

**BOTANICAL SURVEY OF THE SCRATCHGRAVEL HILLS
LEWIS AND CLARK COUNTY, MONTANA**

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SUMMARY

Systematic baseline survey was conducted in the Scratchgravel Hills, documenting two Montana plant species of special concern, two watch species, and six plant associations. They represent a biological crossroads pattern, made up of the following noteworthy features:

- An extensive population of lesser rushy milkvetch (*Astragalus convallarius*), a Great Basin plant species disjunct at the northern end of its range
- A small population of linearleaf fleabane (*Erigeron linearis*), a Columbia Plateau plant species disjunct at the eastern end of its range
- Two small populations of taxa that remain on the watch list because they live primarily or exclusively in Montana and nowhere else, Klausí bladderpod (*Lesquerella klausii*) and rabbitsfoot crazyweed (*Oxytropis lagopus* var. *conjugens*)
- Two relatively intact and well-developed Rocky Mountain plant associations that are noteworthy for their site-specific conditions, though not for their plant association rarity; the Douglas fir/rough fescue plant association (*Pseudotsuga menziesii*/*Festuca scabrella* p.a.), and the foothills form of the bluebunch wheatgrass plant association (*Pseudoroegneria spicata* ñ *Bouteloua gracilis* p.a.)

One of these, the lesser rushy milkvetch occurrence, represents among the best examples in the state. Two more of these represent the only documented examples in the Helena Valley and among the most unusual examples in the state, including the linearleaf fleabane occurrence and the Douglas fir/rough fescue plant association.

The Scratchgravel Hills have a moderate level of state biodiversity significance warranting elevated attention to the most pressing management needs, noxious weed control.

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INTRODUCTION

The Scratchgravel Hills are an island of public land administered by the Bureau of Land Management in the Helena Valley. The Hills represent a prominent landmark, undeveloped open space, window into local mining history, wildlife refugium, and a potentially biologically-unique landscape. For this latter reason, baseline systematic inventory of the flora and vegetation was conducted to analyze its botanical significance.

The only previous written record and review of its botanical resource values was presented in a Scratchgravel Hills planning document (Scratchgravel Planning Committee and Lewis and Clark Areawide Planning Organization 1984), alluding to the presence of the rare species, lesser rushy milkvetch (*Astragalus convallarius*) and characterizing the vegetation in general terms:

Existing vegetation at lower elevations is grasses, herbs and scattered shrubs with occasional juniper and ponderosa pine. Higher elevations and north facing slopes are dominated by pine/fir forest with a bunchgrass or fescue understory.

The source of the collection information to support the rare species report was unknown, and the report of a fescue woodland understory was also undocumented in addition to being unusual for such an arid setting. These potentially indicate botanical significance.

This same Valley is one of rapid conversion as one of the fast-growing rural areas in Lewis and Clark County, a county which is projected to have the greatest population growth between now and the year 2010 (Bureau of Business and Economic Research 1998). Any work on determining the status of sensitive species found in the Helena Valley hinges on investigation of relatively intact public lands in the Valley.

Primary objectives of this study were to systematically survey botanical biodiversity features with emphasis on those with BLM status, providing a botanical baseline. Systematic surveys provide a process of setting and refining conservation targets for the rarest species, and the rarest or most outstanding examples of natural vegetation as plant associations.

For example, Helena National Forest lands have been surveyed for sensitive plant species in the Big Belt and Elkhorn Mountains (Poole and Heidel 1993). Survey targets included three endemic species, that is, species found exclusively or primarily in Montana: Klausí bladderpod (*Lesquerella klausii*), limestone larkspur (*Delphinium bicolor* ssp. *calcicola*) and rabbitís-foot crazyweed (*Oxytropis lagopus* var. *conjugens*). In the course of this study and subsequent studies, these three endemics have been documented at more sites, with little or no threats, such that they are no longer being tracked but have been moved to the watch list for species of limited distribution (Heidel 1997). Despite recent renewed investigations, other uncommon plant species collected in the Helena Valley before the turn-of-the-century (*Atriplex truncata*, *Cypripedium parviflorum*, *Senecio debilis*) have not been seen since.

STUDY AREA

The Scratchgravel Hills are a prominent isolated series of hills in the Helena Valley, Lewis and Clark County. They are situated about four miles north of Helena between the Sevenmile, Tenmile and Silver creeks, and they span about 5,500 acres in 18 sections (Figure 1). They are a largely-unbroken block of public land administered by the Bureau of Land Management (BLM), surrounded by private land. The elongate study area extends east-west, encompassing the Scratchgravel Hills landmark at the eastern end and contiguous rolling lands to the west. Mention of the Scratchgravel Hills in the following geology narrative refers to the landmark, while in the rest of this report it refers to the entire study area.

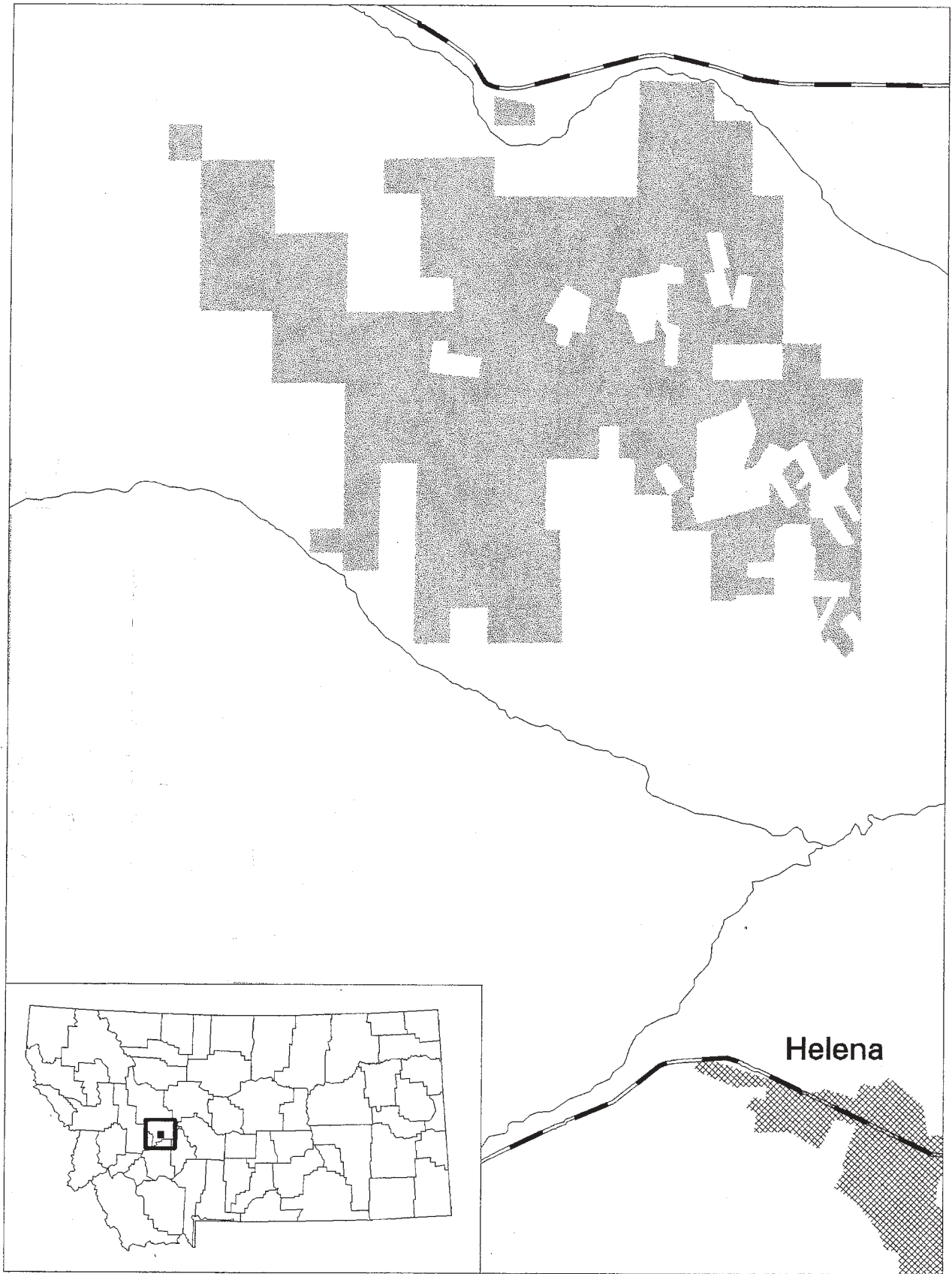
General motorized access to the study area is possible via Echo Lane, foot access or limited motorized access is provided at two public access points established on Tumbleweed Drive and an entry opposite Norris Road, and a roadway that adjoins its western margin also provides foot access.

Geology

The Scratchgravel Hills are composed of the intruding Cretaceous granodiorite satellite pluton of the Boulder Batholith, flanked by metasedimentary rocks of the Belt Supergroup, sedimentary rock, and alluvium (Herrin et al. 1987). The highest hills that represent the Scratchgravel Hills landmark are derived from igneous batholith, weathering into very coarse sand, which with its associated mining activity gave the hills the Scratchgravel name. To the immediate north and west of the highest hills are intruded Tertiary volcanics and metasedimentary rock. Farther west, the Helena Limestone sedimentary formation, including dolomitic and argillaceous materials, covers the western half of the study area. In addition, Quaternary alluvium is at the eastern perimeter (Herrin et al. 1987, Ross et al. 1955, Lorenz and Swenson 1951).

The ore bodies in the Scratchgravel Hills are contact-metamorphic deposits and veins, with at least 32 mines at the perimeter of the batholith stock (Scratchgravel Hills Planning Committee and Lewis and Clark Areawide Planning Organization 1984). Except in the period of 1914-1918 when the Franklin and Scratch Gravel Gold mines were actively producing gold and silver, mining has been sporadic and intermittent. There are reports of historic placer mining predating surface excavations. Most of the historic mining was in adits, but there is at least one open pit mine site, which remains active. The Hills contain both patented and unpatented mining claims, and many claims were filed in periods when precious mineral prices were up. For example, there were about 112 unpatented mining claims filed between 1979-1981 (Scratchgravel Hills Planning Committee and Lewis and Clark Areawide Planning Organization 1984).

Figure 1. Scratchgravel Hills study area



Montana Natural Heritage Program, February 05, 1998

Soils

Soils in the Scratchgravel Hills are highly erodible and several are very shallow, with extensive rock outcrops in the hills (Bingham et al. 1977). Their soil textures are classified as sandy loams and channery loams but gravel makes up a major portion of the ground surface over much of the study area. Despite their loamy textures, profiles are not well-developed, and frost fractures are commonplace early in the season.

The soils on the highest hills, derived from granodiorite, are mainly Woodgulch-Rock Outcrop complex, 8-35% slope, a loamy sand (Bingham et al. 1977). The soils derived from sedimentary rock in the western end are Whitecow-Roto-Pensore channery loam, 4-35%. They are surrounded mainly by Haul-Tolman channery loams, 8-45%; Roto-Pensore-Crago channery loams, 15-45% and Crittenden sandy loam, very rock, 4-35% slope.

Climate

The Helena Valley climate is represented by meteorological data compiled at the Helena Airport (U.S. Dept. Commerce 1982). Median monthly temperatures range from 18.9] F (-7.3] C) in January to 69.3] F (20.7] C) in July. Annual average (median) precipitation is 11.14 inches (27.8 cm). This is consistent with the Helena Valley being among the northernmost of Montana's arid intermontane valleys.

The Hills are an exposed island within the Valley, having microclimate extremes that are exaggerated by the steepness of slopes, heightened exposure to sun and wind, and some soils that are porous (droughty).

Flora

The flora of the general Helena Valley was relatively well-documented in early years because Helena was a major center of growth in the new territory and state; home and hub for botanists and their formal or informal studies and projects. Projects included efforts to display the state flora, represented by sets of specimens that included a Helena-area collection, in the 1892 World's Fair. Subsequent collections of the local flora have been sporadic, and only in recent years have there been efforts to conduct systematic baseline inventories (e.g., Poole and Heidel 1993), collect a representative set of specimens for reference, and compile local floristic lists.

The Hills in particular have been anecdotally noted as among the best places around the Capital to see the state flower, bitterroot (*Lewisia rediviva*), but there was not information on the rest of the local flora.

Vegetation

The Hills are conspicuous from Helena and the surrounding valley as dark promontories with a cover of conifers compared to the light hues of the open plains that surround them. It has been inferred that all timber within proximity of the Helena mining camp and boom-town was extensively logged (Phillips 1997), so that any current stands represent post-settlement regeneration. There have not been stand exams or other vegetation studies in the Hills to characterize the conifer communities or grassland resources.

Wooded lands make up app. 45% of the study area (based on timber cover mapped onto the USGS topographic maps); and grassland makes up virtually all of the remainder. Surface water is absent in the Hills except early in the season along ephemeral watercourses, including a few small springs and seeps, or adjoining rangeland developments (stock tanks). Soils throughout most of the area are very porous, even along the watercourses, so that riparian community development is scant and restricted to narrow bands or more commonly wanting.

The Hills were historically used as rangeland, but have not been grazed since the 1980s.

Wildlife

One of the earliest recorded names given the Helena Valley is *ïTonahî*, which refers to a rich hunting ground in the Blackfoot language. Repeated bison use was reported, with high numbers. The current mammal and bird fauna of the Scratchgravel Hills is listed in the current planning document (Scratchgravel Planning Committee and Lewis and Clark Areawide Planning Organization 1984). This same document notes its significance in providing critical fawning areas for pronghorn antelope as well as supporting small resident populations of pronghorn antelope, mule deer, and whitetail deer.

METHODS

Methods were designed to address botanical and ecological features in a systematic baseline survey approach, identifying all priority species and community diversity features within the landscape. The study was not exhaustive in screening every quarter/quarter section but provides a framework identifying the priority features, evaluating their significance, and enumerating potential management questions and concerns.

Dual-purpose botanical and community surveys were conducted by the principal author throughout the growing season (June 1, 20-21, 24, and 29; July 22 and 31); and by both authors on September 24.

Botanical methods

Prior to fieldwork, the Biological Conservation Database maintained by the MTNHP was queried for occurrences of Montana plant species of special concern (Heidel 1997) and any watch species known from the vicinity of the study area. There are element occurrence records of six species within app. a 5mile radius (Table 1). One of the species, lesser rushy milkvetch (*Astragalus convallarius*), is known from multiple records in the area, and has also been reported and observed in the area in the past (document (Scratchgravel Planning Committee and Lewis and Clark Areawide Planning Organization. 1984; Cooper et al. pers. obs.). Three of the species are on the state watch list as species that are no longer being tracked but which are of limited distribution and biodiversity significance. Fieldwork priority was placed on BLM sensitive and watch species (USDI BLM 1996), but all species recognized as Montana plant species of special concern or as watch species (Heidel 1997a) were considered.

Table 1. Montana plant species of special concern in the Helena Valley area.

SPECIES	RANK	BLM STAT.	COMMENTS
<i>Astragalus convallarius</i> (Lesser Rushy Milkvetch)	G5 S2	Watch	Reported from the study area; collected elsewhere in Helena area
<i>Atriplex truncata</i> (Wedge-leaved saltbush)	G5 SH	Watch	Collected in 1899 in Helena area
<i>Cypripedium parviflorum</i> (Yellow lady's-slipper)	G5 S2S3	Watch	Collected in 1891 in Helena area
<i>Lesquerella klausii</i> (Klausí bladderpod)	G3 S3 Watch	Watch	Remains a state watch species as a state endemic; collected in Big Belt Mts.
<i>Oxytropis lagopus</i> var. <i>conjugens</i> (Rabbitsfoot crazyweed)	G4T3 S3 Watch	-	Remains a state watch species as a regional endemic; collected in Helena area
<i>Senecio debilis</i> (Rocky Mountain ragwort)	G3G4 S3 Watch	Watch	Remains a state watch species as a regional endemic; collected in 1898 around County Fairgrounds

The habitats and phenology of these six species were considered in fieldwork planning. The timing of fieldwork focused around the phenology of the primary target species, lesser rushy milkvetch (*Astragalus convallarius*), because it was already reported from the area. In years with sufficient moisture, such as 1997, it can be identified any time in the growing season during or after flowering in mid June. The habitat of lesser rushy milkvetch has been characterized as grasslands and open woodlands, a broad habitat description that fits most of the Scratchgravel Hills landscape. The

phenology and habitats of the rest of the target species span the entire growing season and represent an array of habitats from wetland to upland outcrop settings, placing a premium on multiple visits through the course of the summer and over the range of study area habitats.

For each sensitive species encountered, a Species of Special Concern survey form was filled out, accompanied by photographic documentation, and a voucher specimen when collecting did not significantly impact the population (Montana Native Plant Society 1993). All voucher specimens will be deposited at the University of Montana (MONTU), with duplicate material deposited in Montana State University (MONT).

The routine sensitive species survey steps in conducting site-specific project reviews can be summarized as follow:

1. Check existing records for sensitive plant information in and around the project area.
2. Set species search targets and timeframe(s) for fieldwork accordingly.
3. Survey the appropriate habitat(s) at the appropriate time(s) of the growing season.
4. Collect information on any sensitive plant populations, and document them by photos and specimens.

These routine sensitive species survey steps were augmented to meet the baseline objectives with the addition of the following steps:

1. Maintain a running list of species observed and collected to produce a preliminary study area flora,
2. Deliberately span the geographic extent of the area, traversing the range of elevations, substrates, and apparent habitats, and
3. Make repeat visits over the course of the growing season.

Ecological Methods

Systematic survey was planned to include the extent of BLM-administered land, the full range of topographic positions, the range of substrates as represented by bedrock geology (Ross et al. 1955), and the observed array of habitat types. The U.S.G.S. topographic maps (Scratchgravel Hills 7.5i, Austin 7.5i) were carried into the field as an aid in determining routes, in traversing the range of topographic positions, and in selecting and mapping vegetation sample sites.

There were no site-specific vegetation references to compile in preparing for the fieldwork. General vegetation classification references for western Montana provide the frame of reference for characterizing timbered habitat types, grassland and steppe habitat types and riparian or wetland habitat types. The compilation of documented vegetation units for Montana is represented in the plant association classification by Bourgeron and Engelking (1994), where plant association is defined as representing existing natural vegetation units encompassing both the habitat type units as climax and

community type units as seral. Throughout this report, we will use the plant association (p.a.) term in reference to any naturally-occurring vegetation unit without regard to successional status.

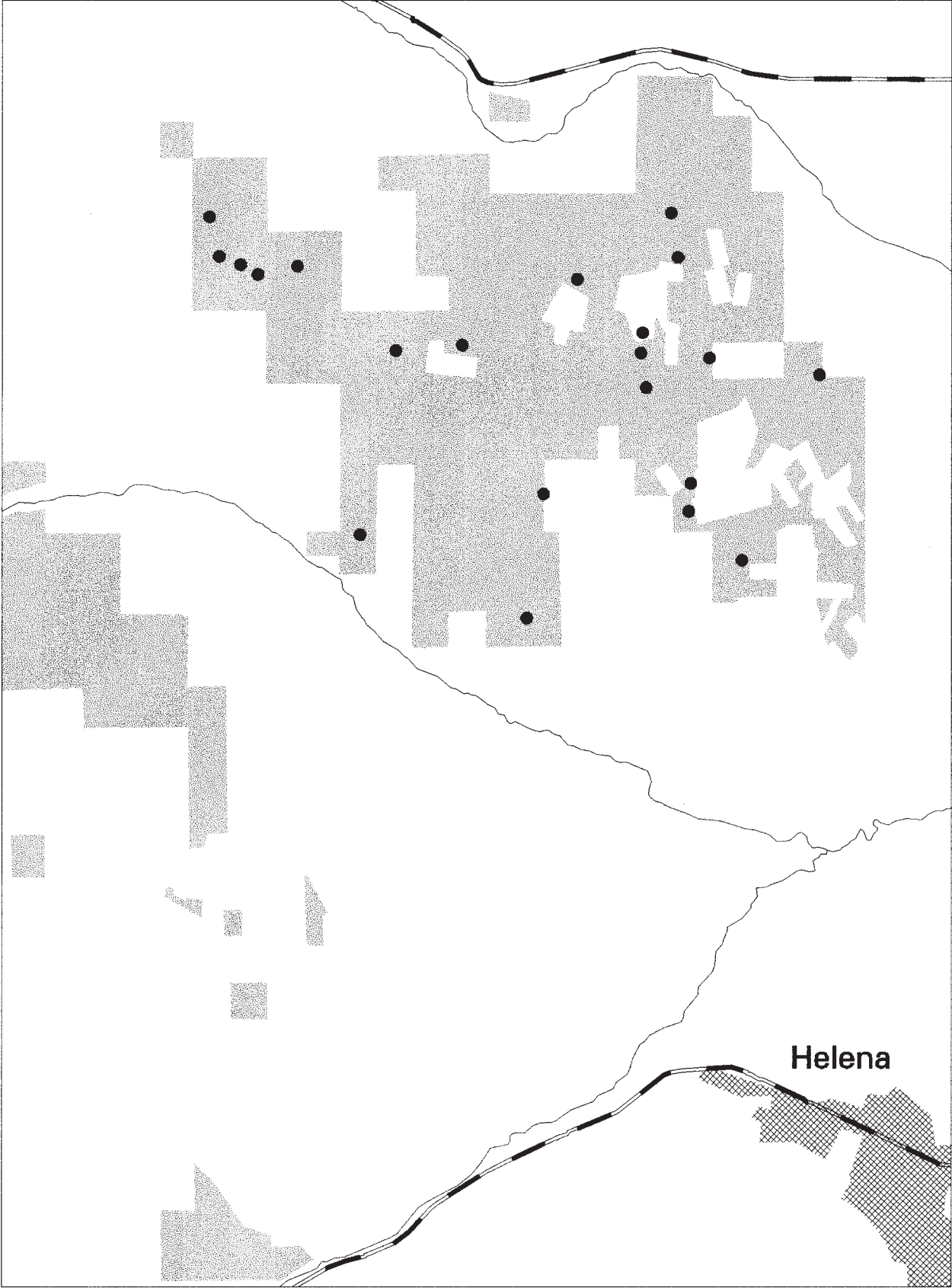
Vegetation and site characteristics were documented for 21 circular 1/10 acre plots according to methodology described in Cooper (1995). Standard MTNHP community survey forms were used to record plot data including location, environmental features (elevation, slope, landscape position, substrate, and ground cover) and ocular canopy cover estimates (Daubenmire 1959) for all vascular plant species. The distribution of vegetation study plots is shown in Figure 2.

The vegetation data set was analyzed using the STRATA program of E.C.A.D.S. (Ecological Classification and Description System), a USDA Forest Service ecological sampling package designed to stratify the data sets in keeping with habitat type classification concepts (Daubenmire 1959).

Note: All taxonomic nomenclature follows Dorn (1984) unless otherwise stated. The most notable exceptions are made for the wheatgrasses using the nomenclature of Kartesz (1994) for consistency with the regional classification (Bourgeron and Engelking 1984), and for which synonymy with other widely used scientific names is provided.

Soils data were not collected, and the soils mapping reference (Bingham et al. 1977) as a preliminary work did not distinguish the likely soil differences accompanying plant associations that occupied small areas.

Figure 2. ECODATA plot locations in the Scratchgravel Hills



Montana Natural Heritage Program, February 05, 1998

BOTANICAL RESULTS

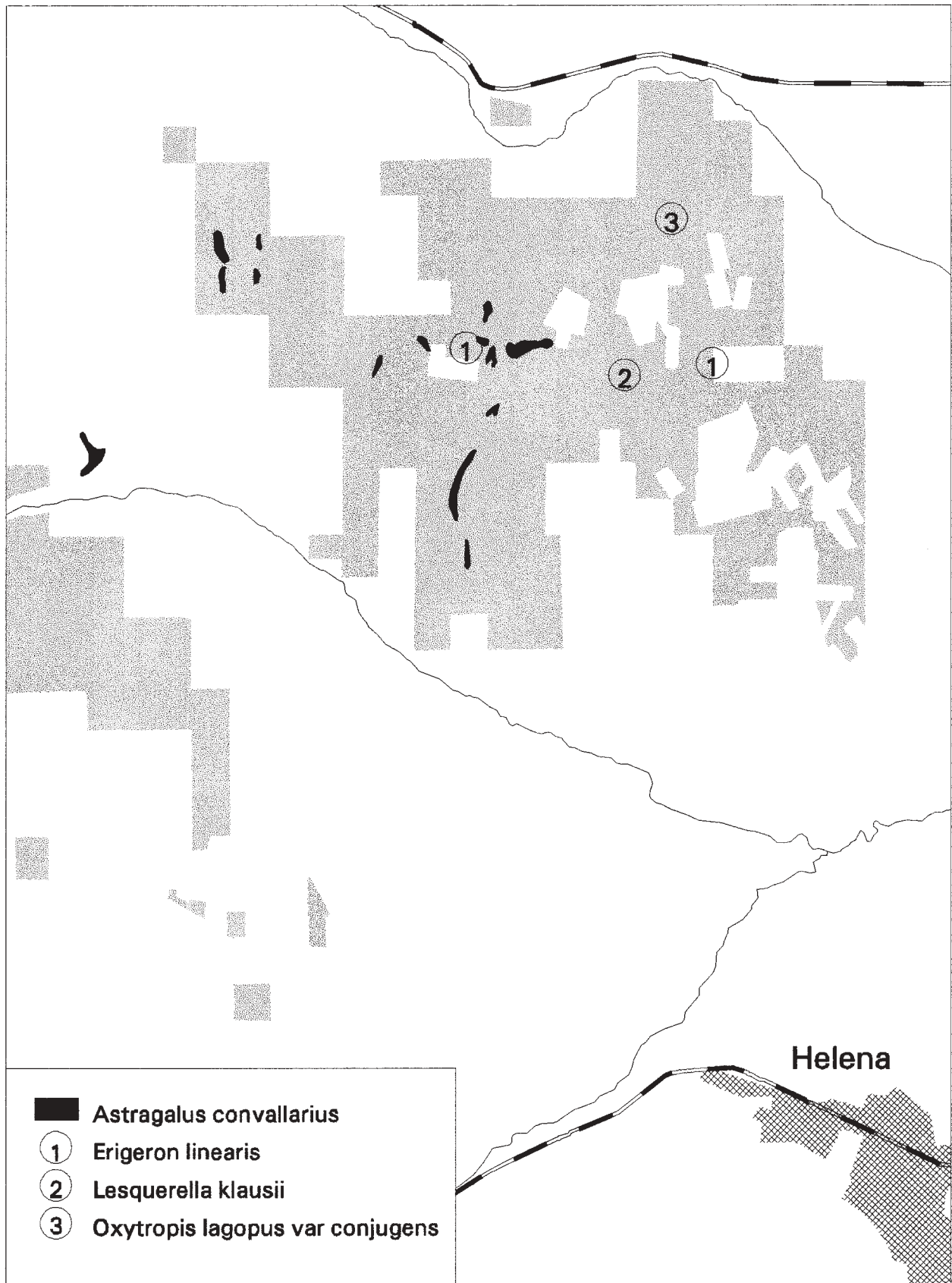
Two Montana plant species of special concern and two watch species were documented in the study area (Figure 3), including:

- One of the four largest known populations of lesser rushy milkvetch (*Astragalus convallarius*) in the state,
- A small, highly disjunct population of linearleaf fleabane (*Erigeron linearis*) representing the easternmost and possibly the best occurrence in the state, and
- Very small populations of the two watch species, Klausí bladderpod (*Lesquerella klausii*) and rabbitfoot crazyweed (*Oxytropis lagopus* var. *conjugens*). Note: A voucher specimen of the first species is still needed. It was collected after all of its fruits had dehisced. While the common species of *Lesquerella* can be ruled out, determination of the specimens as *L. klausii* cannot be considered as certain.

Only 182 plant species were documented in compiling the preliminary Scratchgravel Hills flora (Appendix C.) This is relatively low in total species numbers, but is to be expected considering the near-absence of wetland habitat. It may also reflect the incompleteness of the documentation. This flora, while low in numbers, still presents an interesting combination of Great Plains and Rocky Mountain species.

The status and site conditions for each of the four rare species are highlighted in the following narrative by species.

Figure 3. Sensitive plant locations in the Scratchgravel Hills



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Astragalus convallarius Greene var. *convallarius*

Lesser rushy milkvetch
Fabaceae (Bean Family)

STATUS

USFWS status: None

BLM status: Watch

USFS Region 1 status: None

Global rank: G5T5

State rank: S2

DESCRIPTION

General Description: Lesser rushy milkvetch is a slender herbaceous perennial with usually 1-6 erect to spreading stems, rising up to 5 dm high from a branching, underground rootcrown (Figure 4). The compound or simple leaves are 2-11 cm long with 0-5 pairs of thread-like leaflets. Upper leaves are usually simple, giving them a grass-like appearance. Foliage is sparsely hairy to glabrous in the upper portion. Off-white or yellowish, pea-like flowers are sparsely scattered on stalks which are 2-14 cm long and arise from the axils of the upper leaves. The upper petal of each flower is 7-11 mm long and bent upward. The calyx is 4-6 mm long and sparsely covered with white or black hairs. Pendent, green or purple-mottled fruits are linear, flattened, 13-50 mm long, and 2-4 mm wide.

Flowering takes place in late June; prolonged to early August in years with ample soil moisture. Fruiting is in July through August.

Diagnostic Characteristics: A. CONVALLARIUS is the only milkvetch in the Helena Valley with both grass-like leaves and pendent, linear fruits. The closely-related ASTRAGALUS DIVERSIFOLIUS is not known from Montana. The variety ASTRAGALUS CONVALLARIUS VAR. CONVALLAERIUS is the only variety in Montana.

GEOGRAPHIC DISTRIBUTION

Rangewide Distribution: Southeastern Idaho to southwestern Montana, south to Wyoming and Utah. Peripheral.

Figure 4

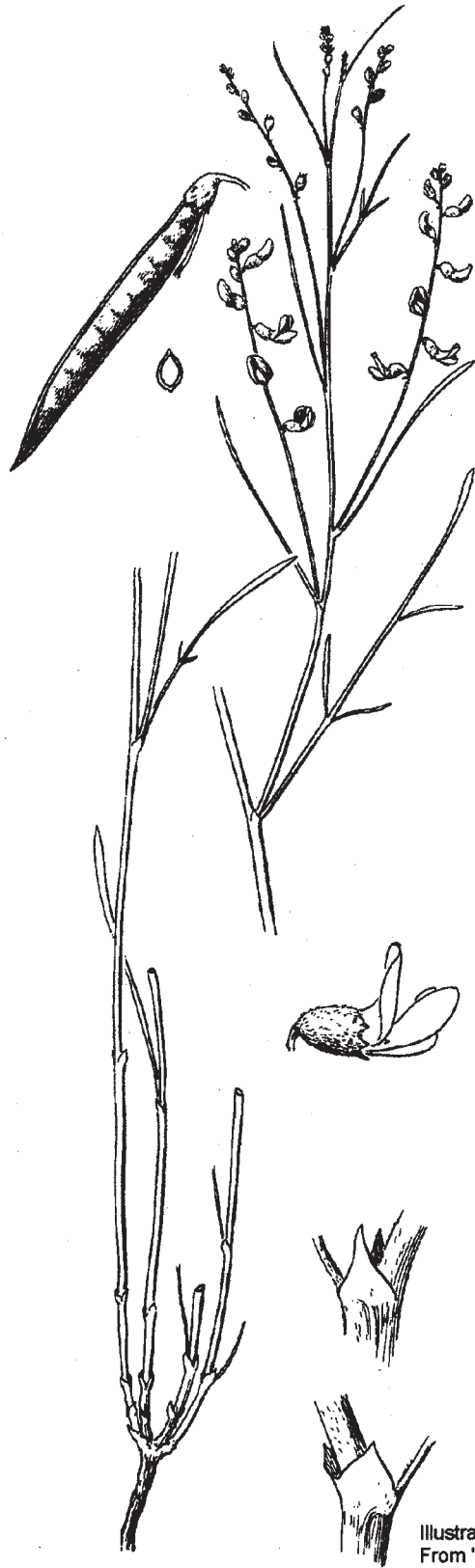
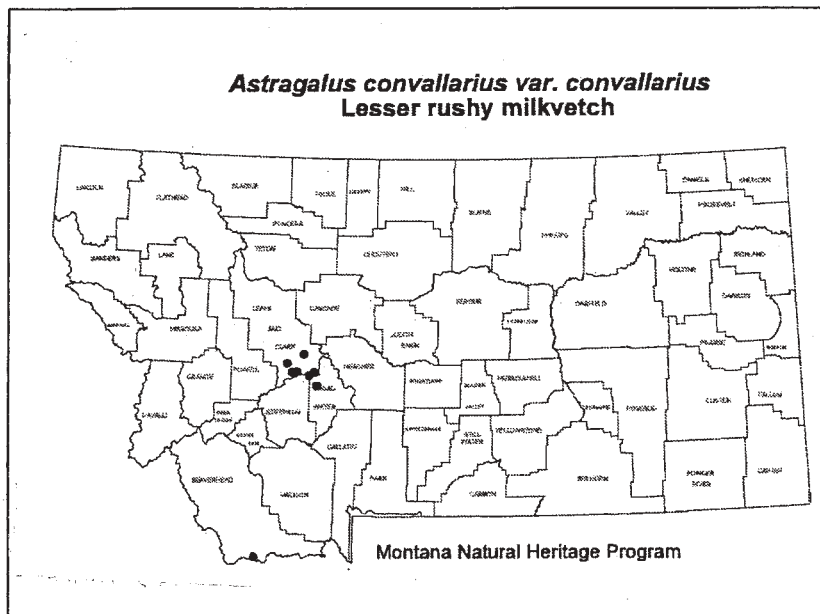


Illustration by Jeanne R. Janish
From 'Vascular Plants of the Pacific Northwest'

Astragalus convallarius
Lesser rushy milkvetch



State Distribution: Eight Montana occurrences are on record from southwestern counties that include Beaverhead, Broadwater, and Lewis and Clark counties. One new record documented by Peter Lesica in the Centennial Valley is being processed. Two more occurrences have been documented by Westech researchers in 1997 and are being submitted, including a large occurrence in the Limestone Hills on or adjoining BLM lands, and

another occurrence in the Fort Harrison Military Reservation immediately south of the study area (Ken Scow pers. commun.). All eleven records for the species in Montana are either in the Helena Valley vicinity, where it is disjunct at the northern end of its distribution, or in the Centennial Valley; with no known records in between.

Historical Distribution: It was first collected in Montana near Helena in 1891 by F. D. Kelsey. The precise Helena area location was not specified with this collection or with a later Blankinship collection made in the Helena area in 1909. These historical collections are merged with more recent collection records into the single large occurrence that is sporadic across much of the Helena South Hills.

Study Area Distribution: *Astragalus convallarius* occurs in the western half of the study area, in patches and bands that cover several sections while covering only a limited total area (Figure 3). It tends to be most consistently present at the margins of woodlands and in openings; found to a lesser extent in some areas of open woodland, above watercourses where there is at least scattered tree cover, and sometimes in restricted zones below forested slopes.

Environment: The ecological amplitude of the species is broad, but the species' distribution pattern is often localized and uncommon. It occurs in both woodlands and grasslands in the foothills of the Helena Valley at 3,880-5,200 ft. elevation. It is in grassland settings of the Centennial Valley at 8,100 ft. elevation. It is in a wide range of topographic positions of varying moisture content. It is most common on well-drained slopes but can also be found in swale microhabitats.

Soils: Rangewide the species grows on most soil textures including sandy, loamy or clayey soils of various origin and composition, most frequently on sedimentary formation (Barneby 1964). In the Helena Valley it usually grows on loamy soil derived from calcareous sedimentary parent material. Its restriction to the western half of the study area may correspond with the extent of sedimentary parent material.

Vegetation: Despite its limited distribution in Montana, it is found in a wide range of woodland, shrubland and grassland plant associations, sometimes in multiple associations at one site. An extreme example of local ecological amplitude is found in an occurrence above Winston (EO#004), where it has been documented on vegetation transects in the following habitat types (Scow et al. 1986):

1. *Elymus spicatus*-*Bouteloua gracilis* p.a.,
2. *Elymus spicatus*-*Poa secunda* p.a.,
3. *Festuca idahonis*-*Elymus spicatus* p.a., and
4. *Festuca scabrella*-*Elymus spicatus* p.a.;

Note: It has locally highest canopy cover, frequency and constancy in the last of these plant associations, which is also the most mesic.

In the Limestone Hills, it extends into arid plant associations on the toeslopes of the limestone outcrops in *Artemisia nova* and *Festuca idahoensis* plant associations as well as in associations dominated by *Juniperus scopulorum* or by *Artemisia tridentata* (Ken Scow pers. commun.).

In the Scratchgravel Hills study area it occupies mainly wooded habitat and ecotones, and discrete areas of grassland and steppe. It is found in segments of the *Pinus ponderosa*/*Pseudoroegneria spicata* plant association, plus the localized *Artemisia tridentata*/*Pseudoroegneria spicata* plant association, and restricted related phases (*Pinus ponderosa*/*Arctostaphylos uva-ursi*/*Pseudoroegneria spicata*; *Pseudoroegneria spicata*-*Gutierrezia sarothrae*). Immediately west of the study area, an outlying cluster of plants occurs in a subpopulation found on alluvium along an ephemeral watercourse within a landscape dominated by *Pseudoroegneria spicata* - *Bouteloua gracilis* p.a. Immediately south of the study site it occupied swale microsites, possibly an association of *Pascopyrum smithii*-*Nessula viridula* with a high component of *Poa pratensis*, within open plains dominated by *Pseudoroegneria spicata*-*Bouteloua gracilis* (Ken Scow pers. comm.). A composite list of associated species in the Scratchgravel Hills includes:

Achillea millefolium
Antennaria (mic)
Antennaria parvi
Arenaria congesta
Arnica soraria
Artemisia campestris
Artemisia frigida
Artemisia tridentata ssp. vaseyana
Bouteloua gracilis
Chrysopsis villosa

Commandra umbellatum
Crepis intermedia
Dodecatheon pungens
Douglasia montana
Erigeron compositus
Festuca idahoensis
Festuca scabrella
Gaillardia aristata
Gutierrezia sarothrae
Hymenoxys richardsonii
Lepidium densiflorum
Lewisia rediviva
Linum lewisii
Lomatium triternatum
Oryzopsis hymenoides
Penstemon procerus
Phlox bryoides
Pinus ponderosa
Pseudoroegneria spicata
Senecio canus
Stipa comata
Zigadenus venosus

SPECIES BIOLOGY

Life history: The longevity of this perennial species is not known.

Reproduction: It is assumed to be reproducing sexually by insect pollination.

Dispersal: Although the pod probably splits rapidly from tip to base, the force of the release is seldom so violent as to eject the seeds any great distance (Barneby 1964). The fact that the species has almost no cluster pattern of distribution, and has a sporadic distribution in a variety of habitats suggests that it has some as yet unidentified dispersal agent if not habitat specificity.

Biological interactions: No signs of browsing or predation were found. The species has a highly reduced, drought-tolerant growth form indicating that it is not likely to be good competitor. But it is perhaps more stress-tolerant than many of its associated montane species, maintaining growth and reproductive activity longer in the growing season.

POPULATION BIOLOGY

Population size and condition: This species is easily overlooked, and population size estimates are provided for only a couple of the occurrences in the state, ranging from app. 10 plants to over 5000 plants as estimated for the study area. In the Scratchgravel Hills it may be connected with subpopulations on the Fort Harrison Military Reservation. In the upcoming second year of a two-year study it will be possible to delimit species' distribution and consider this possibility (Scow pers. commun.).

Population structure: It was frequently found in sporadic distribution at low densities. It was occasionally found to be common or occasional in small openings. It has been noted in one place outside the study area to be locally abundant along a highly ephemeral watercourse on droughty soils under particular grazing regimes.

ASSESSMENT AND MANAGEMENT RECOMMENDATIONS

Threats to currently known populations: Land use conversions from rangeland to building sites or cropland are immediate threats to the species on private property. The widespread indirect threat throughout the Helena Valley is invasion of noxious weeds like spotted knapweed (*Centaurea maculata*) and Dalmatian toadflax (*Linaria dalmatica*), and potentially as serious invasions by leafy spurge (*Euphorbia esula*), diffuse knapweed (*Centaurea diffusa*), and Russian knapweed (*Centaurea repens*).

Management practices and response: Limited information is available, though some of the highest species' densities have been noted west of the study area on pasture that is part of a rotation grazing system and which is heavily grazed in the winter or else early in the growing season. Note: At this site of high density, it is restricted to a very well-drained ephemeral small water course. It has also been noted at an old homestead site under heavy grazing on the Fort Harrison Reservation (Ken Scow pers. commun.).

Recommendations for maintaining viable populations: Vigilant weed treatment at the three largest occurrences on public land (Scratchgravel Hills, Limestone Hills and Mount Helena) is needed to maintain viable populations in Montana. It is not known whether the fourth large site, the Chatham site, has been converted to mining use since its local vegetation was documented.

Recommendations for further assessment: The breadth of habitat would suggest that it is not imperiled unless there is landscape-wide loss of habitat, or unless the habitats collectively are threatened or degenerating from weed invasion or alteration in the absence of natural processes. It is recommended that it be retained as a BLM watch species and a Montana plant species of special concern unless there are more occurrences including large ones outside the Helena Valley with no known threats. In any case, this species is one of biogeographic significance as a disjunct.

***Erigeron linearis* (Hook.) Piper**
(Linearleaf Fleabane; or Desert Yellow Daisy)
Family: ASTERACEAE

STATUS

USFWS status: None
BLM status: None
USFS Region 1 status: Sensitive
Global rank: G5
State rank: S1

DESCRIPTION

General Description: Linearleaf Fleabane is a perennial herb with unbranched stems that are 5-30 cm tall and which arise from a stout taproot and branched rootcrown (Figure 5). The mostly basal leaves are linear and 1-9 cm long. The bases of the stems and leaves are enlarged and straw-colored or purplish, and the herbage is covered with fine gray hairs. The flower heads are usually solitary at the ends of the stems. The involucre bracts are 4-7 mm long and are covered with long, appressed hairs and occasionally also with glands. The 15-45 yellow rays are 4-11 mm long and the yellow disk flowers are 3-5 mm long. There are 10-20 pappus bristles at the top of each achene.

Flowering in May-early June.

Diagnostic Characteristics: The Scratchgravel Hills plants had consistently short rays (4 mm) unlike the conspicuous rays of the Beaverhead County population shown in Appendix B. Superficially, the Scratchgravel Hill material resembled the HAPLOPAPPUS genus. However, the species and the ERIGERON genus have taproots, narrow involucre bracts in one series, and the very short style appendages less than 0.5 mm long. This is the only ERIGERON in our area with yellow rays.

DISTRIBUTION

Rangewide distribution: Southern B.C., south through e. WA and OR to n. NV and Yosemite National Park, east through central ID to Yellowstone National Park and adjacent MT. Peripheral.

Figure 5

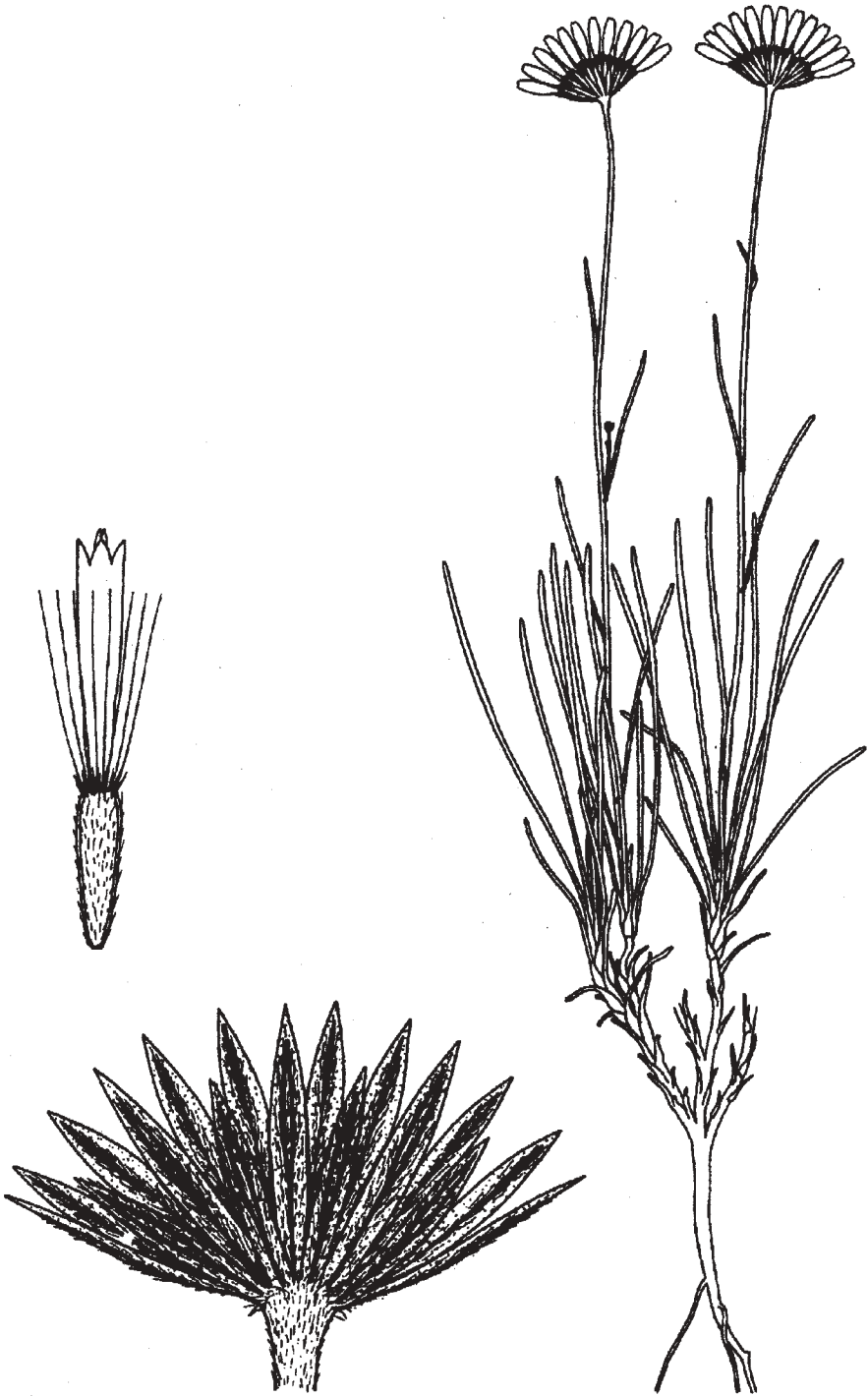
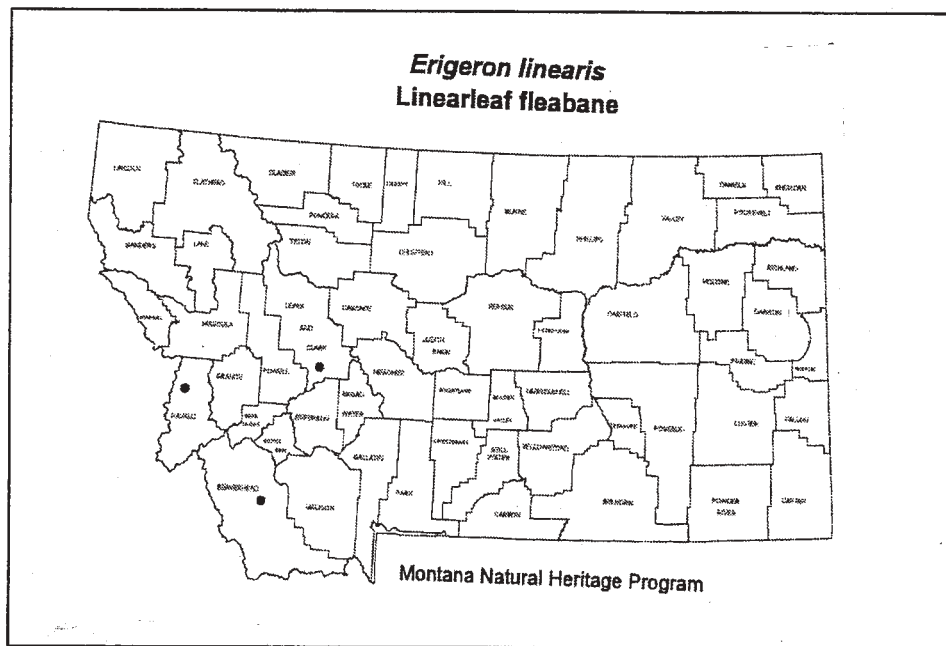


Illustration by Jeanne R. Janish
From 'Vascular Plants of the Pacific Northwest'

Erigeron linearis
Linearleaf Fleabane



State Distribution: Bitterroot and Pioneer mtns., and Scratchgravel Hills

Montana counties: Beaverhead, Lewis and Clark, and Ravalli cos.

Historical distribution: Not applicable. This species was first found in Montana in 1960.

Study area distribution: It is located in the eastern half of the study area, at two points on either side of the highest hill (Figure 3). This represents the first time that it has been documented in Lewis and Clark County, a disjunct eastward range extension.

HABITAT

Environment: Dry, often rocky soil from the plains and foothills to moderate elevations in the mountains, often among sagebrush. Elev. 3900-6020 ft.

The settings for the two subpopulations in the Scratchgravel Hills differ markedly. The eastern subpopulation is on 30 degree east-facing midslope setting where there is a steep opening on the timbered hillside. The western subpopulation is on a gentle 5 degree bald lower slope with a southwest aspect in open rolling plains.

Soils: The parent materials are unknown.

Vegetation: The plant associations in which it has been documented to date include dominance or co-dominance by bluebunch wheatgrass (*Pseudoroegneria spicata*), often with mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) directly associated with or surrounding the species' setting.

It is in two different plant associations in the Scratchgravel Hills sites, and associated species are recorded separately for the two:

Festuca idahoensis ñ *Pseudoroegneria spicata* p.a. (eastern subpopulation)

Achillea millefolium

Antennaria spp.

Astragalus flexuosus

Chrysopsis villosa

Crepis acuminata

Cymopterus acaulis

Douglasia montana

Festuca idahoensis

Haplopappus acaulis

Lomatium triternatum

Pseudotsuga menziesii

Sedum lanceolatum

Selaginella densa

Woodsia scopulina

Pseudoroegneria spicata ñ (*Bouteloua gracilis*) p.a. (western subpopulation)

Artemisia frigida

Artemisia tridentata ssp. *vaseyana*

Chrysopsis villosa

Commandra umbellata

Erigeron compositus

Gutierrezia sarothrae

Koeleria macrantha

Lewisia rediviva

Opuntia polyacantha

Plantago patagonica

Pseudoroegneria spicata

SPECIES BIOLOGY

Life history: The longevity of this perennial species is not known.

Reproduction: It is assumed to be reproducing sexually by insect pollination.

Dispersal: The fine pappus attached to each seed aids in wind dispersal.

Biological interactions: This species seems to occupy balds and local extremes in sparse vegetation cover. This may indicate that it is a poor competitor or has germination requirements for bare soil.

Seed predation appears to be high. In examining flower structure under a compound microscope of the 3-5 plant specimens collected per subpopulation, it was observed that grubs had consumed the majority of seeds on many flower heads.

POPULATION BIOLOGY

Population size and condition: Information collected to date indicates that the two subpopulations are small, with an estimated total of 200 individuals. Plants are vigorously multi-stemmed, but significantly shorter in stature (10-15 cm) compared to the Ermont Gulch population. Considering the fact that the species was not located until the end of flowering, and it is not readily discerned after flowering, the population information is to be treated as preliminary.

Population structure: Size class differences that might reflect age class differences were not noted.

ASSESSMENT AND MANAGEMENT RECOMMENDATIONS

Threats to currently known populations: The western subpopulation is close to a private mining inholding that is active or has recently been active but does not directly affect it. There are also nearby claims and exploratory pits on the BLM land. This same subpopulation lies directly above the head of a watercourse in which leafy spurge is abundant in a continuous band at the bottom of the entrenched channel, expanding upstream. Spotted knapweed is in a few patches along the watercourse, and is more abundant in the mining area. Encroachment of the uplands from the watercourse and the mining area has been limited to date.

The eastern subpopulation does not have immediate threats, in that mining activity and accompanying spotted knapweed invasion are at greater distances.

Management practices and response: Unknown.

Recommendations for maintaining viable populations: Leafy spurge control in Section 28 is critical. As the best documented occurrence records in the state, even though it is small, maintenance of the Scratchgravel Hills population may be critical to the species' conservation.

Recommendations for further assessment: The known subpopulations appear to be small in plant numbers and extent, but were found in mid June at the end of flowering activity. Survey during early June is recommended for any project reviews on potentially suitable habitat in the eastern half of the study area.

At least three of the four occurrences in the state are in landscapes with a history of intense mining history. The question was raised whether the Ermont Gulch occurrence represents a population in its natural habitat or an accidental introduction where mining machinery or a spot treatment with e.g., fire, removed sagebrush cover (Heidel and Vanderhorst 1996). The Scratchgravel Hills subpopulations occur within undisturbed vegetation but seem unusually localized, and they do not prove or refute the question about the nature of the species presence in Montana that has been raised.

BLM watch status designation is appropriate for this species, considering that BLM lands are the only public lands where this species occurs in the state, while further assessment and noxious weed control are underway.

Note: A voucher specimen of this species is still needed. It was collected after all of its fruits had dehisced. While the common species of Lesquerella can be ruled out, determination of the specimens as L. klausii cannot be considered as certain.

***Lesquerella klausii* Rollins**
(Klausí Bladderpod)
Family: BRASSICACEAE

STATUS

USFWS status: None

BLM status: Watch

USFS Region 1 status: It was on the watch list but dropped in 1991.

Global rank: G3

State rank: S3

DESCRIPTION

General Description: Klausí Bladderpod is a short-lived, perennial herb with a rosette of basal leaves from a taproot and unbranched rootcrown, and stems that are erect or lie flattened on the ground curving up at the tip, 6-15 cm high (Figure 6). Leaves are broadly spoon-shaped, 15-25 mm long, entire-margined, and have long petioles; stem leaves are spatula-shaped and 6-9 mm long; herbage is densely covered with branched, star-like hairs. The yellow flowers are borne on curved S-shaped pedicels in a simple, loose inflorescence, 10-30 mm long; the 4 petals are ca. 6-8 mm long. The broadly heart-shaped fruits are 5mm wide, 4 mm high, compressed contrary to the suture, and densely hairy (adapted from Shelly 1988, Rollins 1995).

Flowering in May - June, fruiting in June - early July, depending on elevation.

Diagnostic characteristics: This species resembles *PHYSARIA GEYERI*; however, the latter has more deeply notched fruits and appears to be confined to the southwestern part of the state. Its range overlaps with *LESQUERELLA ALPINA*; the latter has narrow leaves (< 5 mm) that are the same at the base and on the stem, and fruits which are narrowed and flattened at the tip.

DISTRIBUTION

Rangewide distribution: Western MT. State endemic.

State distribution: Centered in the Big Belt Mountains and westward to the south end of Rocky Mountain Front.

Montana counties: Broadwater, Lewis and Clark, and Meagher Cos.

Historical distribution: Not applicable. This species was first discovered in 1977 by Klaus Lackschewitz.

Study area distribution: Only found in one location on the highest summit (Figure x).

HABITAT

Environment: Exposed, open, often south-facing slopes usually in montane settings. Elev. 4000-7700 ft. The Scratchgravel Hills occurrence was on 40% southwest-facing slope, in an upper slope position, and below the highest point in the Hills.

Soils: It is characteristic of shale barrens and platy shale rubble, but is also found on limestone, argillite, and quartz-derived substrates. The latter is consistent with its occurrence in the Scratchgravel Hills, where it appears to be restricted to one opening and substrate of limited extent.

Vegetation: Its shale barrens habitat lies within ponderosa pine (*Pinus ponderosa*) or Douglas-fir (*Pseudotsuga menziesii*) plant associations, also extending into higher elevation associations of limber pine (*Pinus flexilis*) and Engelman spruce (*Abies lasiocarpa*). The local bunchgrass dominants often include bluebunch wheatgrass () and sometimes Idaho fescue (*Festuca idahoensis*).

The Scratchgravel Hills occurrence follows the pattern in having local bluebunch wheatgrass dominance, surrounded by both Douglas-fir and ponderosa pine. : A large number of associated species have been documented among all of its occurrences (Poole and Heidel 1993). The species directly associated with it on-site include:

Artemisia frigida
Aster alpigenus
Chrysopsis villosa
Oxytropis sericea
Penstemon nitidus
Pinus ponderosa
Pseudoroegneria spicata
Pseudotsuga menziesii
Senecio canus

SPECIES BIOLOGY

Life history: It is a short-lived perennial. Demographic monitoring of another endemic, *Lesquerella carinata* var. *languida* (summarized in Vanderhorst 1995), provides a tentative framework for understanding recruitment and mortality, and the resulting patterns of boom and bust cycles.

Reproduction: *Lesquerella klausii* is probably cross-pollinated by insects, as are most species in the genus (Rollins and Shaw 1973). Although self-incompatibility is common in *Lesquerella*, it is present in at least some species. No evidence of vegetative reproduction has been observed.

Dispersal: The fruits of *Lesquerella klausii* are papery and dry, and the seed is wingless. Probably most seeds fall near the parent plants, and might be dispersed with the aid of wind and gravity. It is likely to have a seedbank, like many short-lived perennials. High seed germination levels have been noted in the two years following wildfire in Hunters Gulch (Shelly 1988).

Biological interactions: *Lesquerella klausii* occurs most frequently in sparsely-vegetated slopes, including disturbed areas such as unstable roadbanks. These observations suggest that it does not compete well in dense vegetation and in closed forest stands.

POPULATION BIOLOGY

Population size and condition: Populations range in size from less than 20 to over 3000 individuals (Poole and Heidel 1993). In the study area, the population had over 100 plants in a single area. The species was found long after flowering (July 22), and vegetative material was compared with specimens for identification purposes.

Often where the species occurs in the Big Belt Mountains, it is found repeatedly in more than one opening. Other openings in the study area were searched unsuccessfully, but the timing of the search was so late as to leave room for question. It is possible that the Scratchgravel Hills occurrence represents an accidental introduction by some unknown dispersal agent or is more extensive than initially documented.

Population structure: A few first-year plants were observed. Most plants did not produce flowering stalks, indicating a prevalent immature vegetative state or harsh conditions that year.

ASSESSMENT AND MANAGEMENT RECOMMENDATIONS

Threats to currently known populations: Mining, road maintenance and construction, and noxious weed invasion and aerial herbicide application all pose threats among many of the known occurrences. Two populations lie within the Red Mountain RNA and Cabin Creek RNA of the Helena National Forest Service.

The Scratchgravel Hills population is dissected by the gravel road that leads to the top of the highest summit. Leafy spurge (*Euphorbia esula*) is present along the roadside immediately below and adjoining part of the population. It is just beginning to encroach the opening.

Management practices and response: *Lesquerella klausii* is tolerant of disturbance, as evidenced by its ecological preference for open, somewhat unstable habitats. However, large-scale destruction or invasion of this habitat could potentially result in extirpation of populations.

Recommendations for maintaining viable populations: Deliberate management actions are not needed for maintaining the local population.

The exception is that general noxious weed control is needed along the summit road and intensive, controlled spot treatment at the site of the *Lesquerella klausii* is recommended. This is the first site at which leafy spurge is reported invading the species' habitat.

Recommendations for further assessment: It is recommended that distribution data continue to be collected for this taxon as a state endemic species that is vulnerable, subject to periodic state rank review. Its state status may be interpreted as basis for removing it from the Bureau of Management list as a watch species but the threat of leafy spurge invasion may be interpreted as basis for its retention.

Most of the populations in the Big Belt Mountains are not subject to noxious weed encroachment to date.

***Oxytropis lagopus* Nutt. var. *conjugens* Barneby**
RABBIT-FOOT CRAZYWEED
Bean Family (Fabaceae)

STATUS

U.S. Fish and Wildlife Service: None.

U.S. Forest Service: None.

BLM: None

Other: It is given a Priority 2 rating in Canada (Argus and Pryer 1990), and recommended for consideration as a vulnerable species (Smith 1994).

Global rank: It is ranked G4T3; meaning that the species as a whole is potentially secure, but the variety may be vulnerable.

State rank: It is ranked S3, meaning that the variety may be vulnerable in the state. It was taken off of the state species of special concern list in 1993 and moved to the watch list because, despite its narrow distribution, it is found in many places and it appears to increase under grazing pressure. Nevertheless, it is a taxon of limited distribution.

DESCRIPTION

General Description: Rabbit-foot crazyweed is a caespitose perennial herb with a short, branching woody stem at or below the surface (Figure 6). The foliage is densely silky-villous with long silvery hairs. The stipules are membranaceous and densely silky-pilose dorsally, sometimes glabrate with age. Leaves are 3-11 cm long usually 5-9 leaflets. Each leaflet is about the same length as the rachis. Scapes are upright, 2-13 cm long. The racemes are 5-18 flowered. Bracts are shaggy-pilose dorsally, often with dark hairs. The calyx is 8-11 mm long, with silky hairs concealing the face of the tube that is turgid to inflated at anthesis. The corolla is pink-purple, 13-16 mm long. The keel is 11-14 mm. Long. The pod is erect, chartaceous to submembranaceous. The calyx is thickly hirsute, as long as the pod, and usually persistent until after the pod dehisces (from Hitchcock et al. 1984, Smith 1994).

All varieties of OXYTROPIS LAGOPUS can be identified based on the pod that does not rupture and is usually hidden by the calyx. Both OXYTROPIS LAGOPUS VAR. ATROPURPUREA and OXYTROPIS LAGOPUS VAR. LAGOPUS are also present in Montana. But unlike O. L. VAR. CONJUGENS, the calyx of the other varieties is usually deciduous with the enclosed pod before seed dispersal, and they usually have more than nine leaflets, rarely as long as the rachis. ASTRAGALUS

PURSHII superficially resembles O. VAR. CONJUGENS in its hairiness, acaulescent growth form, reddish-purple flowers and similar settings. But the rounded keel, and calyx which is shed before the pod matures, distinguished it from OXYTROPIS LAGOPUS VAR. CONJUGENS.

GEOGRAPHICAL DISTRIBUTION

Global distribution: *Oxytropis lagopus* var. *conjugens* was considered to be a Montana endemic until it was discovered in Alberta in 1986. There, it is only found in the western section of the North Milk River (Smith 1994).

Montana distribution: It occurs in foothills mainly east of the continental Divide between Jefferson and Pondera counties, extending west as far as the Drummond area.

Montana counties: : *Oxytropis lagopus* var. *conjugens* is currently known from seven counties in Montana: Granite, Jefferson, Lewis and Clark, Pondera, Powell and Teton counties, including many scattered localities around the Helena Valley.

Historical distribution: The earliest known collection was made in 1888 by Rev. F. D. Kelsey, giving the location only as "Helena". It was also collected before the turn of the century in an undated collection made "from the vicinity of Deerlodge". In addition, collections were made in 1934 from the Drummond and the Garrison areas.

Study area distribution: It is known from one point at the northeast end of the study area on a ridgetop in Section 23, and is located immediately southwest of the study area as well in Sec. 31.

HABITAT

Environment: Sparse sagebrush plains and grasslands to lower mountain slopes most often on calcareous, well-drained substrates.

Soils: Soils are characteristically entisols or rocky loams, with high calcium carbonate concentrations. The Scratchgravel Hills site is located on a gravel pavement of limestone.

Vegetation: The typical plant association is dominated by the plant association of bluebunch wheatgrass (*Pseudoroegneria spicata*), as found at the study site. It has occasionally been found in low elevation plant associations of needle-and-thread ñ needleleaf sedge (*Stipa comata* ñ *Carex filifolia*; Heidel 1997b). The associated species in the Scratchgravel Hills include:

Figure 6



Illustration by Jeanne R. Janish
From 'Vascular Plants of the Pacific Northwest'

Oxytropis lagopus* var. *conjugens
Rabbitsfoot crazyweed

Chrysopsis villosa
Douglasia montana
Koeleria macrantha
Pseudoroegneria spicata
Selaginella densa

SPECIES BIOLOGY

Life history: *Oxytropis lagopus* var. *conjugens* belongs to a guild of early-flowering plants, completing its flowering activity during May. This is an adaptation to its stressful habitat, taking advantage of early-season moisture. Recruitment and longevity are not known.

Reproduction: Sexually reproducing by cross-pollination. Casual observations of seed-set show high level of fertilization.

Dispersal: Unknown. The shaggy fruits fall to the ground.

Biological interactions: This species seems to occupy sparsely-vegetated slopes and knobs. This may indicate that it is a poor competitor or has germination requirements for bare soil.

POPULATION BIOLOGY

Population size and condition: Plants were found at one point totaling less than 20 plants.

Population structure: Unknown. It may represent a segment of a larger population. The species is dependent on insects for pollination.

ASSESSMENT AND MANAGEMENT RECOMMENDATIONS

Threats to currently known populations: Immediate threats to the population were not identified. There are a few mining claims near it, signifying potential threat. It is at the top of a ridge slope that has leafy spurge encroachment at its base, and it could be impacted by indiscriminate spraying of herbicides and by noxious weed invasion in the future.

Management practices and response: Rabbit-foot crazyweed is an increaser under grazing (Heidel pers. obs.) as is the crazyweed genus in general. Its rarity in the study area may reflect the paucity of appropriate microhabitat and the good overall range conditions. Species of the crazyweed (*Oxytropis*) genus are generally considered undesirable by stockmen because they cause ilocoism that, in extreme cases, kill livestock.

Recommendations for maintaining viable populations: Noxious weed invasion or indiscriminate herbicide application are potential threats, though the high and dry settings in which this species occurs are likely to be the least suitable and last sites to be encroached. Deliberate management actions are not needed for maintaining the local Scratchgravel Hills population.

Recommendations for further assessment: It is recommended that distribution data continue to be collected for this taxon as a limited distribution species subject to periodic state rank review. It is not recommended for BLM status designation.

ECOLOGICAL RESULTS

Six plant associations were documented in the Scratchgravel Hills (Table 2). Status of plant associations is determined by their rangewide rarity (geographic extent) and composition uniqueness, in addition to attributes of the individual stands (quality and condition). The rangewide and statewide status of the plant associations are reflected in global- and state- ranks. There were no rare or unique plant associations documented in the study area, though exemplary individual stands of the *Pseudotsuga menziesii*/*Festuca scabrella* plant association and the *Pseudoroegneria spicata*-*Bouteloua gracilis* plant association were noteworthy for being diverse and relatively intact.

Table 2. Plant associations of the Scratchgravel Hills study area.

STRUCTURE	PLANT ASSOCIATION	CURRENT RANK ¹	PLOT NO.
Woodland	<i>Pinus ponderosa</i> / <i>Pseudoroegneria spicata</i> p.a.	G4 S4	001, 011, 012, 013, 015, 017, 018
Shrubland	<i>Pseudotsuga menziesii</i> / <i>Festuca scabrella</i> p.a.	G4 S4	008, 019
	<i>Artemisia tridentata</i> ssp. <i>vaseyana</i> / <i>Pseudoroegneria spicata</i> p.a.	G5 S5	005, 014
Grassland	<i>Pseudoroegneria spicata</i> ñ <i>Bouteloua gracilis</i> p.a.		002, 003, 006, 007, 009, 010, 020, 021
	<i>Festuca idahonis</i> ñ <i>Pseudoroegneria spicata</i> p.a.	G4 S4	004
	<i>Agropyron smithii</i> - <i>Bouteloua gracilis</i> p.a.	G5 S4	016

The prevailing plant associations in the Scratchgravel Hills are the *Pseudoroegneria spicata* ñ *Bouteloua gracilis* p.a., and the *Pinus ponderosa* / *Pseudoroegneria spicata* p.a. All other plant associations are inclusions within the other two associations and represent topographic, edaphic or disturbance history conditions. Wetland plant associations are degraded and sparse in draw bottoms.

¹ Ranking definitions

G1 S1 Critically imperiled

G2 S2 Imperiled

G3 S3 Vulnerable

G4 S4 Potentially secure

G5 S5 Secure

GU SU Major unresolved status question precludes ranking

Vegetation Descriptions: WOODLAND TYPES

***Pinus ponderosa/Pseudoroegneria spicata* plant association (G4 S4)**

syn. *Pinus ponderosa/Agropyron spicatum* or *Pinus ponderosa/Elymus spicatus*
(PINPON/PSESPI; ponderosa pine/bluebunch wheatgrass; 7 plots)

Environment: PINPON/PSESPI is the prevalent woodland type in the Scratchgravel Hills, covering the highest hills, and part of some ridges and broken topography, including small outlying stands. It forms a timbered island in the Helena Valley. It spans the upper range of topographic positions, all aspects, and the full range of slopes present in the landscape (0-35%); particularly steep slopes.

Soils: This vegetation type is most extensive and continuous on the highest hills, with their coarse, relatively sterile sandy loams formed from intrusive igneous parent material, mapped as Woodgulch-rock outcrop complex, 8-35% slope (Bingham et al. 1977). It is well-developed but less extensive on the loams and broken topography of sedimentary deposits to west, mapped as Whitecow-Roto-Pensore channery loams, 8-35% slope. It is ecotonal and discontinuous on the metamorphic parent material and the Tertiary volcanics in between.

Vegetation: PINPON/AGRSPI in much of the Scratchgravel Hills approaches a closed-canopy structure. This reflects the history of logging, and high levels of regeneration in the absence of fire. The canopy cover of dense stands resembles forested vegetation, though the canopy height, and community structure or lack of it, reflect the original woodland condition. The varied size classes of most stands suggest that the logging history or at least the stand regeneration patterns were staggered rather than episodic. There are many trees persisting in this plant association that probably pre-date settlement, but they would have been sapling size before the turn of the century. For example, two typical trees of Ponderosa pine and Douglas fir, both at about 8 in DBH were bored and determined to be 158 and 167 years old, respectively. The majority of canopy trees in much of this community are close to 100 years old and equal to or less than 5 in DBH. These trees and younger trees have an outermost zone of rings that are very narrow and faint, a pattern which is interpreted to reflect canopy closure. Nearly all of the few old-growth pine trees in the area that significantly predate settlement are outlying individuals surrounded by grassland, including a few mature trees of over 35 in DBH. The historic PINPON/AGRSPI p.a. may have had more of a savanna structure compared to current conditions. Research in photographic archives may help resolve this matter.

In extreme cases of even-aged stand regeneration, there is almost no undergrowth. Mixed age stand structure is found in all of the patchy and ecotone transition pine cover in the center, and in the more broken topography at the west end. Among the latter are semi-open slopes with luxuriant grass cover that may reflect natural parkland conditions, and they have high species diversity, with some of the highest levels of litter cover found locally.

A significant component of Douglas fir (*Pseudotsuga menziesii*) is present throughout the plant association, raising a question about the successional status of the PINPON/PSESPI p.a. as found in the Scratchgravel Hills. The canopy cover of Douglas fir compared to ponderosa pine varies, but it consistently matches or exceeds the cover of pine in the understory, often forming dog-hair patches of saplings. It appears that Douglas-fir may be the climax type in the Hills in the absence of fire. Usually Douglas-fir as climax type is restricted to settings with over 141 of annual precipitation, but the Scratchgravel Hills would appear to be an exception. Limber pine (*Pinus flexilis*) is also present as a canopy tree in low densities throughout much of the area, even on soils derived from igneous parent material.

Typical herbaceous species on igneous parent material include small-flowered penstemon (*Penstemon procerus*). Typical herbaceous species on sedimentary parent material vary with moisture regime but include: moss phlox (*Phlox bryoides*), gray hawkbeard (*Crepis intermedia*), and ballhead sandwort (*Arenaria congesta*). A local variant with an understory of bearberry (*Arctostaphylos uva-ursi*) was found on patches of north-facing slopes and ridge-top barrens. Throughout much of the area, particularly in closed canopies and on sterile soils, the undergrowth is very sparse and bare ground or needle litter is exposed.

This type spans an array of parent materials and other environmental conditions, and has been most-altered by disturbance among all plant associations in the Scratchgravel Hills. It has a pervasive logging history. There were signs of recently logging of a couple mature trees. Mining activity was extensive. The old adits, pits and connecting roads represent frontiers for noxious weed invasion. Evidence of a recent wildfire within the past three years was found on a steep hillslope where less than an acre burned. The increased tree density over much of the area is accompanied by a decrease in understory density, so that woodland fires are unlikely to spread with the possible exception of high-intensity burns (stand-replacing fires).

***Pseudotsuga menziesii*/Festuca scabrella plant association (G4 S4)**

(PSEMEN/FESSCA: Douglas-fir/rough fescue; 2 plots)

Environment: North- and northeast-facing slopes at the head of Iron Gulch support a Douglas-fir stand. This represents the most sheltered setting on the largest promontory of the study area. The Hills in general represent an unusually arid setting for such a mesic plant association.

Soils: The soils are mapped as Woodgulch-rock outcrop complex, 8-35% slope, a loamy sand (Bingham et al. 1977). The litter and duff layers are deep compared to the other local communities, and the organic content of the soil may account for its relatively high moisture-holding capacity.

Vegetation: The PSEMEN/FESSCA p.a. present in the Hills is floristically well-developed, locally distinct, and relatively diverse. Over half of the stand is relatively open with about 50% tree canopy cover and dominated mainly by large, old-growth Douglas fir trees. Most have been damaged by lightning or wind. The oldest trees are over 300 years old, as determined by cores. The remainder of the stand is dominated by pole-size and mature timber. The cover of rough fescue (*Festuca scabrella*) varies with canopy closure, ranging from 30% under closed canopy to 90% under open canopy.

The undergrowth in well-developed settings has a major component of old manís whiskers (*Geum triflorum*; 20%) and a milkvetch (*Astragalus miser*; up to 5%). The moss cover was far higher than in other local plant associations (10-20%) reflecting both mesic conditions and lack of disturbance. Other vascular plant species in this community which were not found elsewhere locally include nodding onion (*Allium cernuum*), pasqueflower (*Anemone patens*), heart-leaved arnica (*Arnica cordifolia*), small-flowered blue-eyed Mary (*Collinsia parviflora*), northern hedysarum (*Hedysarum boreale*) and small-leaved alumroot (*Heuchera parvifolia*).

Vegetation Descriptions: SHRUBLAND TYPE

***Artemisia tridentata* ssp. *vaseyana* / *Pseudoroegneria spicata* plant association**
(syn. *Artemisia tridentata*/*Agropyron spicatum*, *Artemisia tridentata*/*Elymus spicatus*)
(G5 S5)

(ARTTRV/PSESPI; /mountain big sagebrush/bluebunch wheatgrass; 2 plots)

Environment: ARTTRV/PSESPI occurs in small, discretely different environmental settings, perhaps representing an assortment of microhabitats that have a longer fire-free interval. These include exposed segments of steep, open hillsides; small, level openings within woodland; and small bald spots on open ridge. It was sampled on a south-facing, midslope spur surrounded by a sparse PSESPI-BOUGRA p.a. above Iron Gulch, and in a level woodland opening surrounded by a PINPON/PSESPI p.a. in the breaklands north of Echo Lane.

Artemisia tridentata is also abundant but secondary to *Pseudoroegneria spicata* on the alluvium that flanks the eastern end of the Scratchgravel Hills study area, and on a variety of small ridgeline barrens with a continuous range of cover values variously making it dominant or secondary.

Soils: The two sample sites have Hauz-Tolman channery loam and the loamy Musselshell-Crago complex, derived from metamorphic and sedimentary materials, respectively.

Vegetation: These shrubland associations more closely resemble the grassland associations in the vicinity than they resemble one another. Sample plots are provisionally assigned to mountain big sage dominance (*Artemisia tridentata* ssp. *vaseyana*), though Wyoming big sage (*Artemisia tridentata* ssp. *wyomingensis*) is also common in the grassland perimeter. The latter is not known as a dominant in the study area, but is perhaps most abundant on alluvium at the east end. This taxonomic distinction between these subspecies, representing the prevalent Rocky Mountains subspecies and Great Plains subspecies, warrants closer on-site evaluation. The two plots differ greatly in shrub stature corresponding with slope and moisture. Besides dominant species, they have Hoodís phlox (*Phlox hoodii*) and fringed sage (*Artemisia frigida*) in common.

Vegetation Descriptions: GRASSLAND TYPES

***Pseudoroegneria spicata* ñ *Bouteloua gracilis* plant association (G4 S4)**

syn. *Agropyron spicatum* ñ *Bouteloua gracilis*; *Elymus spicatus* ñ *Bouteloua gracilis*
(PSESPI-BOUGRA; bluebunch wheatgrass-blue grama; 8 plots)

Environment: The PSESPI-BOUGRA p.a. encircles most of the Scratchgravel Hills on the flanks, toeslopes and exposed ridge slopes, as well as on the alluvium at the eastern end. It occupies all topographic positions, depending on the aspect and substrate. Typical and extreme sites were sampled including an exposed ridgetop, the steep ridge slopes at the north end, and the expansive grassland margins on the south side. There are some forested openings in the western end dominated by bluebunch wheatgrass with a well-developed grassland flora that are treated as wooded plant associations though tree cover is less than 30%.

Soils: Soils are channery loams and sandy loams. The particle size for the latter is just short of the gravel size class. Bare soil or the ìcoarse-sandî covers over 50% to nearly all the ground surface.

Vegetation: Bluebunch wheatgrass is dominant in the Hills, without the widely-recognized co-dominants of Sandberg's bluegrass (*Poa secunda*) in montane settings, or blue grama (*Bouteloua gracilis*) in plains settings. The only exception where there is a blue grama component of 5% or greater is found on the lowest elevation sites. This corresponds with the alluvial flats at the eastern end of the study area. Elsewhere blue grama is in trace amounts, and junegrass (*Koeleria macranthera*) contributes a relatively larger component. The paucity of blue grama may be due to the fact that it has a shallow root system not suited to the droughty upper horizons of local soils, or that it is a warm-season (C4) grass not suited to the cool-season growth fostered by the setting.

The plant association has a conspicuous bunchgrass appearance, typically with about 30% cover by *Pseudoroegneria spicata*; ranging from about 15-50% on exposed ridgelines and as forest inclusions, respectively. Species composition changes dramatically with the moisture gradient and substrate, and sample plots in this p.a. had high species diversity individually and collectively.

This is also the prevailing plant association of the Fort Harrison Military Reservation nearby on the south side of the Sevenmile Creek (Ken Scow pers. commun.). It was also observed on lands to the west, and considered as typical for the Helena Valley.

***Festuca idahoensis* - *Pseudoroegneria spicata* plant association (G4 S4)**

syn. *Festuca idahoensis*-*Agropyron spicatum*, *Festuca idahoensis*-*Elymus spicatus*
(FESIDA-AGRSPI; bluebunch wheatgrass-Idaho fescue; 1 plot)

Environment: FESIDA-AGRSPI p.a. is on a steep, east-facing, open side-ridge surrounded by woodland. It is thought to represent a localized grassland climax in the more sheltered settings on the contact metamorphics that are in broken bands around the highest hills.

Soils: Soils mapping does not distinguish this area from the surrounding Woodgulch-rock outcrop complex derived from granodiorite, yet the soils were rocky relatively deep, with a loamy texture; and species composition indicated a high calcium concentration.

Vegetation: This is provisionally treated as discrete from the preceding p.a. based on the significant *Festuca idahoensis* component and the highest local cover values recorded for pussytoes (*Antennaria* spp.) and compact selaginella (*Selaginella densa*). It is the only p.a. with plant material making up over 50% of ground cover, and has relatively high total grass cover (close to 50%). Some of the more locally distinguishing associated species included: Rocky Mountain douglasia (*Douglasia montana*), Rocky Mountain woodsia (*Woodsia scopulina*), and wiry milkvetch (*Astragalus flexuosus*). It also harbored linearleaf fleabane (*Erigeron lineare*).

***Pascopyrum smithii* -*Bouteloua gracilis* p.a. (G5 S4)**

Syn. *Agropyron smithii*-*Bouteloua gracilis*, *Elymus smithii*-*Bouteloua gracilis*
(PASSMI-BOUGRA; western wheatgrass-blue grama; 1 plot)

Environment: PASSMI-BOUGRA is a Great Plains plant association found in one large toeslope area on the south side of the Hills, gently rolling at less than 10% slope.

Soils: It is mapped as Crittenden sandy loam, very rocky; but appeared in the field as an even-textured silt loam.

Vegetation: This is the only rhizomatous grassland community in the Hills, and it is a vigorous example with over 50% grass cover total. It has plains species that are absent or rare elsewhere locally, including: green sage (*Artemisia dracuncululus*), scarlet globe-mallow (*Sphaeralcea coccinea*) western gromwell (*Lithospermum ruderale*), indian wheat (*Plantago patagonica*) and rush skeletonweed (*Lygodesmia juncea*).

DISCUSSION

The results of the Scratchgravel Hills baseline survey represent a biological crossroads pattern, made up of four sets of noteworthy features:

1. Lesser rushy milkvetch (*Astragalus convallarius*) is a rare Great Basin plant species that is disjunct and at the northern end of its range in the Helena Valley. It is among the four best examples in the state, and is one of two or three that are primarily on public land without competing uses.
2. Linearleaf fleabane (*Erigeron linearis*) is a rare Columbia Plateau plant species that is disjunct and at the eastern end of its range in the Helena Valley. Though the population is small, it is the best of the two occurrences in the state for which detailed information is available.
3. Two taxa are present that are recognized on the watch list because they live primarily or exclusively in Montana and nowhere else in the world (endemic), though they are not under apparent threat. They are present in the Scratchgravel Hills in low numbers, including Klausí bladderpod (*Lesquerella klausii*) and rabbitsfoot crazyweed (*Oxytropis lagopus* var. *conjugens*).
4. Two relatively intact and well-developed Rocky Mountain plant associations are noteworthy for their site-specific conditions though not for their plant association rarity; the Douglas-fir/rough fescue plant association (*Pseudotsuga menziesii*/*Festuca scabrella* p.a.), and the foothills form of the bluebunch wheatgrass plant association (*Pseudoroegneria spicata* ñ *Bouteloua gracilis* p.a.). The Douglas-fir/rough fescue p.a. is a well-developed and relatively intact Rocky Mountain vegetation type has an old-growth component and an exceptionally mesic flora for such a dry landscape. The bluebunch wheatgrass ñ blue grama p.a. is also a relatively intact Rocky Mountain vegetation type.

One of these, the lesser rushy milkvetch occurrence, represents among the best examples in the state. Two more of these represent the only documented examples in the Helena Valley and among the most unusual examples in the state, including the linearleaf fleabane occurrence and the Douglas fir/rough fescue plant association.

The combination of botanical and ecological features in the Scratchgravel Hills points to an existing opportunity to safeguard state-level biodiversity in the Headwaters Resource Area. The most serious imminent threats to these values are noxious weed encroachment, summarized in this paragraph. Leafy spurge (*Euphorbia esula*) is invading along the watercourses, most serious along the Iron Gulch road and bottoms, Iowa Gulch and the watercourse below Echo Drive. It is invading along upland roads, with sporadic encroachments even along the spur to the summit. It is found at a few mine sites, and is uncommon in undisturbed natural habitat, perhaps dispersed by animals that are known to feed on it,

like whitetail deer or mourning doves. Spotted knapweed (*Centaurea maculosa*) is the noxious weed most consistently found at old mine sites, including pits where it is in broad, dense swathes. It is also readily distributed along roads and trails, and is usually present in the same settings where leafy spurge is found. Diffuse knapweed (*Centaurea diffusa*) is less common of the three species and is found on the finger ridge above Echo Drive and at the far eastern end on alluvium. Yet the Scratchgravel Hills have low weed numbers compared to some of the surrounding lowlands, suggesting that they may be a sink rather than a source. In light of their central location, and the wind and wildlife distribution vectors of the weeds, the Hills could become a major source of noxious weeds in the Helena Valley if Scratchgravel Hills infestations are not kept in check.

This study documents two Montana plant species of special concern and two outstanding plant associations that are unprotected or only partially protected elsewhere in the Helena valley. In the evaluation process, we have ruled out the presence of globally imperiled features or exemplary state botanical and vegetation features. The relative state biodiversity significance of the Scratchgravel Hills hinges on a few unknown factors. These include:

1. The species' status of lesser rushy milkvetch is likely to be refined or confirmed with more survey work and information on its persistence, e.g., at the Chatham site.
2. The protection status of low elevation sites of Douglas-fir/rough fescue in Montana are to be reviewed among Forest Service protected areas to evaluate the relative significance of the Scratchgravel Hills stand.
3. The success at curtailing noxious weed invasion in the Hills conditions the viability of these Scratchgravel Hills features into the future.

This study does not integrate recreation values, cultural values or animal biodiversity and values associated with game or nongame species; all of which factor into effective management planning. It does contribute to the landscape overview and inventory of resources, for further management consideration and reference.

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Appendix A. Element Occurrences

Scientific Name: ASTRAGALUS CONVALLARIUS
Common Name: LESSER RUSHY MILKVETCH

Global rank: G5T5 Forest Service status:
State rank: S2 Federal Status:

Element occurrence code: PDFAB0F2D1.009
Element occurrence type:
Survey site name: SCRATCHGRAVEL HILLS EO rank: A
EO rank comments:

County: LEWIS AND CLARK

USGS quadrangle: AUSTIN, SCRATCHGRAVEL HILLS

Township: Range: Section: TRS comments:
011N 004W 29 NW4; 20 SW4; 27 SW4; 28; 31 W2; 33 E2; 34 NW4
010N 004W 4 NE4

Precision: S
Survey date: 1997-07-31 Elevation: 4300 - 4800
First observation: 1997-06-20 Slope/aspect: 0-15%/ALL ASPECTS
Last observation: 1997-07-31 Size (acres):

Location: SCRATCHGRAVEL HILLS, NNW OF HELENA.

Element occurrence data:

CA. 5000+ PLANTS WIDELY DISPERSED IN MANY LOW DENSITY SUBPOPULATIONS ACCROSS FULL RANGE OF SPECIES' POTENTIAL HABITAT. FLOWERING LATE JUNE TO MID-AUGUST IN 1997. TYPICALLY SINGLE-STEMMED, BUT SECTION 31 HAD ROBUST, MULTI-STEMMED ROOT CROWNS.

General site description:

OPENINGS, OPEN WOODS, AND ON GRASSLANDS ADJOINING WOODS AND DRAINAGE COURSES, ON MAINLY LOAMY SOILS OF MAINLY SEDIMENTARY ORIGIN. WHILE IT OCCUPIES THE PREVALENT ASSOCIATIONS OF AGROPYRON SPICATUM WITHOUT PINUS PONDEROSA, IT IS OFTEN AT ECOTONES OR TRANSITIONS WITHIN THE MATRIX. ASSOCIATED SPECIES VARIOUSLY INCLUDE CREPIS INTERMEDIA, ZIGADENUS VENOSUS, PHLOX MUSCOIDES, CHRYSOPSIS VILLOSA, BOUTELOUA GRACILIS, STIPA COMATA OR FESTUCA SCABRELLA.

Land owner/manager:

BLM: BUTTE DISTRICT, HEADWATERS RESOURCE AREA
PRIVATELY OWNED LAND (INDIVIDUAL OR CORPORATE)

Comments:

THE HIGHEST DENSITIES ARE IN THE SECTION 31 WATERCOURSE FOLLOWED BY THE SECTION 20 FOREST OPENINGS. LEAFY SPURGE AND SPOTTED KNAPWEED ARE IMMINENT THREATS.

Information source: HEIDEL, BONNIE. [BOTANIST] MONTANA NATURAL HERITAGE PROGRAM, 1515 EAST SIXTH AVENUE, P.O. BOX 201800, HELENA, MT 59620-1800. WORK: 406/444-3009.

Specimens: HEIDEL, B. (1562). 1997. MONTU.
HEIDEL, B. (1570, 1595). 1997. MONT.

Scientific Name: ERIGERON LINEARIS
Common Name: LINEARLEAF FLEABANE

Global rank: G5 Forest Service status: SENSITIVE
State rank: S1 Federal Status:

Element occurrence code: PDAST3M2B0.004
Element occurrence type:
Survey site name: SCRATCHGRAVEL HILLS
EO rank:
EO rank comments:

County: LEWIS AND CLARK

USGS quadrangle: SCRATCHGRAVEL HILLS

Township: Range: Section: TRS comments:
011N 004W 28 SE4; 26 NE4SW4

Precision: S
Survey date: Elevation: 4400 - 4480
First observation: 1997-06-21 Slope/aspect: 2-30%/SOUTH AND EAST
Last observation: 1997-06-24 Size (acres): 1

Location:

CA. 4 MILES NORTHWEST OF HELENA; ACCESSIBLE VIA ECHO DRIVE ON THE WEST SIDE OF THE SCRATCHGRAVEL HILLS, AND VIA NORRIS ROAD TURN ON THE EAST SIDE.

Element occurrence data:

OVER 200 PLANTS IN TWO SUBPOPULATIONS, LOCALLY COMMON IN SMALL CLUSTERS IN SECTION 28, BUT OCCASIONAL AND MORE SPREAD OUT IN SECTION 26; BOTH WITH VIGOROUS MULTI-STEMMED CLUMPS. PLANTS IN SECTION 28 WERE STILL FLOWERING IN LATE JUNE WHEN THOSE IN SECTION 26 HAD NEARLY FINISHED, EVEN THOUGH THE SECTION 28 SETTING SEEMED MUCH MORE ARID AND HARSH.

General site description:

TWO CONTRASTING SETTINGS INCLUDING A STEEP GRASSLAND SLOPE OPENING SURROUNDED BY FOREST WITH AGROPYRON SPICATUM-FESTUCA IDAHOENSIS HT PLUS LOMATIUM TRITERNATUM, HAPLOPAPPUS ACAULIS AND SENECIO CANUS; AND A SPARSELY-VEGETATED SAGE BALD ON AN OPEN BENCH DOMINATED BY ARTEMISIA TRIDENTATA AND AGROPYRON SPICATUM WITH LEWISIA REDIVIVA AND ERIGERON COMPOSITUS.

Land owner/manager:

BLM: BUTTE DISTRICT, HEADWATERS RESOURCE AREA

Comments:

SURVEY IN SECTION 26 WAS NOT COMPLETE BECAUSE PLANTS WERE NOT IN FLOWER.

Information source: HEIDEL, BONNIE. [BOTANIST] MONTANA NATURAL HERITAGE PROGRAM, 1515 EAST SIXTH AVENUE, P.O. BOX 201800, HELENA, MT 59620-1800. WORK: 406/444-3009.

Specimens: HEIDEL, B. L. (1567, 1568). 1997. MONTU.

Appendix B. Photo Documentation

1. Lesser rushy milkvetch (*Astragalus convallarius*)
2. Linearleaf fleabance (*Erigeron linearis*)
3. Klausí bladderpod (*Lesquerella klausii*)
4. Woodland opening habitat supporting Klausí bladderpod
5. Rabbitsfoot crazyweed (*Oxytropis lagopus* var. *conjugens*)
6. Bluebunch wheatgrass perimeter; looking south to Helena
7. Typical ponderosa pine/bluebunch wheatgrass plant association
8. Coring mature Douglas-fir in the Douglas-fir/rough fescue plant association
9. Bitterroot (*Lewisia rediviva*), a common plant in the Scratchgravel Hills

Not reproduced in on-line version. See Rare Plant Field Guide. <http://nhp.nris.state.mt.us/plants/index.html>

Appendix C. Preliminary flora of the Scratchgravel Hills¹

Trees

Juniperus scopulorum
Pinus flexilis
Pinus ponderosa
Populus acuminata
Prunus mahaleb
Pseudotsuga menziesii

Shrubs and vines

Arctostaphylos uva-ursi
Artemisia frigida
Artemisia tridentata ssp. *vaseyana*
Artemisia tridentata ssp. *wyomingensis*
Ceratoides lanata
Chrysothamnus nauseosus
Chrysothamnus viscidiflorus
Clematis ligusticifolia
Gutierrezia sarothrae
Rhus aromatica
Ribes aureum
Ribes cereum
Rosa woodsii
Shepherdia canadensis
Symphoricarpos spp.

Grasses and grass-like plants

*Agropyron cristatum**
Aristida longiseta
Bouteloua gracilis
*Bromus inermis**
*Bromus japonicus**
*Bromis tectorum**
Calamagrostis purpurascens
Carex filifolia
Carex geeyeri
Carex petasata
Carex stenophylla
Elymus lanceolatus (*Agropyron dasystachyum*)
Elymus smithii (*Pascopyrum smithii*)
Elymus spicatus (*Pseudoregneria spicata*)
Festuca idahonis
Festuca scabrella
Koeleria macrantha
Muhlenbergia cuspidata
Oryzopsis hymenoides
Poa nevadensis
*Poa pratensis**
Poa secunda
Stipa comata
Stipa viridula

¹ An asterisk after the species name indicates that the species is exotic (non-native).

Herbs (includes ferns)

Achillea millefolium

Allium cernuum

Allium textile

Anemone patens

Antennaria dimorpha

Antennaria parvifolia

Antennaria plantaginea

Antennaria spp.

Achillea millefolium

Allium cernuum

Allium textile

*Alyssum desertorum**

Amaranthus albus

Ambrosia spp.

Androsace occidentalis

Anemone patens

Antennaria corymbosa

Antennaria microphylla

Antennaria parvifolia

Arabis holboellii

Arabis microphylla

Arenaria congesta

Arnica cordifolia

Artemisa campestris

Artemisia dracuncululus

Artemisia ludoviciana

Aster alpigenus

Astragalus agrestis

Astragalus bisulcatus

Astragalus convallarius

Astragalus flexuosus

Astragalus gilviflorus

Astragalus lotiflorus

Astragalus miser

Astragalus purshii

*Camelina sativa**

Campanula rotundifolia

Castilleja flava

*Centaurea diffusa**

*Centaurea maculosa**

*Chenopodium album**

Chenopodium fremontii

Cirsium undulatum

Chrysopsis villosa

Collinsia parviflora

Comandra umbellata

*Convolvulus arvensis**

Conyza canadensis

Coryphantha missouriensis

Crepis acuminata

Crepis intermedia

Cryptantha torreyi

Cymopterus acaulis
*Cynoglossum officinale**
Cystopteris fragilis
*Descurainia pinnata**
Dodecatheon conjugens
Douglasia montana
Draba reptans
Erigeron caespitosum
Erigeron compositus
Erigeron lineare
Eriogonum flavum
Eriogonum spp. (E. mancum?)
Eriogonum umbellatum
Erysimum asperum
*Euphorbia esula**
Evolvulus nuttallii
Filago arvensis
Fragaria virginiana
Gaillardia aristata
Galium boreale
Gaura coccinea
Gayophyton spp.
Geum triflorum
Grindelia squarrosa
Hackelia floribunda
Haplopappus acaulis
Hedysarum boreale
Heuchera parvifolia
Hymenopappus filifolius
Hymenoxys acaulis
Hymenoxys richardsonii
*Hyoscyamus niger**
Lappula redowskii
Lepidium densiflorum
*Lepidium perfoliatum**
Leptodactylon pungens
Lesquerella alpina
Lesquerella klausii
Lewisia rediviva
Liatris punctata
*Linaria dalmatica**
Linum lewisii
Lithospermum incisum
Lithospermum ruderales
Lomatium macrocarpum
Lomatium triternatum
Lygodesmia juncea
*Medicago lupulina**
*Medicago sativa**
*Melilotus officinalis**
Mentzelia dispersa
Musineon divaricatum
Nothocalais troximoides
Oenothera caespitosa

Opuntia polyacantha
Orobanche fasciculata
Oxytropis lagopus var. *conjugens*
Oxytropis sericea
Paronychia sessiliflora
Penstemon diphyllus
Penstemon eriantherus
Penstemon nitidus
Penstemon procerus
Phlox albomarginata
Phlox bryoides
Phlox hoodii
Plantago patagonica
Polygonum spp.
Potentilla spp. (*P. concinna*?)
Potentilla glandulosa
*Salsola kali**
Sedum lanceolatum
Selaginella densa
Senecio canus
Sisymbrium altissimum
Solidago occidentalis
Solidago spp.
Sphaeroclea coccinea
Stephanomeria runcinata
*Taraxacum officinale**
Townsendia hookeri
Tragopogon miscellus
Trifolium spp.*
*Verbascum thapsus**
Viola nuttallii

Appendix D. ECODATA analysis

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