

ECOLOGICAL EVALUATION OF
THE POTENTIAL ARROW MOUNTAIN RESEARCH NATURAL AREA
WITHIN THE SHOSHONE NATIONAL FOREST,
FREMONT COUNTY, WYOMING

Prepared for the
Shoshone National Forest,
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PARK COUNTY, WYOMING

INTRODUCTION

The potential Arrow Mountain Research Natural Area (RNA) is located on the eastern flank of the Wind River Mountains in west-central Wyoming. The area includes foothills grasslands and shrublands, montane and subalpine forests, and alpine tundra characteristic of calcareous bedrock in the region, populations of two vascular plants on the Forest Service Region 2 Sensitive Species list, and populations of 13 more vascular plants of limited distribution in the region. The potential RNA is in the Shoshone National Forest and is used primarily for recreation, watershed protection, and wildlife habitat.

In 1997, The Nature Conservancy entered a contract with the USDA Forest Service, Shoshone National Forest, to prepare ecological evaluations of areas in the Forest for use by the Forest Service in examining the suitability of the areas as research natural areas. The evaluation of the Arrow Mountain area was done by the Wyoming Natural Diversity Database. This report presents the results of that evaluation.

Land Management Planning

In 1997, Arrow Mountain was selected by USDA Forest Service staff as a potential RNA for possible analysis during revision of the Land and Resource Management Plan. This ecological evaluation is intended to aid the Forest Service staff in that analysis.

OBJECTIVES

One of the primary objectives of research natural areas is to "...preserve a wide spectrum of pristine representative areas that typify important forest, shrubland, grassland, alpine, aquatic, geologic and similar natural situations..." (Forest Service Manual 4063.02).

The objectives of an Arrow Mountain RNA would be to 1) maintain a reference area for (a) monitoring effects of resource management techniques and practices applied to similar ecosystems, (b) comparing results from manipulative research, and (c) determining the range of natural variability; 2) protect elements of biological diversity; 3) provide a site for non-manipulative scientific research; and 4) provide on-site and extension educational opportunities.

PRINCIPAL DISTINGUISHING FEATURES

The principal distinguishing features of the potential Arrow Mountain RNA include northeastward-facing, limestone and dolomite mountain slopes and the steep-walled canyons of three northeastward-flowing, perennial streams. A notable feature is the large proportion of the alpine zone underlain by dolomite and conglomerate, and the small proportion on granitic rock. Vegetation in the area varies from grassland and sagebrush shrubland in the foothills, through montane and subalpine woodlands and forests, to alpine tundra. The alpine zone consists mainly of vegetation associated most often with calcareous sandstones and carbonate sediments. Fifteen vascular plant species of limited distribution in the region grow in the alpine zone. Many of these plants have a strong affinity for calcareous substrates.

LOCATION

The potential Arrow Mountain RNA is located within the Shoshone National Forest in west-central Wyoming. The approximate center of the potential RNA is at latitude 43^o23'30" North and longitude 109^o31'20" West.

The potential RNA includes all or parts of the following sections (all on the 6th Principal Meridian): T39N, R105W, Sec 4, 5, 6, 7, 8, 9, 16, 17, 18; T39N, R106W, Sec 1, 2, 3, 10, 11, 12, 13, 14, 15; T40N, R105W, Sec 34, 31, 32; T40N, R106W, Sec 13, 23, 24, 25, 26, 27, 34, 35, 36.

Boundary

(See Figure 1).

The proposed boundary of the potential RNA follows administrative boundaries and topographic features. On the east side, the boundary of the potential RNA follows the boundary of the Shoshone National Forest. On the north, the boundary follows the National Forest boundary and the foot of the south wall of the valley of Torrey Creek. On the west, the northern-most ca. 1 mile (1.6 km) of the boundary of the potential RNA follows the divide between drainages of two tributaries of Torrey Creek, and the remainder of the western boundary follows the divide between the drainage of Torrey Creek on the west and the drainages of Blue Hole, Little Red Creek, and Red Creek on the east. On the south, the boundary follows the divide between the drainage of Red Creek on the north and Dinwoody Creek on the south.

Area

The total area of the potential Arrow Mountain RNA is ca. 14,216 acres (5757 ha).

Elevation

The elevation of the potential Arrow Mountain RNA ranges from ca. 7600 feet (2318 m) at the northern end of the area to ca. 11,696 feet (3567 m) at the southwestern corner.

Access

The potential Arrow Mountain RNA may be reached via foot or horseback from National Forest Trail 801 (the Glacier Trail) along the western boundary.

Ecoregion

The potential Arrow Mountain RNA lies within the Southern Rocky Mountain Steppe-Open Woodland-Coniferous Forest-Alpine Meadow Province, Wind River Mountains Section (M331J) of the ecoregion classification of Bailey et al. (1994) (Freeouf 1996).

Maps

USDA Forest Service 1/2 inch = 1 mile scale map of the Shoshone National Forest.

USDI Geological Survey 7.5-minute topographic Quadrangle Maps: Blue Holes, Hays Park, Ink Wells, and Torrey Lake quads.

VEGETATION

Description

Field work in 1998 revealed the presence of the following plant associations (Anderson et al. 1998) in the potential Lake Creek RNA: *Picea engelmannii*/*Juniperus communis* Forest, *Pinus albicaulis*/*Vaccinium scoparium* Woodland, *Pinus albicaulis*/*Juniperus communis* Woodland, *Pinus contorta*/*Juniperus contorta* Woodland, *Pinus flexilis*/*Juniperus communis* Woodland, *Pseudotsuga menziesii*/*Juniperus communis* Forest, *Populus angustifolia*/*Rosa woodsii* Forest, *Artemisia tridentata* ssp. *vaseyana*/*Pseudoroegneria spicata* Shrubland, *Dryas octopetala*/*Carex rupestris* Dwarf-Shrubland, *Salix arctica* Dwarf-Shrubland, *Salix drummondiana* Shrubland, *Salix planifolia*/*Carex scopulorum* Shrubland, *Carex elynoides* Herbaceous Vegetation, *Carex nelsonii* Herbaceous Vegetation, *Carex scirpoidea*/*Potentilla diversifolia* Herbaceous Vegetation, *Festuca idahoensis* Herbaceous Vegetation, *Geum rossii*/*Trifolium* spp. Herbaceous vegetation, *Mertensia ciliata* Herbaceous Vegetation, *Pseudoroegneria spicata*-*Poa secunda* Herbaceous Vegetation. Synonyms are shown in Appendix 5. Data from sample plots and descriptions of vegetation at various locations are given in Appendix 3.

Upland vegetation

In the foothills and the montane zone of the potential RNA, below elevations of approximately 8600 feet (2623 m) on north-

facing slopes and in valley bottoms to approximately 9600 feet (2928 m) on south-facing slopes, the vegetation is a mix of montane woodland and forest with openings of grassland and sagebrush shrubland. The woodland and forest is a mosaic of several types that blend into one another. *Pseudotsuga menziesii*/*Juniperus communis* forest appears to cover the most area, primarily on north- and east-facing slopes (locations 34, 38). South-facing slopes (and the few west-facing exposures) support *Pinus flexilis*/*Juniperus communis* woodland (locations 34b, 39b). Both of these types contain *Picea engelmannii*, especially at the higher elevations. One stand of *Pinus contorta*/*Juniperus communis* woodland was encountered in the valley of Little Red Creek (location 35).

The non-forested vegetation in the foothills and montane zone consists of *Artemisia tridentata* ssp. *vaseyana*/*Pseudoroegneria spicata* shrubland on lower slopes and in valley bottoms (locations 36, 37a), and *Pseudoroegneria spicata*-*Poa secunda* grassland on middle and upper slopes (Table 305, locations 36b, 37b). These two types merge into one another. Seedlings and saplings of *Pinus flexilis* are common in the sagebrush shrubland.

In the subalpine zone, the vegetation consists of forest and woodland, usually with a mixed overstory. *Picea engelmannii* dominates in most of the area, and the *Picea engelmannii*/*Juniperus communis* type (locations 22, 39a) and the *P. engelmannii*/*Ribes montigenum* type (locations 26, 28) apparently are the major subalpine types. *Pinus flexilis* is common at lower elevations and dominates on south-facing slopes, and the vegetation classifies as the *Pinus flexilis*/*Juniperus communis* woodland (locations 34b, 39b). *Pseudotsuga menziesii* is present in both of these types, and the subalpine forest merges with the *Pseudotsuga* - dominated montane woodland. At higher elevations, *Pinus albicaulis* is present in the forest and dominates on south-facing slopes (probably the *P. albicaulis*/*Juniperus communis* association, location 25). Both *Picea engelmannii* and *Pinus albicaulis* woodlands are found at timberline (locations 20, 21, 22). Non-forest vegetation in the subalpine zone apparently is mostly *Festuca idahoensis* grassland (location 23b), *Carex scirpoidea* Herbaceous Vegetation (locations 29 and 39c), and unclassified types (location 27)

In the alpine zone, the *Carex elynoides* turf appears to be far and away the most common vegetation type (Table 3-1, locations 30, 31, 33), covering most of the alpine zone on carbonate substrates. Other types covering small areas within the matrix of *C. elynoides* turf are *Carex rupestris* turf on various landscape positions (Table 3.3); *Carex scirpoidea*/*Potentilla diversifolia* turf on northerly aspects (Table 3-2, location 29); sparse *Dryas octopetala*/*Carex rupestris* dwarf-shrub vegetation on a dolomite dip slope at the head of Blue

Hole Creek (Table 3.6); and *Geum rossii*/*Trifolium* spp. vegetation (Table 3.4), apparently on sandstone and crystalline rocks.

Riparian and wetland vegetation

Field survey and aerial photographs indicate that riparian and wetland vegetation are minor types in the potential RNA, consisting of narrow fringes of shrubland and woodland along streams in the montane and subalpine zone and patches of herbaceous vegetation and shrubland in the alpine zone. A stand of *Populus angustifolia*/*Rosa woodsii* woodland was observed in the montane zone (location 37c), and patches of *Salix drummondiana* Shrubland (location 23a) and *Mertensia ciliata* Herbaceous Vegetation (location 24) were observed in the upper subalpine zone. In the alpine zone, patches of herbaceous wetland dominated by *Carex nelsonii* (plot 50.6) and *Salix planifolia*/*Carex scopulorum* shrubland (location 32) were both observed.

Area by Type

Kuchler vegetation types (Kuchler 1966) were mapped on 1:24,000-scale topographic maps using aerial photographs and field reconnaissance, and the area of each type was estimated from the maps.

Areas of complexes of plant community types (Table 2) were estimated in the same manner. (The vegetation map shows complexes because delineating stands of individual vegetation types was impossible.)

Table 1. Areas of Kuchler Types (Kuchler 1966) in the potential Arrow Mountain RNA See Figure 1.

<u>Cover Type</u>	<u>Acres</u>	<u>Hectares</u>
Douglas-fir forest (11)	3778	1530
Western spruce-fir forest (14)	3830	1551
Weatgrass-bluegrass (44) + Sagebrush steppe (49)	2732	1106
Alpine meadows and barrens (45)	3876	1570

Table 2. Areas of SAF cover types (Eyre 1980) in the potential Arrow Mountain RNA See Figure 1.

<u>Cover Type</u>	<u>Acres</u>	<u>Hectares</u>
Interior Douglas fir (210)	778	1530
Engelmann spruce-subalpine fir (206)	3830	1551
Other, non-SAF type	9608	3891

Table 3. Areas of complexes of plant community types in the potential Arrow Mountain RNA. Major communities in each complex are indicated by "(M)" following the names, and minor communities by "(m)". Appendix 5 contains synonyms.

<u>Complex</u>	<u>Acres</u>	<u>Hectares</u>
<i>Artemisia tridentata</i> ssp. <i>vaseyana</i> / <i>Pseudoroegneria spicata</i> (M) + <i>Pseudoroegneria spicata</i> - <i>Poa secunda</i> (M) + <i>Festuca idahoensis</i> (m)	2732	1106
<i>Pseudotsuga menziesii</i> / <i>Juniperus</i> <i>communis</i> (M) + <i>Pinus flexilis</i> / <i>Juniperus communis</i> (M) + <i>Populus</i> <i>angustifolia</i> / <i>Rosa woodsii</i> (m)	3778	1530
<i>Picea engelmannii</i> / <i>Juniperus communis</i> (M) + <i>Pinus flexilis</i> / <i>Juniperus communis</i> (M) + <i>Pinus albicaulis</i> / <i>Juniperus</i> <i>communis</i> (m) + <i>Salix drummondiana</i> (m) + <i>Mertensia ciliata</i> (m)	3830	1551
<i>Carex elynoides</i> (M) + <i>Carex rupestris</i> (m) + <i>Carex scirpoidea</i> / <i>Potentilla</i> <i>diversifolia</i> (m) + <i>Dryas octopetala</i> / <i>Carex</i> <i>rupestris</i> (m) + <i>Geum rossii</i> / <i>Trifolium</i> spp. (m) + <i>Carex nelsonii</i> (m) + <i>Salix</i> <i>arctica</i> (m) + <i>Salix planifolia</i> / <i>Carex</i> <i>scopulorum</i> (m)	3876	1570

PHYSICAL AND CLIMATIC CONDITIONS

Physical Setting

The potential Arrow Mountain RNA is located on the eastern flank of the Wind River Mountains. The main physical features in the area are broad, northeastward-facing slopes separated by steep-sided canyons cut by three northeastward-flowing, perennial streams.

Geology

The bedrock in the proposed RNA is mainly northeastward-dipping Madison limestone (Mississippian), Bighorn dolomite (Ordovician), and Flathead sandstone (Cambrian) (Love and Christiansen 1985). Northeastward-dipping sandstones and shales of the Tensleep and Amsden formations (Pennsylvanian) are found along the eastern margin of the area. The northeastern corner of the area, on the south side of Torrey Creek, contains Quaternary gravel deposits. The western fringe of the area lies atop Precambrian granite gneiss.

A large proportion of the alpine zone is underlain by sandstone and dolomite, and a small proportion by granitic rock.

DESCRIPTION OF VALUES

Vegetation Types

See Table 1 for the estimated acreage of the Kuchler (1966) vegetation types present in the area, Table 2 for estimated acreage of the SAF cover type (Eyre 1980), and Table 3 for a list of the plant associations.

Flora

Threatened, Endangered, and Sensitive Plant Species

No federally listed Threatened or Endangered plant species are found in the Arrow Mountain potential RNA. Two species listed as Sensitive in USFS Region 2 (*Lesquerella fremontii* and *Parrya nudicaulis*) are known from the study area (Estill 1993; Fertig et al. 1994). Thirteen other plants listed as "species of special concern" by WYNDD (Fertig and Beauvais 1999) were discovered in the potential RNA during surveys in 1996 and 1998, including three species that had not previously been reported for Wyoming (Fertig 1996, 1999a). The status of each of these species is briefly summarized below. Complete Element Occurrence Records and location maps for each population are included in Appendix A. Many of these plants are calciophiles, and the large number of plant species of interest in the potential RNA probably is due in large part to the extensive alpine zone on sandstone and dolomite.

Androsace chamaejasme* var. *carinata (Sweet-flowered rock jasmine)

Heritage Rank: G5T4/S1S2.

Federal Status: Bridger-Teton NF Sensitive; Targhee NF Sensitive.

Geographic Range: Alaska and western Canada south in the Rocky Mountains to Colorado. In Wyoming, known from the Absaroka, Owl Creek, and Wind River Ranges (Fremont, Hot Springs, and Park counties).

Habitat: Montane rock crevices and rocky soils derived from limestone or dolomite, or occasionally in moist limey meadows or beneath shrub cover (Fertig *et al.* 1994).

Comments: A population estimated at 10,000 individuals occurs on both semi-barren sedimentary gravels and densely-vegetated alpine turf communities on the south slopes of Circle Peak within the Arrow Mountain pRNA (Fertig 1997). Three other populations are found on Shoshone National Forest, all of which occur in designated wilderness areas or other proposed or potential research natural areas (Fertig 1998).

Antennaria aromatica (Aromatic pussytoes) WYNDD Watch List

Heritage Rank: G3G4/S2 (WYNDD Watch List).

Federal Status: None.

Geographic Range: Regional endemic of southwest Montana and northwestern Wyoming (although apparently falsely reported from other areas of western North America). In Wyoming, known from the Absaroka, Beartooth, Bighorn, Wind River, Gros Ventre, and Wyoming/Salt River ranges (Big Horn, Fremont, Lincoln, Park, Sublette, and Teton counties).

Habitat: Cushion plant communities on rocky subalpine or alpine calcareous slopes and ridgetops.

Comments: Several thousand plants were observed on the upper slopes and summit of the ridge connecting Arrow Mountain and Peak 10925 to the east by W. Fertig in 1996 (Fertig 1997). Additional small populations are likely to occur on dolomite ridges in the Arrow Mountain pRNA. Aromatic pussytoes is currently known from 27 occurrences in Wyoming, at least 10 of which are found in designated wilderness areas. Additional populations also occur in the proposed Bald Ridge and potential Beartooth Butte and Pat O'Hara Mountains RNAs on Shoshone National Forest (Fertig 1998).

Arnica angustifolia* ssp. *tomentosa (Alpine arnica)

Synonym: *Arnica alpina*.

Heritage Rank: G5T5/S1.

Federal Status: None.

Geographic Range: Circumboreal, south in the Rocky Mountains to British Columbia, southwestern Montana, and northwest Wyoming. In Wyoming, known only from the northeast Wind River Range.

Habitat: Bare, rocky alpine slopes and summits (Cronquist 1955). On Arrow Mountain, this species occurs in alpine cushion plant

communities on dry, gravelly calcareous clay soils or in denser vegetation dominated by *Artemisia scopulorum* near timberline.

Comments: Alpine arnica was discovered for the first time in Wyoming on the slopes of Circle Peak in 1996 (Fertig 1996). George Jones located a second colony in the same area during vegetation surveys in 1998. The entire state range of this species is limited to the potential Arrow Mountain RNA (Fertig 1998).

Braya humilis (Low braya)

Heritage Rank: G4/S1.

Federal Status: None.

Geographic Range: Circumboreal, extending across northern Alaska and Canada, south to Vermont, and the Great Lakes, with disjunct populations in southwestern Montana, western Wyoming, and central Colorado (Rollins 1993). In Wyoming, known only from the northeastern Wind River Range in Fremont County.

Habitat: Sandy-gravelly soils of streambanks, lakeshores, moraines, and alpine slopes.

Comments: A sparse population of about 50 individuals was discovered by W. Fertig on whitish gravel beds on the south side of Circle Peak in 1996. This occurrence was the first to be documented for this species in Wyoming (Fertig 1996, 1997), and remains the only known population in the state.

Carex incurviformis (Incurved sedge)

Synonym: *Carex maritima*, *C. incurviformis* var. *danaensis*

Heritage Rank: G4G5T3/S2

Federal Status: USFS R4 Sensitive.

Geographic Range: *Carex incurviformis* (*sensu stricto*) occurs sporadically from central Alberta to northwest Montana, east-central Idaho, and northwest Wyoming, with disjunct populations in the Sierra Nevada of central California and central Colorado (Fertig 1999 b). In Wyoming, it occurs in the Absaroka and Wind River ranges in Fremont, Park, and Sublette counties.

Habitat: Occurs on moist alpine or subalpine tundra, wet rock ledges, frost scars, or fellfields (Fertig 1999 b; Scott 1997).

Comments: Richard Scott documented this species from Arrow Mountain in 1985. This population was not relocated during surveys in 1996–1998. Incurved sedge is presently known from 10 locations in Wyoming, 7 of which occur in designated wilderness areas and potential RNAs (Fertig 1999 b).

Carex microglochin (False uncinia sedge)

Heritage Rank: G5?/S1.

Federal Status: None.

Geographic Range: Occurs from Greenland to Alaska and south to Alberta and Quebec, with disjunct populations in the Rocky Mountains of Montana, Wyoming, Colorado, and Utah. In Wyoming,

known from the Absaroka and Wind River ranges and Yellowstone Plateau in Fremont, Park, and Sublette counties.

Habitat: Moist, often calcareous wetlands and fens, from montane valleys to the alpine.

Comments: George Jones discovered a new population of this species in a small wetland on the north side of Mount 11696 within the Arrow Mountain pRNA in 1998. Previously, this species was known from only 4 other occurrences in the state. Populations are currently protected in Yellowstone National Park, the Swamp Lake Special Botanical Area, and the potential Kendall Warm Springs Special Interest Area (Fertig 1998).

Carex misandra (Short-leaf sedge)

Heritage Rank: G5/S1.

Federal Status: None.

Geographic Range: Circumboreal, south to Quebec, Alberta, Utah, and Colorado. In Wyoming, known from the Bighorn, Beartooth, and Wind River ranges in Fremont, Johnson, and Park counties.

Habitat: Alpine meadows and open slopes. In the Arrow Mountain area, this species occurs in an alpine wetland dominated by *Carex nelsonii*.

Comments: George Jones discovered a new population of this species on the north side of Mount 11696 with 3 other rare wetland graminoids in August 1998. Short-leaf sedge is now known from 4 occurrences in Wyoming: two within the Fitzpatrick Wilderness Area and two others near or within the Line Creek and McLain Lakes potential RNAs on Shoshone and Bighorn National Forests (Fertig 1998).

Carex nelsonii (Nelson's sedge)

Heritage Rank: G3?/S2.

Federal Status: None.

Geographic Range: Regional endemic of Wyoming, Colorado, and Utah. In Wyoming, known from the Medicine Bow, Sierra Madre, Beartooth, and Wind River ranges in Albany, Carbon, Fremont, and Park counties.

Habitat: Subalpine or alpine moist meadows and slopes. In the Arrow Mountain area, this species may be locally dominant in alpine wetlands.

Comments: Nelson's sedge was first discovered in the Arrow Mountain pRNA by George Jones in 1998. Only two other occurrences are presently known from the Shoshone National Forest, one in the Popo Agie Wilderness and the other near the proposed Line Creek RNA. This species could be impacted by sheep grazing or heavy recreational use (Fertig 1998).

Erigeron radicans (Taprooted fleabane)

Heritage Rank: G3/S2.

Federal Status: None (formerly listed as Sensitive by USFS Region 4).

Geographic Range: Occurs from Alberta to Saskatchewan, south to Idaho and western Wyoming. In Wyoming, known from the Wind River, Gros Ventre, Beartooth, and Absaroka ranges in Fremont, Park, and Sublette counties.

Habitat: Cushion plant communities and rocky alpine turf meadows, usually on calcareous substrates.

Comments: Several small and widely scattered colonies of taprooted fleabane were observed on the south side of Circle Peak by W. Fertig in 1996. Seven other populations are known in Wyoming, six of which occur in wilderness areas (Fertig 1998).

Helictotrichon mortonianum (Alpine oatgrass)

Heritage Rank: G4/S1.

Federal Status: None.

Geographic Range: Southern Rocky Mountains of central Colorado and northern New Mexico, with disjunct populations in the Uinta Range of Utah and northeastern Wind River Range of Wyoming (Fremont County).

Habitat: Alpine meadows. Populations on Arrow Mountain occur on both granitic and calcareous substrates in alpine meadows of *Geum rossii*, *Trifolium nanum*, and *Artemisia scopulorum*.

Comments: Ron Hartman first discovered this species on Arrow Mountain in 1996, but it remained unknown until relocated by George Jones in 1998 (Fertig 1999a). The Arrow Mountain colony is the only population currently known for Wyoming.

Juncus triglumis* var. *albescens (Northern white rush)

Heritage Rank: G5T5/S1.

Federal Status: None.

Geographic Range: Circumpolar, south in North America to Utah and Colorado. In Wyoming, known from the Medicine Bow, Wind River, and Absaroka ranges in Albany, Fremont, and Sublette counties.

Habitat: Wet alpine meadows and streambanks.

Comments: George Jones discovered a new population of this species in an alpine wetland on the north side of Peak 11696 in 1998. Previously, northern white rush had been collected by Hartman and Rosenthal from the vicinity of Circle Peak (Rosenthal 1998). The Arrow Mountain population and one colony from the Bridger Wilderness are the only occurrences of this species in the state to currently receive protection (Fertig 1998).

Lesquerella fremontii (Fremont bladderpod)

Heritage Rank: G2/S2.

Federal Status: USFS R2 Sensitive.

Geographic Range: Endemic to the east slope of the Wind River Range and Beaver Rim area of Fremont County, Wyoming.

Habitat: Occurs primarily in sparsely vegetated montane meadows on slopes and ridges with scattered *Pinus flexilis*, *Artemisia tripartita* var. *rupicola*, bunchgrasses, and low cushion plants (Fertig 1995). Less frequently, populations can also be found in soil-filled cracks of limestone boulders and bedrock. The Arrow Mountain population occurs in an alpine cushion plant community on limey-sandstone gravels covering clay-shale soils (Fertig 1997).

Comments: The Arrow Mountain population is the northernmost known occurrence of Fremont bladderpod, and the only one from an alpine habitat. Eight other occurrences are known in the state, only one of which is afforded protection (on The Nature Conservancy's Red Canyon Ranch). Historically, some populations in the state have been lost to limestone quarrying and road construction (Fertig 1998).

Parrya nudicaulis (Naked-stemmed parrya)

Heritage Rank: G5/S2.

Federal Status: USFS R2 Sensitive; USFS R4 Sensitive.

Geographic Range: Siberia to Alaska and northern Canada, with disjunct populations in the Beartooth, Gros Ventre, and Wind River mountains of northwestern Wyoming. Similar populations in the Uinta Mountains of Utah have been referred to as *P. rydbergii*.

Habitat: Alpine talus slopes and scree fields, often on limestone substrates (although also found on quartzites in the Uinta Range).

Comments: Ron Hartman and David Rosenthal discovered a new population of this species while conducting a floristic survey of the area in 1996 (Fertig 1997; Rosenthal 1998). Seven other populations occur in Wyoming, all of which occur in designated wilderness areas (Fertig 1998).

Saussurea weberi (Weber's saw-wort)

Synonym: Included in *Saussurea densa* by some authors.

Heritage Rank: G3Q/S2.

Federal Status: USFS R4 Sensitive.

Geographic Range: Regional endemic of southwestern Montana, western Wyoming, and central Colorado. In Wyoming, known from the Gros Ventre and Wind River ranges in Fremont, Sublette, and Teton counties.

Habitat: Alpine talus and gravel slopes, often on limestone. Populations on Arrow Mountain are found in alpine cushion plant communities on calcareous shale-clay soils, steep talus slopes of limey-slate, and openings amid stunted mats of *Betula glandulosa*

and *Salix glauca* on dry, loamy soils over quartz gravel (Fertig 1997).

Comments: The Arrow Mountain populations of Weber's saw-wort were first discovered by Hollis Marriott and Richard Scott in 1988. Marriott estimated the population at several thousand individuals. Comparable numbers were found by Fertig in July 1996. Only six occurrences of this species are currently known from Wyoming, all of which are found within designated wilderness areas.

Silene kingii (King's campion)

Synonym: Includes var. *kingii* and an "undescribed variety" (Dorn 1992).

Heritage Rank: G2G4Q/S1.

Federal Status: None.

Geographic Range: Circumpolar, in North America extending from Alaska to northern Quebec, and south in the Rocky Mountains to Alberta, northwestern Wyoming, and central Colorado. In Wyoming, it is known from the Absaroka and Wind River ranges in Fremont and Park counties.

Habitat: Alpine and subalpine talus slopes and fellfields. On Arrow Mountain, populations have been found on igneous and metamorphic boulder fields and alpine meadows.

Comments: Arrow Mountain appears to contain a mixed population of "var. *kingii*" (recognized by its downward-pointing non-glandular hairs on the lower leaves) and the undescribed "var. *novum*" (with spreading, glandular hairs on the lower leaves). Var. *novum* may be a local endemic of the Absarokas and northeastern Wind River Range (Ron Hartman, personal communication). King's campion is known from only 7 extant populations in Wyoming, at least 5 of which occur in wilderness areas or the Carter Mountain Area of Critical Environmental Concern (Fertig 1998).

Plant Species List

The following species checklist is based on field surveys conducted by the authors in late July 1996 and August 1998. For more information on the vascular plant flora of the Wind River Range and Shoshone National Forest, consult Fertig (1992), Rosenthal (1998), and Scott (1997). Nomenclature follows Dorn (1992) for scientific names and Hitchcock and Cronquist (1973) and Welsh et al. (1993) for common names. Family acronyms are based on Weber (1982).

<u>Scientific Name</u>	<u>Common Name</u>	<u>Family</u>
	SHRUBS	
<i>Betula glandulosa</i>	Bog birch	BET
<i>Pentaphylloides floribunda</i> [<i>Potentilla fruticosa</i>]	Shrubby cinquefoil	ROS
<i>Ribes inerme</i>		GRS
<i>Ribes montigenum</i>		GRS
<i>Salix arctica</i> var. <i>petraea</i>		SAL
<i>Salix brachycarpa</i>	Short-fruited willow	SAL
<i>Salix drummondiana</i>		SAL
<i>Salix glauca</i> var. <i>villosa</i>	Grayleaf willow	SAL
<i>Salix reticulata</i> var. <i>nana</i>		SAL
	GRAMINOIDS	
<i>Bromus inermis</i> var. <i>purpurascens</i>		POA
<i>Calamagrostis purpurascens</i>		POA
<i>Carex atrata</i> var. <i>erecta</i>		CYP
<i>Carex elynoides</i>	Kobresia-like sedge	CYP
<i>Carex filifolia</i>		CYP
<i>Carex haydeniana</i>		CYP
<i>Carex incurviformis</i>	Incurved sedge	CYP
<i>Carex microglochin</i>	False uncinia sedge	CYP
<i>Carex misandra</i>	Short-leaf sedge	CYP
<i>Carex nardina</i>	Spikenard sedge	CYP
<i>Carex nelsonii</i>	Nelson's sedge	CYP
<i>Carex norvegica</i> var. <i>stevenii</i>		CYP
<i>Carex praegracilis</i>		CYP
<i>Carex rupestris</i>		CYP
<i>Carex scirpoidea</i> var. <i>pseudoscirpoidea</i>		CYP
<i>Carex scopulorum</i>		CYP
<i>Carex stenophylla</i>		CYP
<i>Deschampsia cespitosa</i>	Tufted hairgrass	POA
<i>Eleocharis</i> sp. (immature)		CYP
<i>Elymus scribneri</i>		POA
<i>Elymus trachycaulus</i>	Bearded wheatgrass	POA
<i>Festuca idahoensis</i>		POA
<i>Festuca saximontana</i>		POA
<i>Helictotrichon mortonianum</i>	Alpine oatgrass	POA
<i>J. tweedyi?</i> (immature)		JUN
<i>Juncus drummondii</i>		JUN
<i>Juncus triglumis</i> var. <i>albescens</i>	Northern white rush	JUN
<i>Koeleria macrantha</i>		POA
<i>Luzula spicata</i>		JUN
<i>Poa alpina</i>		POA
<i>Poa cusickii</i> var. <i>cusickii</i>		POA

<i>Poa fendleriana</i>		POA
<i>Poa juncifolia</i> var. <i>juncifolia</i>		POA
<i>Poa pattersonii</i>	Patterson bluegrass	POA
<i>Poa pratensis</i>		POA
<i>Poa rupicola</i>		POA
<i>Poa secunda</i> var. <i>elongata</i>		POA
<i>Poa secunda</i> var. <i>secunda</i>		POA
<i>Trisetum spicatum</i>		POA
	FORBS	
<i>Agoseris glauca</i>	Short-beaked agoseris	AST
<i>Allium cernuum</i>		LIL
<i>Androsace chamaejasme</i> var. <i>carinata</i>	Sweet-flowered rock jasmine	PRM
<i>Androsace septentrionalis</i>		PRM
<i>Antennaria aromatica</i> .	Aromatic pussytoes	AST
<i>Antennaria media</i>		AST
<i>Antennaria microphylla</i>		AST
<i>Aquilegia jonesii</i>	Jones' columbine	RAN
<i>Arabis lyallii</i>		BRA
<i>Arenaria congesta</i> var. <i>congesta</i>	Ballhead sandwort	CAR
<i>Arenaria congesta</i> var. <i>limnophila</i>		CAR
<i>Arenaria nuttallii</i> [<i>Minuartia nuttallii</i>]	Nuttall's sandwort	CAR
<i>Arenaria obtusiloba</i> [<i>Minuartia obtusiloba</i>]	Arctic sandwort	CAR
<i>Arnica angustifolia</i> ssp.	Alpine arnica	AST
<i>Arnica latifolia</i> var. <i>gracilis</i>		AST
<i>Artemisia michauxiana</i>		AST
<i>Artemisia scopulorum</i>	Rocky Mountain sagewort	AST
<i>Artemisia tridentata</i> var. <i>vaseyana</i>		AST
<i>Aster alpigenus</i> var. <i>haydenii</i>		AST
<i>Astragalus kentrophyta</i> var. <i>tegetarius</i>	Mountain thistle milkvetch	FAB
<i>Astragalus miser</i> var. <i>decumbens</i>		FAB
<i>Besseyia wyomingensis</i>		SCR
<i>Braya humilis</i>	Low braya	BRA
<i>Bupleurum americanum</i>	American thorough-wax	API
<i>Campanula uniflora</i>	Arctic harebell	CAM
<i>Castilleja flava</i>		SCR
<i>Castilleja pulchella</i>	Showy paintbrush	SCR
<i>Cerastium beeringianum</i>		CRY

Chaenactis alpina var. leucopsis	Alpine dusty-maiden	AST
Cirsium pulcherrimum		AST
Claytonia megarhiza	Alpine spring-beauty	POR
Cymopterus longilobus	Mountain spring-parsley	API
Cymopterus nivalis		API
Draba oligosperma		BRA
Dryas octopetala var. hookeriana	White mountain avens	ROS
Epilobium sp.		ONA
Erigeron compositus var. discoideus		AST
Erigeron radicans	Taprooted fleabane	AST
Erigeron simplex		AST
Eriogonum flavum var. flavum	Yellow buckwheat	PLG
Eriogonum ovalifolium var. purpureum		PLG
Eriogonum umbellatum var. majus		PLG
Eritrichium nanum var. elongatum		BOR
Geum rossii var. turbinatum	Alpine avens	ROS
Hymenoxys acaulis var. acaulis		AST
Hymenoxys grandiflora	Old-man-of-the-mountain	AST
Ipomopsis spicata var. orchidacea	Mountain spicate gilia	PLM
Lesquerella fremontii	Fremont bladderpod.	BRA
Lewisia pygmaea		POR
Lloydia serotina	Alpine lily	LIL
Lomatium cous		API
Lupinus argenteus var. depressus	Subalpine silvery lupine	FAB
Mertensia alpina	Alpine bluebells	BOR
Mertensia oblongifolia		BOR
Myosotis alpestris		BOR
O. sericea var. spicata		FAB
Oxytropis campestris var. cusickii		FAB
Oxytropis sericea	Silky crazyweed	FAB
Parrya nudicaulis	Naked-stemmed parrya	BRA
Pedicularis parryi var. parryi		SCR
Phlox hoodii		PLM
Phlox pulvinata	Cushion phlox	PLM
Polemonium viscosum	Sky-pilot	PLM

<i>Polygonum bistortoides</i>	American bistort	PLG
<i>Potentilla diversifolia</i> var. <i>diversifolia</i>	Vari-leaf cinquefoil	ROS
<i>Potentilla diversifolia</i> var. <i>perdissecta</i>		ROS
<i>Potentilla glandulosa</i> var. <i>pseudorupestris</i>		ROS
<i>Potentilla ovina</i> var. <i>decurrens</i>		ROS
<i>Potentilla ovina</i> var. <i>ovina</i>	Sheep cinquefoil	ROS
<i>Ranunculus eschscholtzii</i> var. <i>trisectus</i>		RAN
<i>Rumex paucifolius</i>	Mountain dock	PLG
<i>Saussurea weberi</i>	Weber's saw-wort	AST
<i>Saxifraga rhomboidea</i>		SAX
<i>Sedum integrifolium</i>		CRS
<i>Senecio canus</i>	Woolly groundsel	AST
<i>Senecio integerrimus</i> var. <i>exaltatus</i>		AST
<i>Senecio lugens</i>	Black-tipped groundsel	AST
<i>Senecio sphaerocephalus</i>		AST
<i>Senecio streptanthifolius</i> var. <i>rubricaulis</i>		AST
<i>Senecio streptanthifolius</i> var. <i>streptanthifolius</i>		AST
<i>Silene acaulis</i> var. <i>subacaulescens</i>	Moss campion	CRY
<i>Silene kingii</i>	King's campion	CRY
<i>Silene parryi</i>	Parry's catchfly	CRY
<i>Smelowskia calycina</i> var. <i>americana</i>	Alpine smelowskia	BRA
<i>Solidago multiradiata</i> var. <i>scopulorum</i>	Northern goldenrod	AST
<i>Stellaria monantha</i>		CRY
<i>Taraxacum ceratophorum</i>		AST
<i>Thalictrum alpinum</i>	Alpine meadow-rue	RAN
<i>Townsendia parryi</i>		AST
<i>Trifolium dasyphyllum</i>	Thickleaf clover	FAB
<i>Trifolium haydenii</i>	Hayden's clover	FAB
<i>Veronica wormskjoldii</i>		SCR

Fauna

Threatened, Endangered, and Sensitive Vertebrates

As of May 1999, WYNDD files contain no extant occurrences of Federally threatened or endangered species from this site.

However, it is likely that Canada lynx (*Lynx canadensis*), a USDA Forest Service Region 2 Sensitive Species, will be soon listed as threatened under the U. S. Endangered Species Act. The presense of lynx was documented in the vicinity by the Wyoming Game and Fish Department in 1985 and 1998. The relatively large area of montane and subalpine forest has high potential to support lynx activity. Also, this area is within the current range of the Yellowstone grizzly bear (*Ursus arctos*) population (a federally listed threatened species) and may support some grizzly bear activity.

Yellowstone cutthroat trout (*Onchorhynchus clarki bouveri*), a USDA Forest Service Region 2 Sensitive Species, occur in the Wind River near the mouths of Blue Hole, Little Red, and Red creeks. Although this area is within the historic range of Yellowstone cutthroat trout, neither the origin (endemic or stocked) nor genetic purity (degree of introgression from exotic salmonids or other cutthroat subspecies) of this population are known. Population segments may occur near the headwaters of Blue Hole, Little Red, and Red creeks on the site.

Animal Species List

The field work in the potential Arrow Mountain RNA did not include identification of the animal species present.

Lands

The potential Arrow Mountain RNA is National Forest System land in the Wind River Ranger District of the Shoshone National Forest. Approximately 96% of the area (13,616 acres, or 5514 ha) is within the Fitzpatrick Wilderness Area. The 600 acres (243 ha) outside of the Wilderness Area is in the northern end of the potential RNA.

SUITABILITY FOR RESEARCH NATURAL AREA SELECTION

An area is suitable for designation as a research natural area according to how well it meets four criteria: quality, condition, viability, and defensibility (USDA Forest Service 1993). Each criterion is briefly defined below, and the information collected during field work that is pertinent to each criterion is described.

Quality

The degree to which the potential RNA represents the range in variability within the ecosystem types that it contains.

At the lowest elevations, the foothills ecosystem of the potential RNA is a mix of intermingled grassland and shrubland stands represented by the *Pseudoroegneria spicata*-*Poa secunda*

grassland and the *Artemisia tridentata* ssp. *vaseyana*/*Pseudoroegneria spicata* shrubland growing on a variety of slopes and aspects. Both of these vegetation types are widespread on the Shoshone National Forest (Tweit and Houston 1980) and northward in Montana (Mueggler and Stewart 1980). These foothills types give way at intermediate elevations to the montane forest of intermingled stands of the *Pseudotsuga menziesii*/*Juniperus communis* and *Pinus flexilis*/*Juniperus communis* woodlands on a variety of slopes and aspects, and with a range in the amount of canopy cover and understory vegetation. Both of these woodland types are common in northwestern Wyoming, western Montana, and east-central Idaho and are found predominantly (though not exclusively) on sandstone and limestone substrates (Steele et al. 1983). Higher-elevation, subalpine forest is similarly a mosaic of the *Picea engelmannii*/*Juniperus communis* forest and *Pinus albicaulis* forest growing on various slopes and aspects. These two forest types are best-developed in the Wind River Mountains, the *Picea engelmannii* type on calcareous substrates and the *Pinus albicaulis* woodland on igneous rocks (Steele et al. 1980). Finally, at the highest elevations, the potential RNA contains an extensive alpine ecosystem consisting of a matrix of the *Carex elynoides* turf with patches of other upland and riparian types. This turf, characteristic of relatively dry alpine sites, is widespread throughout the Rocky Mountains and apparently is the most common type in western Montana, predominantly (though not exclusively) on calcareous substrates (Cooper et al. 1997).

In the foothills and montane zones, then, the potential Arrow Mountain RNA contains large areas of ecosystem types common in the region, and each of these ecosystem types in the potential RNA includes a range of sites. The subalpine zone of the potential RNA appears to represent a forest type of the Wind River Range, not a type widespread in entire region. And in the alpine zone, the potential RNA represents a vegetation type characteristic of the drier environments in the region. The sequence of ecosystems types from the foothills upward through the montane and subalpine zones into the alpine, with ecotones where the ecosystem types meet, is a common arrangement in the Rocky Mountains.

Floristically, the potential Arrow Mountain RNA is unusual in containing a large number of plant species rare in the region, many of which species are calciophiles.

Condition

The degree to which the potential RNA has been altered from pre-settlement conditions.

- Exotic Plants

Only two exotic plants were noted during field survey in the potential Arrow Mountain RNA. Small amounts of *Poa pratensis* (Kentucky bluegrass) occurred in several of the alpine sample plots, and this ubiquitous grass probably is present at riparian zones at lower elevations. A patch of knapweed (*Centaurea* sp.) was observed at the National Forest boundary (the eastern boundary of the potential RNA) on Blue Holes Creek. This patch contained several hundred stems and covered approximately 50 square meters. Large patches of knapweed were observed along U.S. Highway 26/287 approximately 3 miles (4.8 km) east of the potential RNA in the vicinity of Blue Holes Creek, and this noxious weed may be present elsewhere in the eastern, low-elevation part of the area.

- Structures

No structures or maintained trails were observed during field survey in the potential RNA, and none are shown on 7.5-minute topographic maps.

Viability

The prospect for long-term maintenance of the ecosystem types in the area and the survival of their constituent species.

The long-term maintenance of the ecosystem types in the potential RNA depends in large part on maintenance of the ecological processes that shaped those ecosystems. In Rocky Mountain montane and subalpine forests, fire has been a major ecological force (Peet 1988). Details of the role of fire in the potential Arrow Mountain RNA can only be known from research in the area, but some aspects of fire's role can be inferred from research elsewhere. Fischer and Clayton (1983) have summarized information on fire in groups of habitat types (fire groups) in Montana, and their review can serve as a starting point for consideration of fire in the potential Arrow Mountain RNA.

In the low-elevation *Pseudoroegneria spicata* grasslands in the eastern part of the area, fuel may be so sparse that fire has had little influence. The *Artemisia tridentata* stands in that part of the potential RNA grow in more mesic sites such as draws and valley bottoms, and some of those stands contain *Pinus flexilis* seedlings and saplings. Fire may be necessary to prevent the spread of woodlands into those shrublands, as suggested by the reviews of Knight (1994) and Fischer and Clayton (1983, fire group four).

The *Pinus flexilis*/*Juniperus communis* woodlands in the potential RNA apparently belong to Fischer's and Clayton's fire group 1, which includes vegetation types where fires hot enough or large enough to leave fire scars apparently have been

infrequent (50-100 year intervals). Cool fires may be more frequent in these dry woodlands and keep fuels from accumulating to a level that supports large fires. The *Pseudotsuga menziesii*/*Juniperus communis* woodlands on more mesic sites seem to belong to fire group 6, in which fires are more common woodlands (46-year intervals in Montana) than in the drier *Pinus flexilis* woodlands. In fire group 4, frequent, cool fires are important in thinning stands and preventing fuel accumulation; fire suppression may increase fuel loads and thereby increase the probability of severe, stand-replacing fires. The subalpine *Picea engelmannii*/*Juniperus communis* forest and the *Pinus albicaulis* woodland apparently are in fire group 10, where fire is infrequent and plays a smaller role than do physical environmental factors (slope, aspect, substrate) in forest development. In the alpine zone, wind and topographic position are dominant ecological factors (Billings 1988, Knight 1994); fire plays little role in this ecosystem.

Defensibility

The extent to which the area can be protected from extrinsic, anthropogenic factors that might worsen the condition of the area or threaten the viability of the ecosystems present.

The location of most of the potential Arrow Mountain RNA within a wilderness area, and the absence of maintained or mapped trails, probably reduce the potential for direct human impacts. Weeds, such as the knapweed noted on Blue Holes Creek, may present a threat to ecosystems at the lower-elevation side of the area.

Degree to Which the Potential RNA Meets Criteria

Field survey in the potential Arrow Mountain RNA indicates that the area represents a variety of vegetation types characteristic of calcareous substrates from the foothills up to the alpine zone. The types of the foothills, montane zone, and alpine zone are widespread throughout the region, and the types of the subalpine zone are characteristic of the Wind River Mountains. The flora of the potential RNA is unusual in containing a large number of vascular plant species rare in the region.

Field survey also suggests that the condition of the ecosystems in the area has been affected very little by exotic plants, and not at all by structures or travel corridors. Of the major ecological processes operating in the area (the determinants of ecosystem viability) only fire appears to be subject to influence by managers. Exotic weeds appear to constitute the major extrinsic threat to the area and, in the absence of a rigorous survey for weeds in the eastern part of the area, the degree of that threat appears to be low.

IMPACTS AND POSSIBLE CONFLICTS

This section is limited to the conflicts obvious from field survey and from conversations with USDA Forest Service staff.

Mineral Resources

No evidence was noted of mineral exploration or production. Most of the area is withdrawn from mineral entry because of its status as wilderness.

Grazing

No evidence of livestock grazing was observed in the area. Elk were noted in the area, but their influence on the area is unknown.

Timber

The location of most of the potential RNA within a wilderness area removes the potential for conflicts with the timber program.

Watershed Values

No watershed structures were noted that might conflict with RNA designation.

Recreation Values

Recreational use apparently is limited to hunting in the fall and incidental use by hikers and horseback riders. No evidence was observed during field survey of recreational use that would conflict with RNA designation.

Wildlife and Plant Values

The potential RNA contains populations of two vascular plants on the Forest Service Region 2 Sensitive Species list, and 13 more plants rare in the region. None of these species requires any management that would conflict with RNA designation.

Transportation Values

The potential RNA contains no roads and no maintained or mapped trails. Trails established by incidental use may exist in the area, but no evidence was observed during field survey of any trails that would conflict with RNA designation.

MANAGEMENT CONCERNS

No management concerns were identified other than the need to prevent the spread of knapweed.

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APPENDIXES

Appendix 1. Maps of the potential Arrow Mountain Research
Natural Area

Figure 1. Contour map showing Kuchler (1966) vegetation types and SAF cover types (Eyre 1980) in the potential Arrow Mountain RNA.

<u>Kuchler/SAF Types</u>	<u>Map Symbol</u>
Kuchler: Douglas-fir forest (11) SAF: Interior Douglas fir (210) + Limber pine (219)	
Kuchler: Western spruce-fir forest (14) SAF: Engelmann spruce-subalpine fir (206) + Whitebark pine (208) + Lodgepole pine (218)	
Weatgrass-bluegrass (44) + Sagebrush steppe (49)	
Alpine meadows and barrens (45)	
Sample plots	
Locations of vegetation descriptions	

Figure 2. Contour map showing complexes of plant communities in the potential Arrow Mountain RNA. Synonyms for community names are listed in Appendix 5.

<u>Communities</u>	<u>Map Symbol</u>
<i>Artemisia tridentata</i> ssp. <i>vaseyana</i> / <i>Pseudoroegneria spicata</i> (M) + <i>Pseudoroegneria spicata</i> - <i>Poa secunda</i> (M) + <i>Festuca idahoensis</i> (m)	
<i>Pseudotsuga menziesii</i> / <i>Juniperus</i> <i>communis</i> (M) + <i>Pinus flexilis</i> / <i>Juniperus communis</i> (M) + <i>Populus</i> <i>angustifolia</i> / <i>Rosa woodsii</i> (m)	
<i>Picea engelmannii</i> / <i>Juniperus communis</i> (M) + <i>Pinus flexilis</i> / <i>Juniperus communis</i> (M) + <i>Pinus albicaulis</i> / <i>Juniperus</i> <i>communis</i> (m) + <i>Salix drummondiana</i> (m) + <i>Mertensia ciliata</i> (m)	
<i>Carex elynoides</i> (M) + <i>Carex rupestris</i> (m) + <i>Carex scirpoidea</i> / <i>Potentilla</i> <i>diversifolia</i> (m) + <i>Dryas octopetala</i> / <i>Carex</i> <i>rupestris</i> (m) + <i>Geum rossii</i> / <i>Trifolium</i> spp. (m) + <i>Carex nelsonii</i> (m) + <i>Salix</i> <i>arctica</i> (m) + <i>Salix planifolia</i> / <i>Carex</i> <i>scopulorum</i> (m)	
Sample plots	
Locations of vegetation descriptions	

Appendix 2. Photographs from the potential Arrow Mountain RNA

All photographs were taken by G. Jones in August 5 - 7, 1998.

Photo 98GJ3.2

Looking east from the southwestern corner of the area, at dolomite peak atop Cambrian shale and sandstone, on divide forming south boundary of area. Drainage to left is Red Creek.

Photo 98GJ3.7

Looking up dipslope of Flathead sandstone (Cambrian) in southwestern part of area. Vegetation is *Geum rossii-Triflorum* spp. Turf with patches of *Salix planifolia* shrubland.

Photo 98GJ3.11

Looking up dipslope of Flathead sandstone (Cambrian) to western boundary of area. Vegetation is *Carex elynoides* alpine turf with stone stripes.

Photo 98GJ3.15

Looking east down Red Creek, at south-facing slopes on dolomite. Vegetation is *Carex elynoides* alpine turf.

Photo 98GJ3.19

Looking northeast down Blue Holes Creek, north-central part of area. Herbaceous vegetation in foreground is *Carex elynoides* alpine turf; forest in background is mosaic of Engelmann spruce and whitbark pine types at higher elevation, merging into Douglas-fir and limber pine at lower elevations.

Appendix 3. Canopy cover of plants in plots and at locations of vegetation descriptions in the potential Arrow Mountain Research Natural Area

Estimates of canopy cover from sample plots are shown in tables. The cover values for species are midpoints of the following cover classes:

<u>Cover Value</u>	<u>Range of Canopy Cover</u>
1	<1%
3	1% - 5%
10	5% - 15%
20	15% - 25%
30	25% - 35%
40	35% - 45%
50	45% - 55%
60	55% - 65%
70	65% - 75%
80	75% - 85%
90	85% - 95%
97	95% - 100%

The vegetation descriptions are for parts of stands and were not made for formal sample plots. At each location, the species in each stratum of the vegetation are listed approximately in order from those with the most canopy cover to those with the least.

Locations of sample plots and of vegetation descriptions are shown on Figures 1 and 2.

Table 3-1. Canopy of plants in *Carex elynoides* sample plots in the potential Arrow Mountain RNA.

Species	50.18	50.10	50.14	Plot #					
				50.5	50.9	50.15	50.8	50.20	50.12
SHRUBS				1				1	
<i>Artemisia tridentata</i> var. <i>vaseyana</i>				1					
<i>Pentaphylloides floribunda</i>								1	
GRAMINOIDS	40	60	60	50	70	40	40	30	60
<i>Bromus inermis</i> var. <i>purpurascens</i>		30							
<i>Calamagrostis purpurascens</i>				1					
<i>Carex elynoides</i>	30	30	30	10	60	30	10	20	20
<i>Carex praegracilis</i>					10	3			
<i>Carex rupestris</i>	1		10				10	10	
<i>Carex scirpoidea</i>							1		
<i>Elymus scribneri</i>	3		1		1	1	1		
<i>Elymus spicatus</i>				10					20
<i>Elymus trachycaulus</i>	1								
<i>Helictotrichon mortonianum</i>		10					3	10	
<i>Koeleria macrantha</i>		1	1					1	
<i>Leucopoa kingii</i>		1	3	1	1	1			10
<i>Luzula spicata</i>							1		
<i>Poa alpina</i>			1		1	1	1		
<i>Poa cusickii</i> var. <i>cusickii</i>		1			1				
<i>Poa fendleriana</i>			1	3		3		1	3
<i>Poa pratensis</i>		1	1		3		1		
<i>Poa rupicola</i>	1							1	
<i>Poa secunda</i> var. <i>secunda</i>	1		1	10	1	10		1	10
<i>Trisetum spicatum</i>	1	1							

Species	50.18	50.10	50.14	Plot # 50.5	50.9	50.15	50.8	50.20	50.12
FORBS	50	30	40	45	40	20	30	30	40
<i>Achillea millefolium</i>									1
<i>Agoseris glauca</i>		1	1	1	3	3	1	1	1
<i>Allium cernuum</i>	1			1					
<i>Androsace chamaejasme</i> var. <i>carinata</i>			1					1	
<i>Antennaria microphylla</i>			1	1					
<i>Arenaria nuttallii</i>									1
<i>Arenaria obtusiloba</i>			10					10	
<i>Artemisia frigida</i>				10	3	20			10
<i>Artemisia scopulorum</i>	1	1			1				
<i>Astragalus miser</i> var. <i>decumbens</i>			3	3					20
<i>Balsamorhiza incana</i>				1					
<i>Besseyia wyomingensis</i>	1	1							
<i>Bupleurum americanum</i>			1	1	1	1	1	3	1
<i>Campanula uniflora</i>								1	1
<i>Castilleja flava</i>				1					1
<i>Castilleja pulchella</i>	1		1			1	1		
<i>Cirsium pulcherrimum</i>				1					
<i>Cymopterus longilobus</i>				1				1	10
<i>Dodecatheon</i> sp.		1							
<i>Draba oligosperma</i>			1	1					1
<i>Erigeron compositus</i>			1						1
<i>Erigeron compositus</i> var. <i>discoideus</i>	1		1				1		
<i>Eriogonum flavum</i> var. <i>flavum</i>				3					
<i>Eriogonum ovalifolium</i> var. <i>purpureum</i>						1			
<i>Eriogonum umbellatum</i> var. <i>majus</i>									3

				Plot #					
Species	50.18	50.10	50.14	50.5	50.9	50.15	50.8	50.20	50.12
Eriogonum sp.									1
Eritrichium nanum var. elongatum								1	
Frasera speciosa									1
Geum rossi	10	1					10		
Hymenoxys acaulis var. acaulis			1	1	1			1	
Hymenoxys grandiflora	1	1	1	1		1	1		1
Ipomopsis aggregata?				1					
Ipomopsis spicata								1	1
Lesquerella fremontii									1
Linum lewisii				1					
Lomatium cous		1			3	1		1	
Lupinus argenteus var. depressus	3	10				1			
Mertensia oblongifolia		1			10		1		
Mustard				1					
Myosotis alpestris	1								
Oxytropis campestris var. cusickii	1	1	3		1	3	1	3	3
Oxytropis sericea var. spicata				1					
Penstemon laricifolius?				1					
Phlox hoodii						10		1	
Phlox pulvinata	1	1			1	1	1		1
Polemonium viscosum	20	1					1		
Polygonum bistortoides	3	1					1		
Potentilla diversifolia var. diversifolia							1		
Potentilla ovina var. decurrens		20	1		1	3			1
Potentilla sp.				1	1				
Saxifraga rhomboidea	1								

				Plot #					
Species	50.18	50.10	50.14	50.5	50.9	50.15	50.8	50.20	50.12
<i>Sedum lanceolatum</i>			3	1		3	1	3	
<i>Selaginella densa</i>			3						
<i>Senecio canus</i>			1				1	3	1
<i>Silene acaulis</i> var. <i>subacaulescens</i>							1		
<i>Silene kingii</i>					1	1	1	?	
<i>Smelowskia calycina</i> var. <i>americana</i>	1				1	1	1	1	
<i>Solidago multiradiata</i>	1						1		
<i>Stellaria monantha</i>							3		
<i>Taraxacum ceratophorum</i>		1							
<i>Townsendia parryi</i>			1	1				1	1
<i>Trifolium dasyphyllum</i>		3			20	1			
<i>Trifolium nanum</i>		1			1	1	1	1	
TOTAL VEG COVER	80	75	70	70	65	60	60	60	70
GROUND COVER (%)									
Soil	2	30	12	25	5	3	10	10	7
Gravel	<1	1	20	40	7	50	1	10	40
Rock		<1	20	15	1	13	40		
Bedrock								10	10
Litter	90	61	40	15	81	25	43	66	38
Wood									
Basal Veg	7	6	4	5	5	8	5	4	5
Lichen & Moss		1	4		1	1	1	3	
LANDSCAPE									
Slope (degrees)	15	20	10	20	18	10	18	5	20
Aspect (degrees)	5		170	180	175	220- 250	60	5	155

Notes:

- Plot 50.5: 20m x 20m, on lower slope ca. 50 m downslope from dolomite (?) outcrop. Represents south-facing grassland on dolomite (?) talus. Elevation 9900 feet.
- Plot 50.8: 30m x 30m, representing area of *Carex elynoides* with little *Geum rossii*. Patterned ground throughout. Substrate Flathead sandstone. Elevation 11,150 feet.
- Plot 50.9: 30m x 30m, on south-facing slope with dolomite (?) bedrock below dolomite (?) outcrops. Elevation 11,000 feet.
- Plot 50.10: 30m x 30m, representing lupine patch. Ca. 200 m east of plot 50.9. Elevation 10,900 feet.
- Plot 50.14: 30m x 30m, representing low turf on gentle, south-facing dolomite (?) slope. Elevation 10,900 feet.
- Plot 50.15: 10m x 50m, representing upper part of west-facing alcove on dolomite (?). Elevation 10,000 feet.
- Plot 50.18: 20m x 20m, representing deeper soil area on dolomite (?) dip slope, next to plot 50.17. Elevation 10,800 feet.
- Plot 50.20: 20m x 20m. Appears to represent much of vegetation on dolomite (?) substrate at head of valley. Elevation 10,500 feet.
- Plot 50.12: 30m x 30m, on middle slope. Dolomite (?) substrate. Elevation 10,600 feet.
-

Table 3-2. Canopy of plants in *Carex scirpoidea* sample plots in the potential Arrow Mountain RNA.

Species	Plot #	
	50.4	50.7
TREES	1	
<i>Picea engelmannii</i>	1/1.5	
SHRUBS	3	1
<i>Dryas octopetala</i>	1	
<i>Pentaphylloides floribunda</i>		1
<i>Salix glauca</i>	1	
GRAMINOIDS	40	30
<i>Carex elynoides</i>		1
<i>Carex rupestris</i>	3	10
<i>Carex scirpoidea</i>	30	10
<i>Festuca saximontana</i>	1	
<i>Helictotrichon mortonianum</i>		1
<i>Luzula spicata</i>	10	1
<i>Poa alpina</i>	1	
<i>Poa secunda</i> var. <i>elongata</i>	1	
<i>Poa secunda</i> var. <i>secunda</i>		1
<i>Trisetum spicatum</i>	1	1
FORBS	40	30
<i>Agoseris glauca</i>	1	
<i>Allium cernuum</i>	1	
<i>Androsace septentrionalis</i>	1	
<i>Arenaria congesta</i> var. <i>limnophila</i>	1	
<i>Arenaria obtusiloba</i>	10	
<i>Arnica angustifolia</i>	1	1
<i>Artemisia frigida</i>		1
<i>Artemisia scopulorum</i>	20	1
<i>Artemisia scopulorum</i>		1
<i>Aster alpigenus?</i>	1	
<i>Besseya wyomingensis</i>	1	
<i>Bupleurum americanum</i>		1
<i>Castilleja pulchella</i>	1	1
<i>Erigeron simplex?</i>		3
<i>Geum rossi</i>	3	3
<i>Hymenoxys grandiflora</i>	1	
<i>Lomatium cous</i>	1	1
<i>Mertensia oblongifolia</i>		1
<i>Myosotis alpestris</i>	1	1
<i>Oxytropis campestris</i> var. <i>cusickii</i>	1	
<i>Oxytropis sericea</i> var. <i>spicata</i>		1
<i>Phlox pulvinata</i>	1	
<i>Polygonum bistortoides</i>	1	1

Species	Plot #	
	50.4	50.7
<i>Polygonum viviparum</i>	1	
<i>Potentilla diversifolia</i> var. <i>diversifolia</i>	10	3
<i>Saxifraga rhomboidea</i>		1
<i>Sedum lanceolatum</i>	1	1
<i>Selaginella densa</i>		1
<i>Silene acaulis</i> var. <i>subacaulescens</i>	1	3
<i>Silene kingii</i>	1	
<i>Smelowskia calycina</i> var. <i>americana</i>		1
<i>Stellaria monantha</i>		1
TOTAL VEG COVER	70	65
GROUND COVER (%)		
Soil	10	10
Gravel	5	3
Rock	10	20
Bedrock		
Litter	69	61
Wood		
Basal Veg	6	5
Lichen & Moss		1
LANDSCAPE		
Slope (degrees)	8	9
Aspect (degrees)	25	120

Notes:

Plot 50.4: 30m x 30m, representing upper timberline ecotone. More open and with less *Geum rossii* than 50.1 and 50.2. Substrate sandstone (Flathead) Elevation 10,700 feet.

Plot 50.7: 20m x 20m, on upper slope ca. 100m from north-south ridge. Precambrian substrate; stone stripes present. Elevation 11,200 feet.

Table 3-3. Canopy of plants in *Carex rupestris* sample plots in the potential Arrow Mountain RNA.

Species	Plot #			
	50.11	50.16	50.19	50.20
SHRUBS	1	1		1
<i>Pentaphylloides floribunda</i>	1	1		1
GRAMINOIDS	3	30	70	30
<i>Bromus inermis</i> var. <i>purpurascens</i>			10	
<i>Carex elynoides</i>		1	10	20
<i>Carex rupestris</i>	3	20	50	10
<i>Elymus scribneri</i>	1			
<i>Festuca saximontana</i>	1			
<i>Helictotrichon mortonianum</i>		3		10
<i>Koeleria macrantha</i>				1
<i>Poa alpina</i>		1		
<i>Poa fendleriana</i>				1
<i>Poa rupicola</i>				1
<i>Poa secunda</i> var. <i>secunda</i>			1	1
FORBS	10	10	10	30
<i>Agoseris glauca</i>				1
<i>Allium cernuum</i>	1			
<i>Androsace chamaejasme</i> var. <i>carinata</i>	1	1	1	1
<i>Antennaria media</i>	1			
<i>Aquilegia jonesii</i>	1	1		
<i>Arenaria nuttallii</i>	1			
<i>Arenaria obtusiloba</i>	?	3		10
<i>Besseyia wyomingensis</i>			1	
<i>Bupleurum americanum</i>	1	1		3
<i>Campanula uniflora</i>	1			1
<i>Castilleja pulchella</i>	1	1	1	
<i>Cymopterus longilobus</i>				1
<i>Cymopterus nivalis</i>	1			
<i>Erigeron compositus</i> var. <i>discoideus</i>	1	1	1	
<i>Erigeron simplex</i>	1			
<i>Eriogonum flavum</i> var. <i>flavum</i>		1		
<i>Eritrichium nanum</i> var. <i>elongatum</i>		1		1
<i>Geum rossi</i>			10	
<i>Hymenoxys acaulis</i> var. <i>acaulis</i>				1
<i>Ipomopsis spicata</i>		1		1
<i>Lesquerella fremontii</i>	1			
<i>Lomatium cous</i>			1	1
<i>Lupinus argenteus</i> var. <i>depressus</i>	1			
<i>Myosotis alpestris</i>			1	

Species	Plot #			
	50.11	50.16	50.19	50.20
<i>Oxytropis campestris</i> var. <i>cusickii</i>	1	1		3
<i>Pedicularis parryi</i>			1	
<i>Phlox hoodii</i>				1
<i>Phlox pulvinata</i>	1	1	1	
<i>Polemonium viscosum</i>			1	
<i>Polemonium viscosum</i>	1			
<i>Polygonum bistortoides</i>			3	
<i>Potentilla ovina</i> var. <i>decurrens</i>	3		1	
<i>Ranunculus eschscholtzii</i> var. <i>trisectus</i>			1	
<i>Sedum lanceolatum</i>	1	1	1	3
<i>Senecio canus</i>	1	1		3
<i>Silene acaulis</i> var. <i>subacaulescens</i>		1	1	
<i>Silene kingii</i>		1	1	?
<i>Smelowskia calycina</i> var. <i>americana</i>	1	1		1
<i>Solidago multiradiata</i>			1	
<i>Townsendia parryi</i>		1		1
<i>Trifolium nanum</i>				1
unknown			1	
TOTAL VEG COVER	12	40	70	
GROUND COVER (%)				
Soil	10	1	10	
Gravel	60	86	<1	
Bedrock				
Rock	25	4	<1	
Litter	3	<1	76	
Wood				
Basal Veg	2	2	8	
Lichen & Moss		10	5	
LANDSCAPE				
Slope (degrees)	20	11	15	
Aspect (degrees)	180	30	345	

Notes:

Plot 50.11: 20m x 50m, representing sparsely vegetated band below dolomite outcrop. Substrate dolomite colluvium over shale? Elevation 11,100 feet.

Plot 50.16: 20m x 30m, on dolomite (?) dipslope ca. 100 m below ridge. Elevation 10,700 feet.

Plot 50.19: 20m x 20m, representing matrix vegetation on slope beneath Circle Peak. Elevation 10,700 feet.

Table 3-4. Canopy of plants in *Geum rossii* sample plots in the potential Arrow Mountain RNA.

Species	Plot #	
	50.1	50.2
GRAMINOIDS	20	20
<i>Carex atrata</i> var. <i>erecta</i>		?
<i>Carex elynoides</i>	1	3?
<i>Carex rupestris</i>	1	
<i>Carex scirpoidea</i> var. <i>pseudoscirpoidea</i>	3	3
<i>Elymus scribneri</i>	1	10
<i>Festuca saximontana</i>		1
<i>Helictotrichon mortonianum</i>	1	
<i>Luzula spicata</i>	3	?
<i>Poa alpina</i>		1
<i>Poa cusickii</i> var. <i>cusickii</i>	3	
<i>Poa pratensis</i>	1	1
<i>Trisetum spicatum</i>	1	1
FORBS	70	60
<i>Achillea millefolium</i>		1
<i>Agoseris glauca</i>		1
<i>Allium cernuum</i>		1
<i>Androsace septentrionalis</i>	1	1
<i>Artemisia scopulorum</i>	10	?
<i>Bupleurum americanum</i>	1	?
<i>Erigeron compositus</i> var. <i>discoideus</i>	1	
<i>Geum rossii</i>	50	50
<i>Hymenoxys grandiflora</i>	1	1
<i>Lomatium cous</i>	1	
<i>Mertensia oblongifolia</i>	1	1
<i>Myosotis alpestris</i>	1	1
<i>Phlox pulvinata</i>	3	1
<i>Polemonium viscosum</i>		1
<i>Polygonum bistortoides</i>	1	1
<i>Potentilla diversifolia</i> var. <i>diversifolia</i>	10	30
<i>Saxifraga rhomboidea</i>	1	1
<i>Sedum lanceolatum</i>	1	1
<i>Selaginella densa</i>	3	
<i>Senecio streptanthifolius</i> var. <i>rubricaulis</i>		1
<i>Silene acaulis</i> var. <i>subacaulescens</i>	1	1

Species	Plot #	
	50.1	50.2
<i>Smelowskia calycina</i> var. <i>americana</i>	1	1
<i>Solidago multiradiata</i>		1
<i>Stellaria monantha</i>	1	1
<i>Taraxaxum ceratophorum</i>	1	1
<i>Trifolium dasyphyllum</i>	1	10
<i>Trifolium nanum</i>		1
TOTAL VEG COVER	95	70
GROUND COVER (%)		
Soil	1	15
Gravel	1	4
Rock	15	35
Bedrock		
Litter	75	52
Wood		
Basal Veg	8	8
Lichen & Moss		
LANDSCAPE		
Slope (degrees)	10	8
Aspect (degrees)	30	85

Notes:

Plot 50.1: 30m x 30m, representing turf of low forbs ca. 50 m downslope from ridgeline. Some patterned ground. Substrate Flathead sandstone Elevation 11,550 feet.

Plot 50.2: 30m x 30m, representing turf with more graminoids than plot 50.1. Patterned ground present. Substrate Flathead sandstone. Elevation 11,400 feet.

Table 3-5. Canopy of plants in a high-elevation *Pseudoroegneria spicata* sample plot in the potential Arrow Mountain RNA.

Species	Plot #
	50.12
GRAMINOIDS	60
Carex elynoides	20
Elymus spicatus	20
Leucopoa kingii	10
Poa fendleriana	3
Poa secunda var. secunda	10
FORBS	40
Achillea millefolium	1
Agoseris glauca	1
Arenaria nuttallii	1
Artemisia frigida	10
Astragalus miser var. decumbens	20
Bupleurum americanum	1
Campanula uniflora	1
Castilleja flava	1
Cymopterus longilobus	10
Draba oligosperma	1
Erigeron compositus	1
Eriogonum sp.	1
Eriogonum umbellatum var. majus	3
Frasera speciosa	1
Hymenoxys grandiflora	1
Ipomopsis spicata	1
Lesquerella fremontii	1
Oxytropis campestris var. cusickii	3
Phlox pulvinata	1
Potentilla ovina var. decurrens	1
Senecio canus	1
Townsendia parryi	1
TOTAL VEG COVER	70

	Plot #
	50.12
GROUND COVER (%)	
Soil	7
Gravel	40
Bedrock	
Rock	10
Litter	36
Wood	
Basal Veg	7
Lichen & Moss	
LANDSCAPE	
Slope (degrees)	20
Aspect (degrees)	155

Notes:

Plot 50.12: 30m x 30m, on middle slope. Dolomite (?) substrate.
 Elvation 10,700 feet.

Table 3-6. Canopy of plants in miscellaneous alpine sample plot in the potential Arrow Mountain RNA.

	Salarc	Carnel	Unknown	Dryoct/ Carrup
		Plot #		
Species	50.3	50.6	50.13	50.17
SHRUBS	30	1	1	10
<i>Dryas octopetala</i>				10
<i>Pentaphylloides floribunda</i>			1	1
<i>Salix arctica</i> var. <i>petraea</i>	30	1		
<i>Salix planifolia</i>	1			
GRAMINOIDS	30	70	10	1
<i>Carex elynoides</i>				1
<i>Carex microglochin</i>		1		
<i>Carex misandra</i>		1		
<i>Carex nelsonii</i>		60		
<i>Carex rupestris</i>				1
<i>Carex scopulorum</i>	30	1		
<i>Deschampsia cespitosa</i>		1		
<i>Eleocharis</i> sp.		3		
<i>Elymus scribneri</i>			1	
<i>Juncus drummondii</i>	1			
<i>Juncus triglumis</i> var. <i>albescens</i>		1		
<i>Leukopoa kingii</i>			1	
<i>Poa alpina</i>			3	
<i>Poa cusickii</i> var. <i>cusickii</i>			1	
<i>Poa fendleriana</i>			1	
<i>Poa secunda</i> var. <i>secunda</i>		1		
FORBS	30	3	10	1
<i>Achillea millefolium</i>			1	
<i>Allium cernuum</i>				1
<i>Allium schoenoprasum</i>		1		
<i>Androsace chamaejasme</i> var. <i>carinata</i>			1	
<i>Antennaria media</i>	?		1	
<i>Aquilegia jonesii</i>				1
<i>Arenaria nuttallii</i>			1	
<i>Arenaria obtusiloba</i>				1
<i>Artemisia michauxiana</i>			1	
<i>Artemisia scopulorum</i>		1		
<i>Astragalus kentrophyta</i> var. <i>tegetarius</i>			1	
<i>Bupleurum americanum</i>			1	1
<i>Castilleja pulchella</i>				1
<i>Cerastium beeringianum</i>		1		
<i>Chaenactis alpina</i> var. <i>leucopsis</i>			1	
<i>Cirsium pulcherrimum</i>			1	

				Dryoct/ Carrup
	Salarc	Carnel	Unknown	
		Plot #		
Species	50.3	50.6	50.13	50.17
<i>Cymopterus longilobus</i>			3	
<i>Erigeron simplex</i>				1
<i>Frasera speciosa</i>			1	
<i>Geum rossi</i>		1		
<i>Heuchera parviflora</i>			1	
<i>Hymenoxys grandiflora</i>			1	1
<i>Ipomopsis spicata</i>			1	
<i>Lupinus argenteus</i> var. <i>depressus</i>			1	1
<i>Oxytropis campestris</i> var. <i>cusickii</i>				?
<i>Pedicularis groenlandica</i>		1		
<i>Polemonium viscosum</i>			1	
<i>Polygonum bistortoides</i>	1	1		
<i>Polygonum vivparum</i>		1		
<i>Potentilla diversifolia</i> var. <i>diversifolia</i>	1	1		
<i>Potentilla ovina</i> var. <i>decurrens</i>			1	
<i>Sedum integrifolium</i>	30	1		
<i>Sedum lanceolatum</i>			1	
<i>Senecio canus</i>			1	
<i>Silene kingii</i>				1
TOTAL VEG COVER	70	70	20	10
GROUND COVER (%)				
Soil	5	3	2	<1
Gravel	<1	1	60	91
Bedrock			1	
Rock	35	7	32	7
Litter	42	81	3	<1
Wood				
Basal Veg	8	7	2	1
Lichen & Moss	10	2		
LANDSCAPE				
Slope (degrees)	<1	5		15
Aspect (degrees)	85	100		10

Acronyms:

Carnel = *Carex nelsonii*; Dryoct/Carrup = *Dryas octopetala*/*Carex rupestris*; Salarc = *Salix arctica*.

Notes:

- Plot 50.3: 5m x 20m, on bench at foot of slope containing plot 50.02. Precambrian substrate. Elevation 11,300 feet.
- Plot 50.6: 20m x 20m, in wetland on bench below north-south ridge. Standing water present. Elevation 11,200 feet.
- Plot 50.13: 10m x 150m, along trail. Appears to represent upper 1/3 of valley wall. Dolomite (?) substrate. Elevation 10,500 feet.
- Plot 50.17: 20m x 20m, in patch of unusually sparse vegetation covering several acres. On dolomite (?) dip slope. Elevation 10,800 feet.
-

VEGETATION DESCRIPTIONS

Numbers following species names indicate canopy cover classes.

LOCATION 20. Timberline in Red Creek Valley.

VEGETATION TYPE: *Pinus albicaulis* Woodland

ELEVATION: 10,500 feet (3,200 meters).

ASPECT: Northeast

TOPOGRAPHIC POSITION: Middle slope

DESCRIPTION: Open woodland (ca. 15% tree overstory cover) of whitebark pine with some Engelmann spruce. Trees are ca. 5 m tall. Currant scattered beneath. Openings have alpine vegetation. Woodland merges into alpine tundra above, as represented by plot 50.4.

Trees: *Pinus albicaulis*, *Picea engelmannii*

Shrubs: *Ribes montigenum*

Dwarf Shrubs:

Graminoids & Forbs: *Carex scirpoidea* var. *pseudoscirpoidea*,
Arenaria congesta, *Polygonum bistortoides*. (Herbs grow mostly in openings between patches of trees.)

NOTES:

LOCATION 21. South-facing slope in upper Red Creek Valley.

VEGETATION TYPE: *Pinus albicaulis* Woodland

ELEVATION: 9,900 feet (3,020 meters). ASPECT: South

TOPOGRAPHIC POSITION: Lower slope

DESCRIPTION: Woodland of whitebark pine with ca. 50% overstory cover; trees to ca. 10 m tall. Undergrowth scattered mountain big sagebrush with herbaceous layer of *Leucopoa kingii* and other herbs.

Trees: *Pinus albicaulis* 40

Shrubs:

Dwarf Shrubs: *Artemisia tridentata* ssp. *vaseyana*

Graminoids & Forbs: *Leucopoa kingii*, *Elymus spicatus*, *Poa juncifolia* var. *juncifolia*, *Carex rossii*, *Carex filifolia*,
Balsamorhiza sagittata

NOTES:

LOCATION 22. Upper elevation woodland in Red Creek Valley.

VEGETATION TYPE: *Picea engelmannii*/*Juniperus communis* Forest

ELEVATION: 10,000 feet (3,050 meters). ASPECT: Northeast

TOPOGRAPHIC POSITION: Middle slope

DESCRIPTION: Woodland (tree overstory ca. 40% cover) within several hundred meters of timberline. Trees are up to ca. 20 m tall. Engelmann spruce contributes most cover and whitebark pine is present in the overstory; subalpine fir is present as a subcanopy of saplings and poles. Dead whitebark pine are common.

Shrubs are present but scattered (<1% total cover). The herbaceous undergrowth is sparse (<5% cover).

Trees: *Picea engelmannii*, *Pinus albicaulis*, *Abies lasiocarpa* (subcanopy)

Shrubs: *Ribes montigenum*, *Juniperus communis*

Dwarf Shrubs:

Graminoids & Forbs: *Vaccinium scoparium*, *Arnica cordifolia*, *Arnica latifolia*, *Potentilla glandulosa* var. *pseudorupestris*

NOTES: This stand merges into the stand upslope described at location 20.

LOCATION 23. Bottom of Red Creek Valley near timberline.

ELEVATION: ca. 9,800 feet (2,989 meters). ASPECT: East

23a.

VEGETATION TYPE: *Salix drummondiana* Shrubland

TOPOGRAPHIC POSITION: Valley bottom

DESCRIPTION: Fringe ca. 10 m wide of willow clumps with patchy herbaceous growth.

Trees:

Shrubs: *Salix drummondiana*, *Salix glauca*; few *Sambucus* sp.

Dwarf Shrubs:

Graminoids & Forbs: *Saxifraga odontoloma*, *Carex norvegica* var. *stevenii*, *Epilobium* sp., *Veronica wormskjoldii*, *Mertensia ciliata* (all in patches)

NOTES:

23b.

VEGETATION TYPE: *Festuca idahoensis* Herbaceous Vegetation

TOPOGRAPHIC POSITION: Valley floor and fans

DESCRIPTION: Belt of herbaceous vegetation up to ca. 150 m wide in narrow valley bottom, above riparian zone. Low shrubs are scattered throughout but contribute <10% cover.

Trees:

Shrubs: *Artemisia tridentata* ssp. *vaseyana*, *Chrysothamnus viscidiflorus*

Dwarf Shrubs:

Graminoids & Forbs: *Festuca idahoensis*, *Poa juncifolia* var. *juncifolia*, *Poa secunda* var. *secunda*, *Artemisia frigida*, *Potentilla glandulosa*, *Castilleja flava*, *Astragalus miser* var. *decumbens*; some *Carex eleocharis* (?), *Poa fendleriana*, *Antennaria* sp., *Carex elynoides*, *Geum triflorum*, *Arenaria congesta*.

NOTES:

LOCATION 24. Riparian zone in forest, upper Red Creek Valley

VEGETATION TYPE: *Mertensia ciliata* Herbaceous Vegetation

ELEVATION: 9,700 feet (2,958 meters). ASPECT: East

TOPOGRAPHIC POSITION: Valley bottom

DESCRIPTION: Fringe of herbaceous vegetation ca. 3 m wide, growing in gully incised ca. 10 m into valley floor; sides well vegetated. Scattered Engelmann spruce present; upland is Engelmann spruce forest.

Trees: *Picea engelmannii*

Shrubs:

Dwarf Shrubs:

Graminoids & Forbs: *Mertensia ciliata*, *Senecio triangularis*,
Saxifraga odontoloma

NOTES:

LOCATION 25. Upper Red Creek Valley

VEGETATION TYPE: *Pinus albicaulis*/*Juniperus communis* Woodland

ELEVATION: 9,600 feet (2,928 meters). ASPECT: East

TOPOGRAPHIC POSITION: Lower slope

DESCRIPTION: Open stand (canopy cover ca. 50%) of whitebark pine with Engelmann spruce secondary; subalpine fir present as subcanopy of saplings and poles. Undergrowth sparse (<5% cover); juniper is most common plant.

Trees: *Pinus albicaulis*, *Picea engelmannii*, *Abies lasiocarpa*
(subcanopy)

Shrubs: *Juniperus communis*

Dwarf Shrubs:

Graminoids & Forbs: *Arnica cordifolia*, *Vaccinium scoparium*

NOTES: Substrate is boulders of Flathead sandstone.

LOCATION 26. Upper Red Creek Valley

VEGETATION TYPE: *Picea engelmannii*/*Ribes montigenum* Forest

ELEVATION: 9,700 feet (2,958 meters). ASPECT: Northwest

TOPOGRAPHIC POSITION: Lower slope

DESCRIPTION: Trees to ca. 20 m tall, with canopy cover ca. 50%. Engelmann spruce forms canopy with scattered whitebark pine. Undergrowth is sparse (ca. 5% cover).

Trees: *Picea engelmannii*, *Pinus albicaulis* (few)

Shrubs: *Ribes montigenum* (ca. 1% cover)

Dwarf Shrubs:

Graminoids & Forbs: *Senecio sphaerocephalus*, *Aquilegia coerulea*,
Astragalus miser var. *decumbens* (all <1% cover).

NOTES: On opposite valley wall from location 25.

LOCATION 27. Upper Red Creek Valley

VEGETATION TYPE: Herbaceous opening

ELEVATION: 10,000 feet (3,050 meters). ASPECT: Northwest

TOPOGRAPHIC POSITION: Middle slope

DESCRIPTION: Openings in Engelmann spruce woodland (see locations 26 and 28). Total vegetation cover ca. 60%; gravel, rock, and bare soil common.

Trees:

Shrubs:

Dwarf Shrubs:

Graminoids & Forbs: *Cymopterus longilobus*, *Poa secunda* var. *elongatus*, *Elymus trachycaulus*, *Leucopoa kingii*, *Oxytropis campestris* var. *cusickii*, *Bupleurum americanum*, *Solidago multiradiata*.

NOTES:

LOCATION 28.

VEGETATION TYPE: *Picea engelmannii*/*Juniperus communis* Forest
ELEVATION: 10,200 feet (3,111 meters). ASPECT: Northwest
TOPOGRAPHIC POSITION: Middle slope
DESCRIPTION: Composition and structure very similar to location 26.

Trees:

Shrubs:

Dwarf Shrubs:

Graminoids & Forbs:

NOTES:

LOCATION 29. Saddle at head of Red Creek, on south side of valley

VEGETATION TYPE: *Carex scirpoidea*/*Potentilla diversifolia*
Herbaceous Vegetation?

ELEVATION: 10,400 feet (3,172 meters). ASPECT: North

TOPOGRAPHIC POSITION: Upper slope and saddle

DESCRIPTION: Turf vegetation without shrubs.

Trees:

Shrubs:

Dwarf Shrubs:

Graminoids & Forbs: *Carex atrata*, *Poa alpina*, *Potentilla diversifolia*, *Artemisia scopulorum*; secondary species are *Deschampsia cespitosa*, *Polygonum bistortoides*.

NOTES: Classification follows Cooper et al. (1997)

LOCATION 30. North side of upper Red Creek Valley

VEGETATION TYPE: *Carex elynoides* Herbaceous Vegetation

ELEVATION: 10,200 feet (3,111 meters). ASPECT: Southeast

TOPOGRAPHIC POSITION: Lower slope

DESCRIPTION: Matrix is low *Carex elynoides* vegetation, but narrow draws (<10% of area) contain taller herbaceous vegetation

Matrix: *Carex elynoides*, *Cymopterus longilobus*, *Poa secunda*, *Arenaria congesta*, *Lomatium cous*, *Artemisia frigida*, *Elymus spicatus*, *Oxytropis campestris*.

Draws: *Elymus trachycaulus*, *Leucopoa kingii*, *Achillea millefolium*, *Arenaria congesta*, *Potentilla* sp.

NOTES:

LOCATION 31. Upper Red Creek Valley

VEGETATION TYPE: *Carex elynoides* Herbaceous Vegetation

ELEVATION: 10,800 feet (3,294 meters). ASPECT: South

TOPOGRAPHIC POSITION: Edge of ridgetop
DESCRIPTION: Low herbaceous vegetation
Trees:
Shrubs:
Dwarf Shrubs:
Graminoids & Forbs: *Carex elynoides*, *Carex rupestris*, *Cymopterus longilobus*, *Sedum lanceolatum*
NOTES: Substrate is dolomite (?)

LOCATION 32. Upper Red Creek Valley

VEGETATION TYPE: *Salix planifolia*/*Carex scopulorum* Shrubland
ELEVATION: 10,900 feet (3,324 meters). ASPECT: Northeast
TOPOGRAPHIC POSITION: Upper slope
DESCRIPTION: 2-3 acre wetland in matrix of *Geum rossii* vegetation.
Trees:
Shrubs: *Salix planifolia*, *Betula glandulosa* (willow slightly more common)
Dwarf Shrubs:
Graminoids & Forbs: *Carex scopulorum*
NOTES: Substrate is Flathead sandstone

LOCATION 33. Divide at head of Red Creek

VEGETATION TYPE: *Carex elynoides* Herbaceous Vegetation
ELEVATION: 10,900 feet (3,324 meters). ASPECT: West and northwest
TOPOGRAPHIC POSITION: Upper slopes
DESCRIPTION: Alpine turf vegetation. Composition varies with slope, as follows:
-- West-facing slopes: *Carex elynoides* (strongly dominant), *Trifolium dasyphyllum*, *Oxytropis campestris* var. *cusickii*, *Poa alpina*, *Agoseris glauca*.
-- Northwest-facing slopes: *Carex elynoides*, *Geum rossii*, *Lupinus argenteus* var. *depressus*, *Polygonum bistortoides*, *Helictotrichon mortonianum*, *Agoseris glauca*. Dominance of *C. elynoides* less pronounced.
NOTES: Precambrian substrate. Appears to represent vegetation along western fringe of potential RNA.

LOCATION 34. Lower part Little Red Creek Valley

ELEVATION: 8200 - ca. 9200 feet (2501 meters).

34a.

VEGETATION TYPE: *Pseudotsuga menziesii*/*Juniperus communis* Forest
ASPECT: East and north
TOPOGRAPHIC POSITION: Slopes
DESCRIPTION: Woodland of Douglas-fir with limber pine in the overstory; latter especially common (co-dominates) on southerly and westerly exposures. Shrub cover and herbaceous cover are patchy in the undergrowth.

Trees: *Pseudotsuga menziesii*, *Pinus flexilis*

Shrubs: *Juniperus communis*

Dwarf Shrubs:

Graminoids & Forbs: *Leucopoa kingii*, *Elymus spicatus*

NOTES: This woodland type appears to form the matrix of the montane woodland, with patches of *Pinus flexilis*/*Juniperus communis* woodland on southerly and westerly slopes and ridgetops.

34b.

VEGETATION TYPE: *Pinus flexilis*/*Juniperus communis* Woodland

ASPECT: South and west TOPOGRAPHIC POSITION: Slopes

DESCRIPTION: Woodland of limber pine with some Douglas-fir in the overstory; latter especially common (co-dominates) on easterly exposures. Shrub cover and herbaceous cover are patchy in the undergrowth.

Trees: *Pinus flexilis*, *Pseudotsuga menziesii*

Shrubs: *Juniperus communis*

Dwarf Shrubs:

Graminoids & Forbs: *Leucopoa kingii*, *Elymus spicatus*

NOTES: This woodland type forms patches on southerly and westerly slopes, and on ridgetops, in the matrix *Pseudotsuga menziesii*/*Juniperus communis* woodland. The two types constitute the montane forest in the area.

LOCATION 35. South side of lower Little Red Creek

VEGETATION TYPE: *Pinus contorta*/*Juniperus communis* Woodland

ELEVATION: 9100 feet (3685 meters). ASPECT: Northeast

TOPOGRAPHIC POSITION: Slope

DESCRIPTION: Woodland of lodgepole pine (mostly \leq 10 in. [25 cm] dbh) with patchy juniper in the undergrowth.

Trees: *Pinus contorta*

Shrubs: *Juniperus communis*

Dwarf Shrubs:

Graminoids & Forbs:

NOTES: Only one patch of this type was noted during field survey.

LOCATION 36. Foothills in Little Red Creek Valley

ELEVATION: 8000 feet (2440 meters).

36a.

VEGETATION TYPE: *Artemisia tridentata* ssp. *vaseyana*/

Pseudoroegneria spicata Shrubland

ASPECT: Various

TOPOGRAPHIC POSITION: Slopes, draws, and valley bottoms

DESCRIPTION: Shrub cover is 10% - 25% and patchy, with the densest patches in draws and on lower slopes. Limber pine seedlings and saplings are common, suggesting that some of this type will become limber pine woodland in the absence of fire.

Trees: *Pinus flexilis* (seedlings, saplings, scattered poles)

Shrubs: *Artemisia tridentata* ssp. *vaseyana*

Dwarf Shrubs:

Graminoids & Forbs: *Elymus spicatus* (syn. *Pseudoroegneria spicata*), *Leucopoa kingii*

NOTES: This type merges with grass vegetation dominated by *Pseudoroegneria spicata*, and the two types form the non-forest vegetation in the foothills and montane zone on the eastern side of the potential RNA.

36b.

VEGETATION TYPE: *Pseudoroegneria spicata*-*Poa secunda* Herbaceous Vegetation (?)

ASPECT: Various

TOPOGRAPHIC POSITION: Slopes

DESCRIPTION: Bluebunch wheatgrass is the most common species in an open herbaceous vegetation (cover \leq 50%). Mountain big sagebrush often is present.

Trees: *Pinus flexilis* (few seedlings, saplings, scattered poles)

Shrubs: *Artemisia tridentata* ssp. *vaseyana* (to ca. 10% canopy cover)

Dwarf Shrubs:

Graminoids & Forbs: *Elymus spicatus* (syn. *Pseudoroegneria spicata*), *Leucopoa kingii*

NOTES: This type merges with *Artemisia tridentata* ssp. *vaseyana*/*Pseudoroegneria spicata* shrub vegetation, and the two types form the non-forest vegetation in the foothills and montane zone on the eastern side of the potential RNA.

LOCATION 37. Lower Blue Hole Creek Valley

ELEVATION: 7800 feet (2379 meters).

37a.

VEGETATION TYPE: *Artemisia tridentata* ssp. *vaseyana*/*Pseudoroegneria spicata* Shrubland

ASPECT: Various

TOPOGRAPHIC POSITION: Slopes, draws, and valley bottoms

DESCRIPTION: Bluebunch wheatgrass is the most common species in the herbaceous layer. Mountain big sagebrush canopy cover generally is between 10% and 25%, and is denser in draws and valley bottoms. Limber pine seedlings and saplings are common in stands in valley bottoms, and this type may be converted to limber pine woodland in the absence of fire.

Trees: *Pinus flexilis* (seedlings and saplings)

Shrubs: *Artemisia tridentata* ssp. *vaseyana*

Dwarf Shrubs:

Graminoids & Forbs: *Pseudoroegneria spicata*, *Leucopoa kingii*

NOTES: This type merges with grass vegetation dominated by *Pseudoroegneria spicata*, and the two types form the non-forest

vegetation in the foothills and montane zone on the eastern side of the potential RNA.

37b.

VEGETATION TYPE: *Pseudoroegneria spicata*-*Poa secunda* Herbaceous Vegetation

ASPECT: Various

TOPOGRAPHIC POSITION: Slopes

DESCRIPTION: Bluebunch wheatgrass is the most common species in the herbaceous layer. Mountain big sagebrush often is present with canopy cover <10.

Trees:

Shrubs: *Artemisia tridentata* ssp. *vaseyana* (<10% cover)

Dwarf Shrubs:

Graminoids & Forbs: *Pseudoroegneria spicata*, *Leucopoa kingii*

NOTES: This type merges with mountain big sagebrush/ bluebunch wheatgrass and the two types form the non-forest vegetation in the foothills and montane zone on the eastern side of the potential RNA.

37c.

VEGETATION TYPE: *Populus angustifolia*/*Rosa woodsii* Forest

ASPECT: East

TOPOGRAPHIC POSITION: Valley bottom

DESCRIPTION: Patchy overstory of narrowleaf cottonwood (cover <50%) above shrub layer in which rose is the most common shrub.

Trees: *Populus angustifolia*

Shrubs: *Rosa* sp.

Dwarf Shrubs:

Graminoids & Forbs: *Elymus cinereus*

NOTES:

LOCATION 38. Middle part of Blue Hole Creek Valley

VEGETATION TYPE: *Pseudotsuga menziesii*/*Juniperus communis* Forest

ELEVATION: 8300 feet (2531 meters). ASPECT: North and east

TOPOGRAPHIC POSITION: Slope

DESCRIPTION: Overstory of Douglas-fir with limber pine, the latter co-dominating on upper slopes and ridgetops. The tree overstory generally has 50% - 60% canopy cover. Juniper forms a patchy shrub layer above a sparse and patchy herbaceous undergrowth.

Trees: *Pseudotsuga menziesii*, *Pinus flexilis*

Shrubs: *Juniperus communis*

Dwarf Shrubs:

Graminoids & Forbs: *Leucopoa kingii*, *Orthilia secunda*.

NOTES: This appears to be the major type in the montane forest.

LOCATION 39. Upper Blue Hole Creek Valley

ELEVATION: 9200 feet (2806 meters).

39a.

VEGETATION TYPE: *Picea engelmannii*/*Juniperus communis* Forest

ASPECT: Mainly north- and east-facing slopes, and lower south-facing slopes

TOPOGRAPHIC POSITION: Slopes

DESCRIPTION: Engelmann spruce (trees to ca. 10 in. [25 cm] dbh) dominate in the overstory. Limber pine is present in most places and co-dominates on southerly slopes. Douglas-fir also is present in many places. Juniper forms a patchy shrub layer. King spikefescue is the most common species in the patchy herbaceous undergrowth.

Trees: *Picea engelmannii*, *Pinus flexilis*, *Pseudotsuga menziesii*

Shrubs: *Juniperus communis*

Dwarf Shrubs:

Graminoids & Forbs: *Leucopoa kingii*

NOTES: This type appears to be the most common component of the lower part of the subalpine forest. It merges at lower elevations with *Pseudotsuga menziesii*/*Juniperus communis* woodland (locations 34 and 38), and at higher elevations with the *Picea engelmannii*/*Ribes montigenum* forest (locations 26 and 28).

39b.

VEGETATION TYPE: *Pinus flexilis*/*Juniperus communis* Woodland

ASPECT: South- and west-facing slopes

TOPOGRAPHIC POSITION: Slopes

DESCRIPTION: Open woodland (canopy cover <50%) of limber pine, often with Engelmann spruce and Douglas--fir, above a patchy shrub layer of juniper. Trees are \leq 10 in. (25 cm) dbh.

Trees: *Pinus flexilis*, *Picea engelmannii*, *Pseudotsuga menziesii*

Shrubs: *Juniperus communis*

Dwarf Shrubs:

Graminoids & Forbs:

NOTES: This type forms large patches in, and merges with, the matrix of Engelmann spruce woodland.

39c.

VEGETATION TYPE: *Carex scirpoidea*/*Potentilla diversifolia*

Herbaceous Vegetation?

ASPECT: Various

TOPOGRAPHIC POSITION: Slopes and ridgetops

DESCRIPTION: Dense herbaceous vegetation (cover >60%) mixed with Engelmann spruce woodland.

Trees:

Shrubs:

Dwarf Shrubs:

Graminoids & Forbs: *Carex scirpoidea*, *Leucopoa kingii*

NOTES: This type occurs in the timberline ecotone with patches of *Picea englemannii*/*Ribes montigenum* woodland.

Appendix 4. Explanations of ranks used by the Wyoming Natural Diversity Database

As part of the North American network of natural heritage programs, the Wyoming Natural Diversity Database (WYNDD) uses the natural heritage element ranking system developed by The Nature Conservancy. In this system, each element (in this case, species) is assigned a two-part rank that reflects its rarity and security both globally (the G part of the rank) and within a state or province (the S part of the rank). Both the global rank and the state rank can range from 1 (extremely rare or threatened) to 5 (common and secure). Ranks are defined as follows:

Global Ranks

- G1: Critically imperiled globally because of extreme rarity (5 or fewer occurrences or very few remaining individuals) or because of some factors making it especially vulnerable to extinction.
- G2: Imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals) or because of factors making it very vulnerable to extinction.
- G3: Either very rare and localized throughout its range, or found locally (and perhaps abundantly at some sites) throughout a restricted range, or vulnerable to extinction throughout its range.
- G4: Apparently secure globally, although it may be quite rare in parts of its range, especially at the periphery.
- G5: Demonstrably secure globally and essentially ineradicable under present conditions.
- T: A "T" following the global rank (G#T#) refers to a rank assigned to a subspecific taxon. The number following the "G" is the rank of the species, and the number following the "T" is the rank of the subspecific taxon.
- Q: Taxonomic questions or problems exist about the taxon; more information is needed. A "G#Q" rank implies that the taxonomic distinctiveness of the taxon may be of questionable validity. A "G#T#Q" rank implies that the taxonomic distinctiveness of the subspecific taxon is of questionable validity.

State Ranks

- S1: Critically imperiled in the state or province because of extreme rarity (5 or fewer occurrences or very few remaining individuals) or because of some factors making it especially vulnerable to extinction.
- S2: Imperiled in the state or province because of rarity (6 to 20 occurrences or few remaining individuals) or because of factors making it very vulnerable to extinction.
- S3: Rare or uncommon in the state (on the order of 21 to 100 occurrences).
- S4: Apparently secure in the state or province, with many occurrences.
- G5: Demonstrably secure in the state or province and essentially ineradicable under present conditions.
- SU: Possibly imperiled in the state but status is uncertain; more information needed before a numerical rank can be assigned.
- S?: Status uncertain due to lack of information. The "?" is usually combined with any of the numerical ranks, as in "S3?".

Migratory Ranks

- B: A "B" following a rank (e.g., S3B) indicates that the rank refers to the breeding status of the species within the state. B ranks are usually assigned to birds.
- N: An "N" following a rank (e.g., S3N) indicates that the preceding rank refers to the non-breeding status of the species in the state. N ranks are usually assigned to birds.

A state rank of S2BS5N indicates that the species is rare in the state as a breeder, but abundant as a non-breeder.

Appendix 5. Plant community types in the potential Arrow Mountain Research Natural Area

The vegetation types are listed by the names used for them in the national vegetation classification (Anderson et al. 1998). The code in parentheses following the name is the last four digits of the element code from the national classification. Citations refer to these sources:

- Johnston (1987): equivalent plant association from the list for USDA Forest Service Region 2;
- Tweit and Houston (198): equivalent Shoshone National Forest grassland or shrubland habitat type (if any);
- Steele et al. (1983): equivalent forest habitat type (if any);
- Federal Geographic Data Committee (1997): type in the hierarchy of the National Vegetation Classification Standard to which the association belongs;
- Kuchler (1966): Kuchler vegetation type to which the association belongs;
- Eyre (1980): Society of American Foresters forest cover type to which the association belongs (if any).

Forests and Woodlands

Picea engelmannii/*Juniperus communis* Forest (369)

- Johnston (1987): *Picea engelmannii*/*Juniperus communis* Plant Association
- Tweit and Houston (1980): None
- Steele et al. (1983): *Picea engelmannii*/*Juniperus communis* Habitat Type
- Federal Geographic Data Committee (1997): I.A.8.N.c.; Conical-crown, temperate or subpolar, needle-leaved evergreen forest
- Kuchler (1966): Western spruce-fir forest (14)
- Eyre (1980): Engelmann spruce-subalpine fir (206)

Pinus albicaulis Woodland (127)

- Johnston (1987): *Pinus albicaulis*/*Vaccinium scoparium* Plant Association?
- Tweit and Houston (1980): None
- Steele et al. (1983): *Abies lasiocarpa*/*Ribes montigenum* Habitat Type, *Pinus albicaulis* phase?
- Federal Geographic Data Committee (1997): II.A.4.N.a; Rounded-crown, temperate or subpolar, needle-leaved evergreen woodland
- Kuchler (1966): Western spruce-fir forest (14)
- Eyre (1980): Whitebark pine (208)

Pinus albicaulis/Juniperus communis Woodland (756)

- Johnston (1987): *Pinus albicaulis/Juniperus communis* Plant Association
- Tweit and Houston (1980): None
- Steele et al. (1983): *Abies lasiocarpa/Ribes montigenum* Habitat Type, *Pinus albicaulis* phase?
- Federal Geographic Data Committee (1997): II.A.4.N.a; Rounded-crown, temperate or subpolar, needle-leaved evergreen woodland
- Kuchler (1966): Western spruce-fir forest (14)
- Eyre (1980): Whitebark pine (208)

Pinus contorta/Juniperus communis Woodland (764)

- Johnston (1987): *Pinus contorta/Juniperus communis* Plant Association
- Tweit and Houston (1980): None
- Steele et al. (1983): *Pinus contorta/Juniperus communis* Community Type
- Federal Geographic Data Committee (1997): II.A.4.N.a; Rounded-crown, temperate or subpolar, needle-leaved evergreen woodland
- Kuchler (1966): Douglas-fir forest (11)?
- Eyre (1980): Lodgepole pine (218)

Pinus flexilis/Juniperus communis Woodland (807)

- Johnston (1987): *Pinus flexilis/Juniperus communis* Plant Association
- Tweit and Houston (1980): None
- Steele et al. (1983): *Pinus flexilis/Juniperus communis* Habitat Type
- Federal Geographic Data Committee (1997): II.A.4.N.a; Rounded-crown, temperate or subpolar, needle-leaved evergreen woodland
- Kuchler (1966): Douglas-fir forest (11)
- Eyre (1980): Limber pine (219)

Populus angustifolia/Rosa woodsii Forest (653)?

- Johnston (1987): Unknown
- Tweit and Houston (1980): None
- Steele et al. (1983): None
- Federal Geographic Data Committee (1997): I.B.2.N.d; Temporarily flooded, cold-deciduous forest
- Kuchler (1966): Unknown
- Eyre (1980): Cottonwood-Willow (235)

Pseudotsuga menziesii/*Juniperus communis* Forest (349)

- Johnston (1987):): *Pseudotsuga menziesii*/*Juniperus communis* Plant Association
- Tweit and Houston (1980): None
- Steele et al. (1983): *Pseudotsuga menziesii*/*Juniperus communis* Habitat Type
- Federal Geographic Data Committee (1997): I.A.8.N.c.; Conical-crowned, temperate or subpolar, needle-leaved, evergreen forest
- Kuchler (1966): Douglas-fir forest (11)
- Eyre (1980): Interior Douglas-fir (210)

Shrublands and Dwarf-Shrublands

Artemisia tridentata ssp. *vaseyana*/*Pseudorogeneria spicata* Shrubland(1030)

- Johnston (1987): *Artemisia tridentata*/*Roegneria spicata* Plant Association
- Tweit and Houston (1980): *Artemisia tridentata* ssp. *vaseyana*/*Festuca idahoensis* Habitat Type?
- Steele et al. (1983): None
- Federal Geographic Data Committee (1997): III.A.4.N.a.; Microphyllous evergreen shrubland
- Kuchler (1966): Sagebrush steppe (49)?
- Eyre (1980): None

Dryas octopetala/*Carex rupestris* Dwarf-shrub Herbaceous Vegetation (1892)

- Johnston (1987): *Dryas octopetala*/*Carex rupestris* Plant Association
- Tweit and Houston (1980): None
- Steele et al. (1983): None
- Federal Geographic Data Committee (1997): V.A.8.N.c.; Short, temperate or subpolar, alpine grassland with a sparse, needle-leaved or microphyllous, evergreen dwarf-shrub layer. (Probably mis-classified; should be IV.A.1.N.b.; creeping or matted, needle-leaved or microphyllous, evergreen dwarf-shrubland)
- Kuchler (1966): Alpine meadows and barrens (45)
- Eyre (1980): None

Salix arctica Dwarf-shrubland Alliance (no code)

- Johnston (1987): *Salix arctica*/*Acomastylis rossii* Plant Association, *Sibbaldia procumbens* phase?
- Tweit and Houston (1980): None
- Steele et al. (1983): None
- Federal Geographic Data Committee (1997): IV.B.2.N.b.; Creeping or matted, cold-deciduous, dwarf-shrubland
- Kuchler (1966): Alpine meadows and barrens (45)
- Eyre (1980): None

Salix drummondiana Shrubland (1190)

- Johnston (1987): Unknown
- Tweit and Houston (1980): None
- Steele et al. (1983): None
- Federal Geographic Data Committee (1997): III.B.2.N.d.;
Temporarily-flooded, cold-deciduous shrubland
- Kuchler (1966): None
- Eyre (1980): None

Salix planifolia/Carex scopulorum Shrubland (1229)

- Johnston (1987): Unknown
- Tweit and Houston (1980): None
- Steele et al. (1983): None
- Federal Geographic Data Committee (1997): III.B.2.N.e.;
Seasonally flooded, cold-deciduous shrubland
- Kuchler (1966): Alpine meadows and barrens (45)?
- Eyre (1980): None

Herbaceous Vegetation

Carex elynoides Herbaceous Vegetation (1852)

- Johnston (1987): Unknown (Johnston lists several *C. elynoides*
plant associations)
- Tweit and Houston (1980): None
- Steele et al. (1983): None
- Federal Geographic Data Committee (1997): V.A.5.N.g.; Short
alpine or subalpine sod grassland
- Kuchler (1966): Alpine meadows and barrens (45)
- Eyre (1980): None

Carex nelsonii Herbaceous Vegetation (no code)

- Johnston (1987): None
- Tweit and Houston (1980): None
- Steele et al. (1983): None
- Federal Geographic Data Committee (1997): V.A.5.N.k.;
Seasonally flooded, temperate or subpolar grassland
- Kuchler (1966): Alpine meadows and barrens (45)
- Eyre (1980): None

Carex scirpoidea/Potentilla diversifolia Herbaceous Vegetation (1867)

- Johnston (1987): None
- Tweit and Houston (1980): None
- Steele et al. (1983): None
- Federal Geographic Data Committee (1997): V.A.5.N.g.; Short
alpine or subalpine sod grassland
- Kuchler (1966): Alpine meadows and barrens (45)
- Eyre (1980): None

Festuca idahoensis Herbaceous Vegetation (1897)?

- Johnston (1987): Unknown
- Tweit and Houston (1980): *Festuca idahoensis/ Agropyron caninum* Habitat Type?
- Steele et al. (1983): None
- Federal Geographic Data Committee (1997): V.A.5.N.h.; Short alpine or subalpine dry bunch grassland
- Kuchler (1966): Alpine meadows and barren (45)?
- Eyre (1980): None

Geum rossii/Trifolium spp. Herbaceous Vegetation (1970)

- Johnston (1987): *Acomastylis rossii/Trifolium dasyphyllum* plant association
- Tweit and Houston (1980): *Geum rossii* turf community type
- Steele et al. (1983): None
- Federal Geographic Data Committee (1997): V.B.2.N.b.; Low temperate or subpolar perennial forb vegetation
- Kuchler (1966): Alpine meadows and barrens (45)
- Eyre (1980): None

Herbaceous opening (no code)

- Johnston (1987): Unknown
- Tweit and Houston (1980): None
- Steele et al. (1983): None
- Federal Geographic Data Committee (1997): V.B.2.N.b.; Low temperate or subpolar perennial forb vegetation
- Kuchler (1966): Alpine meadows and barrens (45)
- Eyre (1980): None

Mertensia ciliata Herbaceous Vegetation (1944)?

- Johnston (1987): Unknown
- Tweit and Houston (1980): None
- Steele et al. (1983): \$/\$ Habitat Type
- Federal Geographic Data Committee (1997): V.B.2.N.a.; Tall temperate or subpolar, perennial forb vegetation
- Kuchler (1966): Alpine meadows and barrens (45)?
- Eyre (1980): None

Pseudoroegneria spicata-Poa secunda Herbaceous Vegetation (1677)?

- Johnston (1987): *Roegneria spicata/Poa secunda* Plant Association
- Tweit and Houston (1980): *Agropyron spicatum/Poa sandbergii* Habitat Type
- Steele et al. (1983): None
- Federal Geographic Data Committee (1997): V.A.5.N.d.; Medium-tall, bunch, temperate or subpolar grassland
- Kuchler (1966): Wheatgrass-bluegrass (44)?
- Eyre (1980): None

Appendix 6. Element Occurrence Records for Plant Species of
Special Concern in the potential Arrow Mountain RNA.