glacial; Gravel pediment and fan; and Landslide deposits.

Without precise location information, some of these geological units remain to be confirmed, but they collectively represent large segments of the landscape. Available data indicate that its distribution is not limited by specialized substrate requirements.

Frequently associated species: Common associates of *Astragalus paysonii* are reported in Table 3, as cited in three studies that represent different times and places of survey. It is usually associated with lodgepole pine (*Pinus contorta*), sometimes with other trees, and appears to be associated more closely with environmental conditions than with a consistent guild of other species.

Table 3. Plants associated with Payson's milkvetch (*Astragalus paysonii*) in Wyoming

Scientific name	**Common name**	**Exotic/ Native**	**Reported in 2011 -2012**	**Reported in 1992**	**Reported in 1978 -1979**
Achillea millefolium	Common yarrow	Native	X	X	X
Antennaria microphylla	Littleleaf pussytoes	Native	X		
Arnica cordifolia	Heartleaf arnica	Native	X		
Arnica parryi	Parry's arnica	Native	X		
Astragalus agrestis	Purple milkvetch [Field milkvetch]	Native			
Astragalus miser var. *hylophilus*	Timber milkvetch	Native			
Bromus inermis	Smooth brome	Exotic		X	X ~*B. anomalus*
Bromus carinatus	Large mountain brome [California brome]	Native			X
Calamagrostis rubescens	Pinegrass [Pine reedgrass]	Native	X		

Carduus nutans	Musk thistle	Exotic	X	X	
Ceanothus velutinus	New Jersey tea	Native	X		
Chenopodium spp.	Goosefoot	Native			X
Cirsium arvense	Canada thistle	Exotic	X	X	X
Cirsium foliosum	Elk thistle	Native			X
Cirsium vulgare	Bull thistle	Exotic			X
Collinsia parviflora	Blue-eyed Mary	Native	X		
Epilobium angustifolium	Fireweed	Native	X		
Eriophllyum lanatum	Common woolly sunflower	Native	X		
Fragaria virginiana	Strawberry	Native	X		
Gayophytum spp.	Ground smoke	Native			X
Geranium richardsonii	Richardson's geranium	Native	X		
Geranium viscossisum	Sticky geranium	Native	X		X
Hedysarum occidentale	Western sweet-vetch	Native		X	
Iliamna rivularis	Streambank globemallow	Native	X	X	
Koeleria macrantha	Junegrass	Native			X
Lupinus argenteus	Silver-stem lupine	Native	X	X	X ~ *L. caudatus*
Mahonia repens	Oregon grape	Native			X
Monarda pectinata	Plains beebalm	Native			X
Poa compressa	Flat-stem bluegrass [Canada bluegrass]	Exotic	X		
Poa pratensis	Kentucky bluegrass	Exotic			X
Senecio eremophilus	Desert ragwort	Native			X
Senecio integerrimus	Western groundsel [Lamb-tongue ragwort]	Native			X
Solidago multiradiata	Rocky Mountain goldenrod	Native	X		
Symphyotrichum ascendens	Western aster	Native	X		
Taraxacum officinale	Common dandelion	Exotic	X		X
Thalictrum fendleri	Fendler's meadow-rue	Native		X	
Trifolium gymnocarpon	Hollyleaf clover	Native		X	
Trisetum spicatum	Narrow false oat [Spike trisetum]	Native		X	
Vaccinium scoparium	Grouseberry [Grouse whortleberry]	Native	X		

One of the 2012 settings where *Astragalus paysonii* was found had almost entirely native species that had been seeded rather than present under natural conditions, a corridor planting made up of bluebunch wheatgrass (*Elymus spicatus*) and wild flax (*Linum lewisii*). It tends to be negatively-correlated with woody milkvetch (*Astragalus miser* var. *hylophilus*), another legume adapted to disturbed sites in the Wyoming/Salt River ranges (Shultz and Shultz 1978). It has very similar superficial appearance, and has been characterized as a more successful competitor, particularly in open canopy sites (Fertig and Marriott 1993). It is also negatively correlated with purple milkvetch (*A. agrestis*), though the latter species tends to be in more mesic settings compared to *A. paysonii*. It overlaps in places with another legume, western sweet-vetch (*Hedysarum occidentale*), which is likewise more widespread than *A. paysonii*. It tends to be negatively associated with pinegrass (*Calamagrostis rubescens*), which can develop nearly 100% cover as an understory dominant in some lodgepole pine stands, but also grows in association with it at forest edges and roadcuts (Figure 14). Despite

the predilection for disturbed habitat, the only noxious weeds noted in occupied habitat were Canada thistle (*Cirsium arvense*) and musk thistle (*Carduus nutans*), present at least at Darby Creek and North Horse Creek populations, respectively.

It is beyond the scope of this study to compare *Astragalus paysonii* habitat in the two states, but Idaho populations are at a much lower, narrower range of elevation from 4600-5800 ft. The Idaho habitat is also mainly seral lodgepole pine stands, but the climax community is that of grand fir (*Abies grandis*) sometimes with beargrass (*Xerophyllum tenax*), species that are absent or highly uncommon in Wyoming. There are other major associated species differences.

Topography: Found mainly on gentle to moderate, well-drained slopes and benches. These gentle slopes are found in a range of topographic positions, often at low and midslope positions, but also documented from a ridge top setting (Figure 16). It appears that stable, well-drained soils and fire regime may be more important than the topographic position, though at any given locale it is present at just a narrow segment of the topographic profile.

Water and soil relationships: On North Horse Creek, which was the largest population surveyed in 2011, it was noted as almost always present in microhabitats where the ground was very bare and there were uncompacted mineral soils without duff. However, it is not consistently found where there is bare ground, and may be present at only 5% of the places with apparently suitable substrate. The soils are often sandy, derived from a variety of bedrock and deposits (discussed in the prior description of Geology). On Buck Ridge, the largest population surveyed in 2012, it was almost restricted to roadside edge, usually but not completely where it had originally been bladed, likewise reflecting a preference for uncompacted mineral soils.

Population biology

Population size and condition: Most populations of *Astragalus paysonii* are extremely small and restricted in area, often with fewer than 20 plants in much less than an acre of habitat. Up until 1993, only four Wyoming population records have ever been reported as containing over 100 plants (Appendix C; Fertig and Marriott 1993). As of 2012, there are six populations containing over 100 plants, including one of the original populations that had over 100 plants, and five other populations. In 1993, tallies of the most recent numbers would have been approximately 3660-3700. In 2013, tallies of just 2011-2012 surveys or estimates from within the decade total 2500-3200. This does not include the 11 population records that have not been visited in the past decade.

Trends: The earliest status reports on *Astraglus paysonii* presented conflicting hypotheses. Dorn (1980) hypothesized that this species disappears after about three years following a disturbance. Shultz and Shultz (1978) hypothesized that it peaks in numbers at or over 15 years following disturbance, not appearing until some years after the disturbance event, basing their inference on species' numbers and density in different ages of clearcuts. The reported that plants were most numerous in cuts that were more than 15 years old and which had semi-open canopies with exposed sand or mineral soils. Populations were progressively smaller in younger cuts with open canopies and in older cuts with dense growth of grasses or herbs. The only trend data after fire was reported at one small population discovered in 1992

just one or two years after the area burned (Fertig and Marriott 1993). In any case, the longevity and median lifespan of the species are unknown, but it is generally considered to be short-lived perennial. Life history information is needed for context and monitoring data are needed to evaluate trends.

Historically, this species is probably in decline due to fire suppression in western national forests (Fertig and Marriott 1993). Most populations are very small and probably are unable to persist over long periods of time without some form of disturbance. In 1992, the plants were found to thrive best in human-disturbed sites, such as road cuts and recovering clear-cuts. According to Shultz and Shultz (1978), the age of clear-cut appears to influence population size and density.

At present, *Astragalus paysonii* is known from 37 occurrences in Wyoming, including at least 12 extant, 7 that could not be relocated, and 7 that may be extirpated.. It appears that at least 32% of populations persisted in 2011-12 among those present in 1992 (Appendix C; 12 extant of 37, including two outside the study area). While we did not survey 31% of all populations, they are the smallest populations or the ones with unknown original numbers.

In Idaho, Lorain (1990) reported that all extant populations had small sizes of 10 plants or fewer. Since that time, one additional population surveyed by Nez Perce National Forest staff has been documented as having population size of 423 plants (Idaho Natural Heritage Program 2008).

Table 4. *Astragalus paysonii* population data by habitat conditions (1992 to 2011-12)*

Right: Habitat condition (1992 or earlier) Below: Survey results (2011-12)	**Man-made Disturbance**	**Natural Disturbance**	**Ecotone**	**Undisturbed?**	**Unknown**	**Total**	**%**
Extant	8 (3)	3 (2)	1 (1)			12(6)	
Failed to find	5		2			7	
Possibly extirpated	6					6	
Not surveyed	6	2	1	1	1	11	
Total	25	5	4	1	1	36	

*Includes the three populations outside the study area. Numbers in parentheses represent those populations with over 100 plants

The 2011-12 surveys provide evidence that the species' persistence is not entirely dependent on human-disturbance, but that it also thrives in recent wildfires and in heterogeneous landscapes with openings (Table 4). Of the four populations that have ever been documented as large (over 100 plants), all were relocated. However, three of the four had declined in population size by one or two orders of magnitude. This included the Darby Mountain area population (#001) where the species was reported as "the most abundant species in new clearcut, rapidly decreasing with time" (Shultz and Shultz 1978), later reported as having 187 plants in three locations (Fertig and Marriott 1993), but only 12 plants in 2011 despite recent new logging in the area. The one large population that had not declined was in the Waterdog Lake area (#010), where portions of the population had disappeared, but population boundaries were expanded with the expanded scope of survey in 2011.

Among the most significant information added by 2011-12 surveys are that the species was discovered in a population of over 1000 plants where previously noted as "abundant" in 1991, and discovered in a population of over 250 plants in the area of the type locality on North Horse Creek (last observed in 1922), despite the apparent absence of the species in 1978 surveys (Shultz and Shultz 1978). Results from the 23 surveys of 2011-12 support the hypothesis that the species declines with succession but are maintained by repeated natural disturbance (wildfire at Horse Creek) and by ongoing human disturbance (possibly including ongoing traffic on the logging road after logging at Buck Ridge). The North Horse Creek rediscovery also suggests that the species has a seed bank that persists between disturbance cycles.

Of the *Astragalus paysonii* populations burned in recent decades, surveys at the Blind Trail Fire were unsuccessful and it is possible that the occupied habitat did not burn. Brief visit was made to the Fontenelle Fire that burned earlier in the summer, and may have burned parts or all of three populations, but the only *Astragalus* species that were found emerging from the ashes were *A. miser* var. *hylophilus*. The most likely explanations are that occupied habitat did not burn, or that there is a lag time for the species to become established.

There have been occasional observations of herbivory, including reports of heavy herbivory on 5 out of 29 plants in the Murphy Lake population in 1992, and many plants with grazed tops observed in a small population estimated to be 30-40 in the Blind Bull population (Fertig and Marriott 1993). This pattern of grazing might have more to do with concentrated stock or wildlife travel along roadside settings and indiscriminate grazing than an indication of palatability or forage value.

There has not been work done on the pollination biology of *Astragalus paysonii*, but pollinators have been described as including at least five species of bees (Dorn 1979). It has been noted in Idaho that *Astragalus paysonii* appears to be a poor fruit/seed producer, with less than half of the flowers producing fruit pods (Lorain 1990). This was not noted in 2011-12 surveys, and examination of specimens at Rocky Mountain Herbarium did not show consistently low ratios of fruits/inflorescence vs. flowers/inflorescence. It is possible that the low elevation Idaho sites and possibly the low elevation Wyoming sites on the Snake River Canyon are pollinator-limited.

Previous notes on prevalence of chlorotic plants at the Waterdog Lake population (Fertig and Marriott 1993) were described as possibly showing drought stress, rather than disease. Leaf miner insect activity was noted in the Buck Ridge population in 2012, but at very low levels.

The mechanisms for seed dispersal are unknown. The fact that many populations of *Astragalus paysonii* are restricted to roadcuts has been interpreted to mean that it is a poor competitor. However, this might also reflect the dispersal vector if, for example, seeds of *A. paysonii* passed through the digestive tracts of wildlife that use roadcuts and natural forest edges. The fact that its small populations are unpredictably distributed, e.g., a single small segment having no microhabitat differences from other segments, or repeated segments having limited consistency in microhabitats, may also be a function of dispersal.

Information on species life history is not known, including maximum life span and mean life expectancy. It is not known how long a plant can persist in a vegetative condition (Figure 8). The larger populations surveyed in 2011-12 generally had individuals with a range of stature, e.g., multiple stems as well as single stems, and both tall and short heights. This might indicate a mixed age population structure (e.g., Figure 9 is an example of a robust plant).

Threats

Astragalus paysonii is threatened by succession in the absence of periodic or ongoing disturbances to create suitable habitat for seedling establishment, as first proposed by Shultz and Shultz (1978) and Dorn (1979). It has been speculated that forest succession associated with years of fire suppression contributed to the extirpation of several population records in north-central Idaho (Lorain 1990). Fertig and Marriott (1993) echo this in noting:

> "Fires suppression may have eliminated an important natural source of disturbance, but this loss has probably been offset by a recent increase in road construction and clear cutting. These land use practices do not appear to conflict with the survival of this species, and may in fact be an important management tool."

However, man-made disturbances are not interchangeable if they redirect succession outside of the range of variability. Fertig and Marriott discuss the latter in saying:

> "Invasion of habitat by weedy species and the effects of subsequent weed control measures are significant potential threats. Weeds such as smooth brome (*Bromus inermis*), orchardgrass (*Dactylis glomerata*), musk thistle (*Carduus nutans*), and Canada thistle (*Cirsium arvense*) can out-complete *Astragalus paysonii* in clearcuts and roadsides. Spraying with herbicides, however, could result in increased mortality of *A. paysonii*. Development of biological or other alternative methods of weed control is desirable in known habitat."

Noxious weeds are present in the vicinity of at least two populations, and on Horse Creek, they were noted as present on lower, flatter areas where cattle use is high. Noxious weeds may also spread along the same corridors that mark habitat for *Astragalus paysonii*. Weed invasion has the potential to become a more serious threat over time.

The 2011-12 surveys support the hypothesis that wildfire can continue to play a role in the species' distribution. Furthermore, it is possible, but not proven, that increased levels of bark beetle and blister rust infestations can also play a role in the species' distribution by opening up the canopy. But there are several management issues associated with wildfire, pests and pathogens. Salvage logging, allotment management changes, spread of noxious weeds and ensuing control, and soil stabilization work including seeding or replanting may all arise in the wake of wildfire. *Astragalus paysonii* is generally restricted to exposed mineral soil and is likely a nitrogen-fixer in its early seral habitats (Clark and Dorn 1981). The specific form of disturbance may not be as important as the magnitude of vegetation shift and competition that results among native or non-native plants.

Summary and Recommendations

The 2011-12 *Astragalus paysonii* survey results offer more trend data for this species than ever before available, building on the census and estimates made in the 1990's. The results are mixed. Most populations that could be relocated showed decline. Major decline was documented in 2011 for two of the four populations that had ever been reported as having over 100 plants. At least six and possibly as many as 13 populations are extirpated.

However, persistence or reappearance of *Astragalus paysonii* was documented in relocating it in the vicinity of the 1922 type locality where it could not be found in 1978. Apparently, it had either persisted undetected or else persisted in the seed bank until the Horse Creek fire of 2007, as determined in 2011 surveys. The total number of populations with over 100 plants has increased, though five were populations that did not have any earlier estimates. The high points among 2012 surveys were finding it in high numbers at two sites that had no prior population estimates, at Buck Ridge and The Rim. While population numbers declined overall, the addition of counts for populations in 2011 and 2012, especially ones that did not have prior counts, suggest that original estimates were low and that total numbers, while down, have not plummeted.

Astragalus paysonii is an ideal candidate for a Conservation Strategy because it seems to require or be dependent on active habitat management to prevent decline or extirpation. This was initially proposed by Lorain who referred to a Conservation Strategy as a "species management guide" (1990). If this is not a joint interest of Region 1, if the habitats of *A. paysonii* are two dissimilar between the two regions (as indicated by elevation and vegetation differences), or if the information at hand is judged to be too preliminary, then it would be appropriate for the Bridger-Teton National Forest to develop a Best Management Practices (BMPs) for this species. Topics appropriate to address include, but are not limited to management practices at known sites after wildfire or logging, priority placed on weed management and associated range of suitable treatments at known sites, and conventions for evaluating species' response in timber and grazing plans. The increase of bark beetle and blister rust outbreak may raise a new round of management questions. If *A. paysonii* requires soil exposed to the mineral layer, then opening of the canopy may not suffice for establishment but have indirect effects by increasing fuel loads for fires.

Surveys should continue to be conducted for this species, including surveys at the six populations with detailed location information that were not included in 2011-12 surveys, and repeated attempts to relocate populations where none were found in 2011-12, particularly before or after any management/disturbance change. This particularly holds true for populations in the vicinity of recent wildlifes and the unusual 2012 Fontenelle wildfire that burned in June. Expanded survey at the Darby Basin population that has three detailed surveys (1978, 1992, 2011), including a detailed 1978 map, may be worthwhile to confirm the magnitude of decline up to the present.

A Monitoring Plan would ideally be built into a Best Management Practices document for this species to determine what types and ages of disturbance or seral conditions are favored by the species. A study of species' response to management practices in a controlled, experimental design, possibly including prescribed fire and logging w/o surface blading or

burning, would provide a broader information base upon which to build. It would be valuable to know if ecotonal populations do or do not require disturbance, in which case monitoring individuals in the Bailey Lake area might also advance both life history research.

There is an overarching question on the viability of small populations that might be advanced in a two-prong research program aimed at life history research (monitoring individual plants under field or greenhouse conditions) and seed ecology research to determine whether or not it persists in a seedbank. Likewise, the trends/fate of large and formerly large populations might be monitored in a design that is exhaustive for the population. Exhaustive census offers a complementary perspective to the demographic design of tracking individual plants. This might be pursued at five-year intervals without knowing whether median age is greater or less than five years.

Regardless of the paths taken, land managers and field personnel on the Bridger-Teton National Forest should be informed of the records of *Astragalus paysonii* in their areas. Possible sightings of this plant should be documented by specimens (if the size of the population warrants collecting), and should include both flowers or fruits and shoots. Specimens should be sent to the Rocky Mountain Herbarium for verification of their identity. Confirmed sightings of *A. paysonii* should be submitted to the Wyoming Natural Diversity Database, all of which have been previously recommended for Idaho populations (Lorain 1990).

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