USDA Natural Resources Conservation Service

Ecological site R043AX962MT
Alpine Unstable Talus rocky ledge penstemon (Penstemon ellipticus)

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General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

MLRA notes

Major Land Resource Area (MLRA): 043A–Northern Rocky Mountains

This MLRA is located in Montana (43 percent), Idaho (34 percent), and Washington (23 percent). It makes up about 31,435 square miles (81,460 square kilometers). It has no large cities or towns. It has many national forests, including the Okanogan, Colville, Kootenai, Lolo, Flathead, Coeur d'Alene, St. Joe, Clearwater, and Kaniksu National Forests.

This MLRA is in the Northern Rocky Mountains Province of the Rocky Mountain System. It is characterized by rugged, glaciated mountains; thrust- and block-faulted mountains; and hills and valleys. Steep-gradient rivers have cut deep canyons. Natural and manmade lakes are common.

The major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA are: Kootenai-Pend Oreille-Spokane (1701), 67 percent; Upper Columbia (1702), 18 percent; and Lower Snake (1706), 15 percent. Numerous rivers originate in or flow through this area, including, the Sanpoil, Columbia, Pend Oreille, Kootenai, St. Joe, Thompson, and Flathead Rivers.

This area is underlain primarily by stacked slabs of layered sedimentary or metasedimentary bedrock. The bedrock formations range from Precambrian to Cretaceous in age. The rocks consist of shale, sandstone, siltstone, limestone, argillite, quartzite, gneiss, schist, dolomite, basalt, and granite. The formations have been faulted and stacked into a series of imbricate slabs by regional tectonic activity. Pleistocene glaciers carved a rugged landscape that includes sculpted hills and narrow valleys filled with till and outwash. Continental glaciation over road the landscape in the northern half of the MLRA while glaciation in the southern half was confined to montane settings.

The average annual precipitation is 25 to 60 inches (635 to 1,525 millimeters) in most of this area, but it is as much as 113 inches (2,870 millimeters) in the mountains and is 10 to 15 inches (255 to 380 millimeters) in the western part of the area. Summers are dry. Most of the precipitation during fall, winter, and spring is snow. The average annual temperature is 32 to 51 degrees F (0 to 11 degrees C) in most of the area, decreasing with elevation. In most of the area, the freeze-free period averages 140 days and ranges from 65 to 215 days. It is longest in the low valleys of Washington, and it decreases in length with elevation. Freezing temperatures occur every month of the year on high mountains, and some peaks have a continuous cover of snow and ice.

The dominant soil orders in this MLRA are Andisols, Inceptisols, and Alfisols. Many of the soils are influenced by Mount Mazama ash deposits. The soils in the area have a frigid or cryic soil temperature regime; have an ustic, xeric, or udic soil moisture regime; and dominantly have mixed mineralogy. They are shallow to very deep, are very poorly drained to well drained, and have most of the soil texture classes. The soils at the lower elevations include Udivitrands, Vitrixerands and Haplustalfs. The soils at the higher elevations include Dystrocryepts, Eutrocryepts, Vitricryands , and Haplocryalfs. Cryorthents, Cryepts, and areas of rock outcrop are on ridges and peaks above timberline

This area is in the northern part of the Northern Rocky Mountains. Grand fir, Douglas-fir, western red cedar, western hemlock, western larch, lodgepole pine, subalpine fir, ponderosa pine, whitebark pine, and western white pine are the dominant overstory species, depending on precipitation, temperature, elevation, and landform aspect. The understory vegetation varies, also depending on climatic and landform factors. Some of the major wildlife species in this area are whitetailed deer, mule deer, elk, moose, black bear, grizzly bear, coyote, fox, and grouse. Fish, mostly in the trout and salmon families, are abundant in streams, rivers, and lakes.

More than one-half of this area is federally owned and administered by the U.S. Department of Agriculture, Forest Service. Much of the privately-owned land is controlled by large commercial timber companies. The forested areas are used for wildlife habitat, recreation, watershed, livestock grazing, and timber production. Meadows provide summer grazing for livestock and big game animals. Less than 3 percent of the area is cropland.

LRU notes

This ecological site resides in MLRA 43A in the Livingston-Lewis-Apgar Mountains which includes the bulk of Glacier National Park (GNP) and the lower western valley portions along the Flathead River. The landscape is mountains and landforms include glaciated mountains with associated features such as U-shaped valleys, mountain slopes, alpine ridges, cirques, valley floors and moraines. Glaciation of this area was in the form of alpine, icecaps and valley outlet glaciers. It also includes associated alluvium and outwash features. This area includes low valleys to tall mountains with elevation ranging 989-2,762 m (3,250-9,050 ft.). The climate is cold and wet with mean annual air temperature of 3 degrees Celsius (37 degrees F)., mean frost free days of 65 days and mean annual precipitation of 1295 mm (51 in.) and relative effective annual precipitation is 169 cm (66 in.). The soil temperature regime is cryic and the soil moisture regime is udic. The geology of this area is dominated by metasedimentary rocks of the Belt Supergroup (Grinnell argillite and Siyeh limestone) with minor Tertiary sediments. Soils are generally weakly developed on mountain slopes within U-shaped valleys. Parent materials are commonly of colluvium, till, and residuum from metasedimentary rocks. Limestone bedrock within this part of the Belt Supergroup is not highly calcareous and due to high precipitation received in this area most carbonates at mid and upper elevations have been leached from the soil profiles. Bedrock depth varies greatly with location, landform and slope position. Volcanic ash is often found in the soil surface with various degrees of mixing. Thicker volcanic ash can be found on more stable positions on mid and upper elevation slopes that are protected from wind erosion. Volcanic ash is not typically found in low elevation areas on stream and outwash terraces associated with streams and rivers. There are numerous large lakes including St. Mary, Bowman, Kintla, Lake Sherburne, Logging, Upper Waterton and numerous creeks (

Classification relationships

NVC Classification: *Phacelia hastata*-(*Penstemon ellipticus*) Sparse Vegeation, CEGL005901
Physiognomic Class Sparse Vegetation (VII)
Physiognomic Subclass Boulder, gravel, cobble, or talus sparse vegetation (VII.B.)
Physiognomic Group Sparsely vegetated talus/scree slopes (VII.B.1.)
Physiognomic Subgroup Natural/Semi-natural sparsely vegetated talus/scree slopes (VII.B.1.N.)
Formation High mountain talus/scree (VII.B.1.N.c.)
Alliance *Phacelia hastata* Sparsely Vegetated Alliance (A.2634)
Alliance (English name) Silverleaf Scorpionweed Sparsely Vegetated Alliance
Association *Phacelia hastata* – (*Penstemon ellipticus*) Sparse Vegetation
Association (English name) Silverleaf Scorpionweed- (Rocky Ledge Penstemon) Sparse Vegetation
Ecological Systems: Rocky Mountain Alpine Bedrock and Scree (CES306.809)

Ecological site concept

Ecological Site Concept
This ecological site is found on extensive talus slopes at high elevation near the Continental Divide in the subalpine to alpine life zones. It is found on backslope positions of steep, active and unstable talus slopes with slopes steepness gradients ranging from 35-80%. It occurs on colluvial aprons, cirque walls and glacial valley wall landforms at elevations ranging 1,450-2,700 meters (4750-8850 feet). The reference community describes the site modal concept of unstable scree with little to moderate vegetation development with indicator species including rocky ledge penstemon (*Penstemon ellipticus*), Buttecandle (*Cryptantha celosioides*) and silverleaf phacelia (*Phacelia hastata*). It also has a sparse layer of tall mesophytic forb species including: rocky ragwort (*Senecio*

megacephalus) and yellow columbine (*Aquilegia flavescens*). Soils associated with this ecological site are deep, well to somewhat excessively drained and have abundant rock fragments throughout. These soils are generally classified in the Entisols or Inceptisols soil orders, indicating that they have virtually no soil development because they are on active positions of the landscape or have only weakly developed soil diagnostic characteristics. These sites are found on active colluvial aprons and glacial valley walls where material is transported down slope by gravity and deposited where the slope angle decreases. Soil development is patchy on these active slope positions, creating a mosaic of areas where more recent depositional activity has occurred juxtaposed against areas that have remained more stable and are more vegetated. Soils on the most recent depositional areas will be Entisols and soils on more stable, vegetated positions will be Inceptisols. Diagnostic features in these soils include an ochric epipedon and cambic subsurface horizon. Soils on these sites typically lack an organic surface layer, but if one is present it is very thin with a thickness of less than 3 cm.

Associated sites

R043AX971MT	**Alpine Solifluction Terrace Dryas octopetala (Arctostaphylos uva-ursi/Salix arctica)** The 43A Alpine Solifluction Terrace ecological site is found at high elevations (1,700-2,600 m. 5,575-8,530 ft.) on ridges or backslopes in the mountains or cirque floors mainly on northern or western aspects of moderate to steeper slopes (10-40 percent). Due to frost heave action, solifluction terraces have developed, in which there is a sorting of gravels and vegetation into stripes.The 43A Alpine solifluction terrace ecological site has soils that are moderately deep, well drained, and very gravelly in the surface and subsurface. The highest expression of this site has areas of alternating strips covered by vegetation and rock terracing which has low to moderate vegetation cover. The 43A Alpine solifluction terrace ecological site has soils that are moderately deep, well drained, and very gravelly in the surface and subsurface. The highest expression of this site has areas of alternating strips covered by vegetation and rock terracing which has low to moderate vegetation cover. The 43A Alpine Solifluction Terrace ecological site has a reference vegetation community of eightpetal mountain-avens (kinnikinnick-arctic willow-moss campion-twinflower sandwort)/alpine smelowskia-cutleaf daisy-alpine bistort/curly sedge.
F043AX954MT	**Upper Subalpine Cold Coniferous subalpine fir (Engelmann spruce) /thinleaf huckleberry-rusty menziesia/ Hitchcock’s smooth woodrush-beargrass/yellow avalanche lily.** The 43A Upper Subalpine Cold Coniferous (ABLA/LUGLH) ecological site is found along the continental divide in cold, and moist to moderately dry, high elevations in the upper subalpine. It is primarily on cirque platform and headwall landforms, on backslope and shoulder positions at elevations ranging 1,700 to 2,600 meters (5,575-8,530 ft.) with moderate to steep slopes ranging 10% to 80%.The 43A Upper Subalpine Cold Coniferous (ABLA/LUGLH) has soils associated with this ecological site that are moderately deep, well drained and derived from glacial till or colluvium over residuum weathered from metasedimentary rock. Moderately deep depth class indicates that these soils are greater than 50 cm (20 inches) deep, but less than 100 cm (40 inches). These soils classify in the Inceptisols soil order and in the Typic Haplocryepts taxonomic subgroup. The 43A Upper Subalpine Cold Coniferous (ABLA/LUGLH) ecological site has a reference vegetation community of subalpine fir (and minor Engelmann spruce) with an understory of thinleaf huckleberry, rusty menziesia, Hitchcock’s smooth woodrush-beargrass and yellow avalanche lily.
F043AX958MT	**Alpine Krummholtz Coniferous subalpine fir-whitebark pine/grouse whortleberry Abies lasciocarpa-Pinus albicaulis (Picea engelmannii)/Vaccinium scoparium** The 43A alpine krummholtz coniferous site is found along the Continental Divide in the severe, cold, high elevations of the upper subalpine and timberline zones. The dominant landform is cirque headwalls, on backslope positions, at elevations ranging from 1,800 to 2,600 meters (5,900-8,530 ft.). This site occurs on all aspects and generally on steeper slopes ranging from 15 to 80 percent.The 43A Alpine Krummholtz Coniferous ecological site has soils associated with this ecological site that are deep and well drained and are on steep mountain slopes. Due to the high amount of rock fragments throughout these soils their ability to hold and store water is limited. Active slope processes and erosion limit the amount of soil development causing these soils to be classified in the Inceptisols soil order. The 43A Alpine Krummholtz Coniferous has a reference vegetation community of Subalpine fir and Whitebark pine overstory (with minor Engelmann spruce) and an understory of grouse whortleberry, thinleaf huckleberry, Hitchcock’s smooth woodrush, beargrass, Green false hellebore, Sitka valerian and Yellow avalanche lily.

R043AX963MT	**Alpine Shallow Meadow yellow avalanche-lily-Scouler's St. Johnswort-alpine leafybract aster-Sitka valerian- heartleaf arnica/Hitchcock's smooth woodrush** The 43A Alpine Shallow Meadow ecological site is found on a wide range of high elevation sites that share in common cold winter temperatures, heavy snow loading, and a short growing season. These are large patch size meadows. These sites are on backslopes, with generally slopes below 35 percent, but can be found on steep backslope positions, and on all aspects. It is found at the base of talus slopes and on large, broad areas on colluvial aprons. It also is found in linear areas between ribbons of high elevation forests found on cirque platforms and headwalls, roche moutonées, or scoured bedrock knobs and hills, and saddles.The 43A Alpine Shallow Meadow ecological site is found on soils that are shallow to moderately deep, well drained, have a high amount of rock fragments, and form from till or colluvium over residuum soil parent materials. These soils very rarely have a surface organic layer, and it is typically less than 5 cm (2 in.) deep if it occurs.The 43A Alpine Shallow Meadow ecological site has a reference vegetation community of Yellow avalanche-lily (Erythronium grandiflorum), Scouler's St. Johnswort (Hypericum scouleri), alpine leafybract aster (Symphyotrichum foliaceum), Sitka valerian (Valeriana sitchensis), heartleaf arnica (Arnica cordifolia), Hitchcock's smooth woodrush (Luzula glabrata var. hitchcockii) and shortstalk sedge (Carex podocarpa).

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Penstemon ellipticus* (2) *Cryptantha celosioides*

Physiographic features

This ecological site is found on extensive talus slopes at high elevation near the Continental Divide in the subalpine to alpine life zones. It is found on backslope positions of steep, active and unstable talus slopes with slopes steepness gradients ranging from 35-80%. It occurs on colluvial aprons, cirque walls and glacial valley wall landforms at elevations ranging 1,450-2,700 meters. It can be found on all aspects though have been associated with west to primarily southeast aspects that face prevailing southwesterly winds. Snowbanks at the heads of these slopes persist into late summer, which hold considerable snow which contributes sub irrigation to downslope vegetation via meltwater to downslope positions (NPS Veg map Appendix G, global summary). The surface is dominated by rocks of various sizes with very little litter accumulation. There is fine soil that accumulates below the scree cover and the rock fragment cover on the soil surface to some degree armors and protects from the soil and reduces evaporation. Depending on position and sheltering from associated colluvial sources these sites are able to sustain varying amounts of vegetation. It has been determined that slope disturbance, mass wasting on the steep slopes and cryoturbation on level summits and ridgetops is the primary driver of structural and floristic composition of this and related scree communities (NPS Veg Map Global summary Appendix G).

Figure 1. Landscape view showing bare areas of recent debris accumulation and more stabilized areas with vegetation.

Table 2. Representative physiographic features

Landforms	(1) Mountains > Cirque headwall (2) Mountains > Colluvial apron (3) Mountains > Glacial-valley wall
Elevation	1,450–2,700 m
Slope	60–80%
Aspect	W, SE, S, SW

Climatic features

This ecological site is found in the cryic soil temperature regime and the udic soil moisture regime. Cryic soils have average annual temperature less than 8 degrees C, with less than 5 degrees C difference from winter to summer. Udic soil moisture regime denotes that the rooting zone is usually moist throughout the winter and the majority of summer.
MANY GLACIER SNOTEL:
Mean Average Precipitation 38-105 inches
Mean Average Annual Temperature 27-43 degrees
Frost free days: 70-80
TABLES BELOW ARE FROM CLIMATE STATIONS LOCATED IN VALLEYS AND MAY NOT BE REPRESENTATIVE TO THIS SITE.

Table 3. Representative climatic features

Frost-free period (characteristic range)	57-86 days
Freeze-free period (characteristic range)	111-131 days
Precipitation total (characteristic range)	533-737 mm
Frost-free period (actual range)	17-87 days
Freeze-free period (actual range)	75-132 days
Precipitation total (actual range)	508-813 mm
Frost-free period (average)	66 days
Freeze-free period (average)	116 days
Precipitation total (average)	635 mm

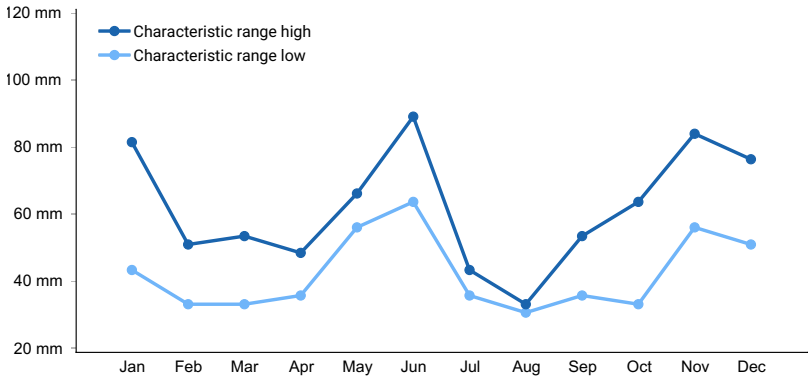


Figure 2. Monthly precipitation range

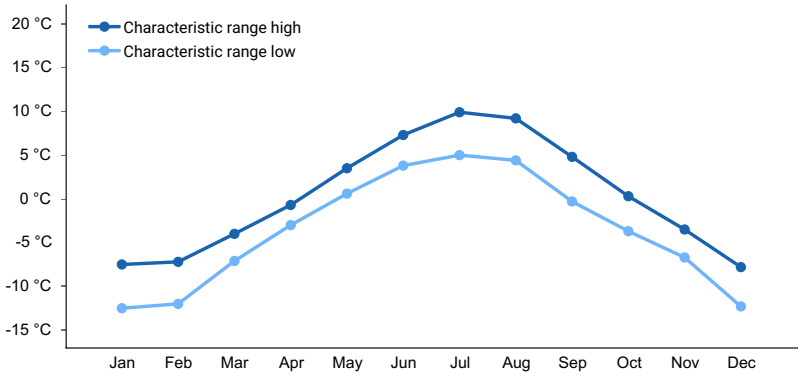


Figure 3. Monthly minimum temperature range

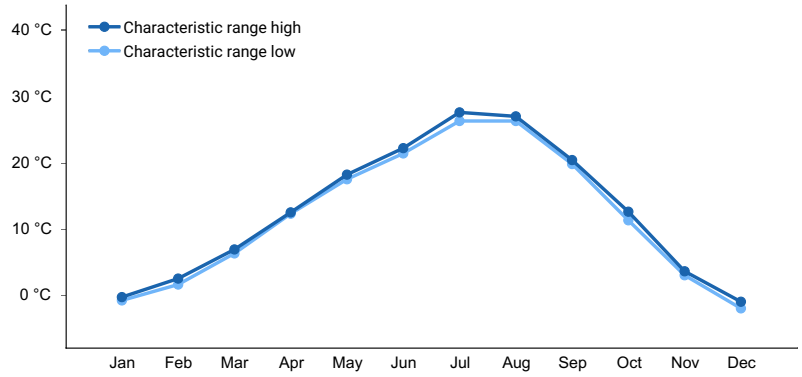


Figure 4. Monthly maximum temperature range

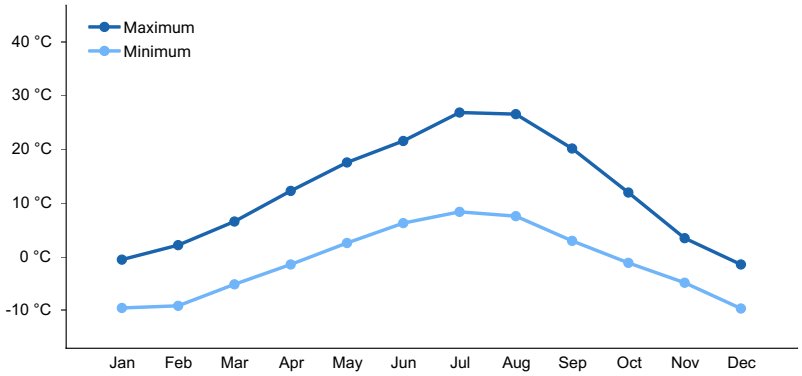


Figure 5. Monthly average minimum and maximum temperature

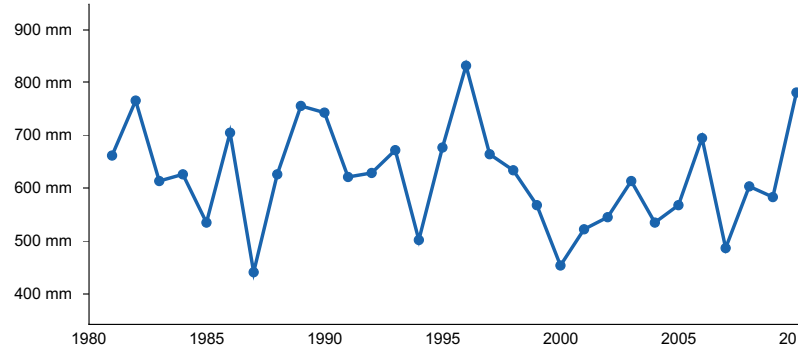


Figure 6. Annual precipitation pattern

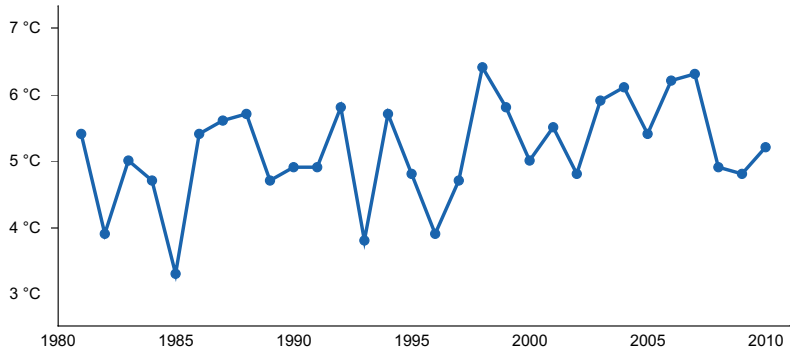


Figure 7. Annual average temperature pattern

Climate stations used

- (1) POLEBRIDGE 1 N [USC00246618], Essex, MT
- (2) POLEBRIDGE [USC00246615], Essex, MT
- (3) WEST GLACIER [USC00248809], Kalispell, MT
- (4) WHITEFISH [USC00248902], Whitefish, MT
- (5) HUNGRY HORSE DAM [USC00244328], Kalispell, MT
- (6) LINDBERGH LAKE [USC00245043], Seeley Lake, MT

Influencing water features

Soil features

This ecological site is found in the cryic soil temperature regime and the udic soil moisture regime. Cryic soils have average annual temperature less than 8 degrees C, with less than 5 degrees C difference from winter to summer. Udic soil moisture regime denotes that the rooting zone is usually moist throughout the winter and the majority of summer.

Soils associated with this ecological site are deep, well to somewhat excessively drained and have abundant rock fragments throughout. These soils are generally classified in the Entisols or Inceptisols soil orders, indicating that they have virtually no soil development because they are on active positions of the landscape or have only weakly developed soil diagnostic characteristics (Soil Survey Staff, 2015). These sites are found on active colluvial aprons and glacial valley walls where material is transported down slope by gravity and deposited where the slope angle decreases. Soil development is patchy on these active slope positions, creating a mosaic of areas where more recent depositional activity has occurred juxtaposed against areas that have remained more stable and are more vegetated. Soils on the most recent depositional areas will be Entisols and soils on more stable, vegetated positions will be Inceptisols. Diagnostic features in these soils include an ochric epipedon and cambic subsurface horizon. Soils on these sites typically lack an organic surface layer, but if one is present it is very thin with a thickness of less than 3 cm.

For more information on soil taxonomy, please follow this link:
http://http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/class/?cid=nrcs142p2_053580

Figure 8. Soils associated with this ecological site.

Figure 9. Soils associated with this ecological site.

Figure 10. Soils associated with this ecological site.

Table 4. Representative soil features

Parent material	(1) Colluvium–metasedimentary rock (2) Till–metasedimentary rock
Surface texture	(1) Very gravelly sandy loam (2) Very gravelly coarse sandy loam (3) Extremely gravelly sandy loam
Family particle size	(1) Loamy-skeletal (2) Sandy-skeletal
Drainage class	Well drained to somewhat excessively drained
Permeability class	Moderately rapid to rapid

Soil depth	102–152 cm
Surface fragment cover <=3"	45–60%
Surface fragment cover >3"	20–30%
Available water capacity (1.8-8.9cm)	Not specified
Soil reaction (1:1 water) (13.5-17.5cm)	Not specified

Ecological dynamics

Ecological Dynamics of the Site
This ecological site encompasses the extensive talus and scree slopes at high elevations near the Continental Divide. The glacially carved, steep mountain slopes along with physical and chemical weathering of the sedimentary parent materials, and downward gravitational forces, allow for the development of talus slopes. The rock debris falls down from the weathering cliffs above and create the most unstable growing conditions of any ecological site. The slopes can have varying degrees of stability and the vegetation communities are adapted to this disturbance. Disturbances include slope movement by soil creep, soil slide, sliding talus, rock avalanches and snow avalanches and bear digging. There is horizontal differentiation of the slopes defined by the different exposure to talus or scree accumulation or movement from upslope. Gaps in upslope cliff bands can create funnels of talus movement which therefore accumulate the talus into a convex shape called a talus cone. In areas protected by upslope cliff bands, there is significantly less talus accumulation and a vertical or horizontal slope shape. Therefore, the slopes have an undulating pattern (Damm 2001).

State 1
This ecological site encompasses the extensive talus and scree slopes at high elevations near the Continental Divide. Vegetation patterns on the slopes are differentiated by numerous factors including: slope stability, steepness, aspect, moisture supply, exposure to wind and snow duration. Due to the extreme mixing caused by the disturbance factors, there is little differentiation due to parent material. In general, the high elevation alpine flora has fewer species that are adapted to the harsh environmental conditions than lower elevation floras. This ecological site has even more constrained species that can thrive in the extreme conditions of this site. These species that are most adapted to this ecological site have less competitive advantage in more stable lower environments and are rarely found there. Slopes that have frequent or severe disturbances have been referred to as being permanent pioneer communities in that they do not progress successionally to more stable communities. Lusher vegetation communities may be lower down slope from late melting snow patches or other sources of water. Coarser textured substrates may lead to extreme, low species communities. Finer textured substrates may have more diversity. Moisture can be less of an issue for vegetation in general, due to the shingle-like rocks of the upper layers which effectively diminish the evaporation rates. This is evidenced by some mesophilic species within the communities. Regardless of community within State 1.0, the ground has very high cover of surface fragments, generally of all size classes. Vegetation canopy cover of the communities within State 1 have been found to range greatly from those having very little cover to higher vegetation cover averaging 80% in total of all lifeforms and strata. There are three types of adaptive strategies to the disturbance of talus or scree movement: passive migration, scree creeping and scree bankers (Damm 2001). Plants that use passive migration generally are small sized and do not send much of their root system down into the lower soil horizons. Therefore, they are not anchored firmly to the non-moving deeper parts of the talus but rather move with the active upper layers. Buttecandle (*Cryptantha celosioides*) and silverleaf phacelia (*Phacelia hastata*) are examples of this type. Another adaptive strategy is following the movement of the substrate (creeping) by growth of superficial prostrate shoots. Examples of plants include: rocky ledge penstemon (*Penstemon ellipticus*), common juniper (*Juniperus communis*) and nuttall's rockcress (Arenaria nuttalli). A third adaptive strategy is to remain stable within the talus or scree and bank or block the movement downward. Roots extend deeply into the stable lower body of the talus slope by strong, often fibrous roots. This banking or blocking of rocks can form mounds which can stabilize slopes and initiate successional seres on not too extreme talus slopes. Examples of plants include: Sandberg bluegrass, Bluebunch wheatgrass, and Yellowdot saxifrage. The most extremely disturbed sites can have only the most adapted species Arenaria nuttallii and *Stellaria americana*. The reference community describes the site modal concept of unstable scree with little to moderate vegetation development with indicator species including rocky ledge penstemon (*Penstemon ellipticus*), Buttecandle (*Cryptantha celosioides*) and silverleaf phacelia (*Phacelia hastata*). It also has a sparse layer of tall mesophytic forb species including: rocky ragwort (*Senecio megacephalus*) and yellow columbine (*Aquilegia*

flavescens). Phase 1.2 represents the community on moderately stable slopes with moderate vegetation cover that are predominantly graminoid species including Geyer's sedge (*Carex geyeri*). It is related to the following community type. Regionally, there is a defined Geyer's sedge grassland community type that occupies moderate to steep slopes on predominantly southern exposures in association with protected gully slopes near stream headwaters where streambeds are deeply incised in colluvial slopes resulting in unstable surfaces (NPS Veg Map Global Summary, Appendix G).

Talus slope vegetation have been studied in Canada as well. In the Caribou Range of British Columbia Canada, the vascular plant vegetation on limestone talus slopes was described and classified. Polster (1980) found that slope stability and aspect and moisture availability were major factors influencing vegetation pattern. They found that succession is initiated on coarse textured south facing slopes by mat forming species and on fine textured northern aspect by willow shrubs.

Community Phase 1.1
Rocky ledge penstemon-buttecandle-silverleaf phacelia-alpine leafybract aster community.
This community represents unstable talus and or scree slopes at high elevation with very steep slopes that are unstable. Disturbances to this community define this ecological site and include: slope erosion or movement due to soil creep, soil slide, sliding talus or rock avalanches, and snow avalanches. The very fact of frequent disturbances create the conditions that constrain the vegetation species able to thrive in this environment. Therefore, defining species are few in number but well adapted to the environmental conditions. On slopes with less disturbance, adventitious colonization by species can occur. Rocky ledge penstemon, silverleaf phacelia, buttecandle and alpine leafybract aster define this site. Average canopy cover of this community is 32%, though can be quite low. There is very low basal cover. Foliar cover, by the line point intercept method, is moderate at 26%. The ground cover is predominantly rock cover including moderate cover of stones (5%), boulders (average 1%), high cover of cobbles (average 31%) and very high cover of gravels (55%). There is lower cover of litter with soil underneath (3%) and this is mostly underneath plants. There is trace amounts of moss and bare soil. The vegetation structure of this community phase is one of two layers of moderate statured shrub, forb and grass species. The tallest layer averages 10-20 inches in height and can include yellow columbine (*Aquilegia flavescens*), fireweed (Chamerian angustifolia), gooseberry currant (*Ribes montigenum*) and field sagewort (*Artemisia campestris*). The lower layer is shorter than 10 inches and is very diverse in grass and forb species and can include Rainier pleated gentian (*Gentiana calycosa*), rocky ledge penstemon (*Penstemon ellipticus*), slender mountain sandwort (*Arenaria capillaris*), and silverleaf phacelia (*Phacelia hastata*). There is high species overlap with community 1.3 which indicates strong fidelity in the communities. Community 1.3 represents more stabilized slopes with some cover, although low, of shrub species notably shrubby cinquefoil (*Dasiphora fruticosa*) and rock willow (*Salix vestita*).

Summarization of canopy cover at community phase 1.1 of this ecological site, 8 NRCS sites (includes one original Damm data point that was revisited and NRCS soil and vegetation data collected). Dataset includes original Damm data in which we revisited and collected further soil and vegetation data. Species with high constancy occur often, those with low constancy are rare. The average canopy cover is the average of the values for which it occurred. Therefore, species that are rare (only occurred once) show the canopy cover value for the one time it was found. Minimum and maximum canopy cover show the range of cover that the species was found. The most frequently occurring species include Rocky ledge penstemon (PEEL5), silverleaf phacelia (PHHA), alpine leafybract aster (SYFO2), spearleaf stonecrop (SELA), shrubby cinquefoil (DAFR6) and yarrow (ACMI2). Species that occur infrequently but with high canopy cover include buttecandle (CRCE) and arrowleaf ragwort (SETR).

Summarization of total annual production in pounds per acre at the community phase 1.1 of this ecological site. Production at this site is dominated by Rocky ledge penstemon (PEEL5) and silverleaf phacelia (PHHA).

Foliar cover summary of 5 sites including average values across sites per species. Foliar cover is dominated by Rocky ledge penstemon (PEEL5) and arrowleaf ragwort (SETR).

Community Phase Pathway 1.1.A
This pathway represents time without disturbances and potentially additional water to the site leading to the community 1.2 which is moderately stable slopes with moderate vegetation cover and moister site conditions. There are two communities within community 1.2, both of which are dominated by sedges with a mix of tall mesic forbs. One is dominated by shortstalk sedge (*Carex podocarpa*), and the other by Geyer's sedge (*Carex geyeri*).

Community Phase Pathway 1.1B

This pathway represents time without disturbances and the establishment of shrub species, albeit at low covers, that define the community of 1.3.

Community Phase 1.2
Carex geyeri/Sitka valerian (CAGE2/VASI) community. This community represents more moderate slope stability in which sedge species dominate but other tall forb mesophilic species occur. There is moderate vegetation cover with total canopy cover averaging 80% for all lifeforms and layers. The most frequently occurring and highest cover specie is Geyer's sedge (CAGE2). Species with moderate frequency and canopy cover are Sitka valerian (VASI) and beargrass (XETE). Species that occur infrequently but in high canopy cover include alpine golden buckwheat (ERFL4), yellow avalanche lily (ERGR9), western showy aster (EUCO36), showy locoweed (OXSP) and rocky ledge penstemon (PEEL5). Species that also occur in community phase 1.1 include Sitka valerian (VASI), alpine golden buckwheat (ERFL4), yellow avalanche lily (ERGR9), and rocky ledge penstemon (PEEL5).
Community Phase Pathway 1.2.A
This pathway represents disturbance to community 1.2 that leads to increased instability, therefore the lowering of cover of species that stabilize the slope and a return to the community that thrives in unstable slopes of community 1.1.

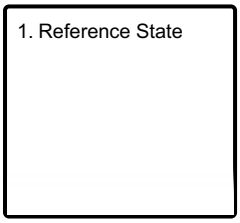
Community Phase Pathway 1.2B
This pathway represents a longer time without disturbance and a transition to a more stable slope community of 1.2 which includes establishment of shrub species, albeit at low cover.

Community Phase 1.3
Shrubby cinquefoil (*Dasiphora fruticosa*)-rock willow (*Salix vestita*)/rocky ledge penstemon (*Penstemon ellipticus*)-alpine leafybract aster (*Symphyotrichum foliaceum*).

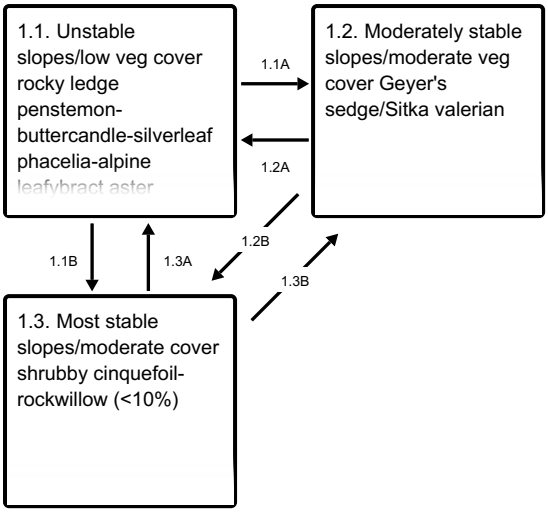
This community represents a more stabilized slope with some shrub establishment, albeit at lower cover. The other species within this community overlap quite a bit with species in community 1.1. The average canopy cover of this community is 65%. 2 sites of NRCS data collected. Snow willow (SANI8) and shrubby cinquefoil (DAFR6) occur as the defining shrub species for this community phase. Other species that occur in both sites include yarrow (ACMI2), Pacific anemone (ANMU), yellow columbine (AQFL), splitleaf Indian paintbrush (CARH4), northern bedstraw (GABO2), alpine timothy (PHAL2), spike trisetum (TRSP2) and mountain deathcamas (ZIEL2). All the species listed here for community phase 1.3 also occur in community phase 1.1, although in different proportions. Species with high constancy occur often, those with low constancy are rare. The average canopy cover is the average of the values for which it occurred. Therefore, species that are rare (only occurred once) show the canopy cover value for the one time it was found. Minimum and maximum canopy cover show the range of cover that the species was found.

State and transition model

Ecosystem states



State 1 submodel, plant communities



State 1
Reference State

This ecological site encompasses the extensive talus and scree slopes at high elevations near the Continental Divide. Vegetation patterns on the slopes are differentiated by numerous factors including: slope stability, steepness, aspect, moisture supply, exposure to wind and snow duration. Due to the extreme mixing caused by the disturbance factors, there is little differentiation due to parent material. In general, the high elevation alpine flora has fewer species that are adapted to the harsh environmental conditions than lower elevation floras. This ecological site has even more constrained species that can thrive in the extreme conditions of this site. These species that are most adapted to this ecological site have less competitive advantage in more stable lower environments and are rarely found there. Slopes that have frequent or severe disturbances have been referred to as being permanent pioneer communities in that they do not progress successionally to more stable communities. Lusher vegetation communities may be lower down slope from late melting snow patches or other sources of water. Coarser textured substrates may lead to extreme, low species communities. Finer textured substrates may have more diversity. Moisture can be less of an issue for vegetation in general, due to the shingle-like rocks of the upper layers which effectively diminish the evaporation rates. This is evidenced by some mesophilic species within the communities. Regardless of community within State 1.0, the ground has very high cover of surface fragments, generally of all size classes. Vegetation canopy cover of the communities within State 1 have been found to range greatly from those having very little cover to higher vegetation cover averaging 80% in total of all lifeforms and strata. There are three types of adaptive strategies to the disturbance of talus or scree movement: passive migration, scree creeping and scree bankers (Damm 2001). Plants that use passive migration generally are small sized and do not send much of their root system down into the lower soil horizons. Therefore, they are not anchored firmly to the non-moving deeper parts of the talus but rather move with the active upper layers. Buttecandle (*Cryptantha celosioides*) and silverleaf phacelia (*Phacelia hastata*) are examples of this type. Another adaptive strategy is following the movement of the substrate (creeping) by growth of superficial prostrate shoots. Examples of plants include: rocky ledge penstemon (*Penstemon ellipticus*), common juniper (*Juniperus communis*) and nuttall's rockcress (Arenaria nuttalli). A third adaptive strategy is to remain stable within the talus or scree and bank or block the movement downward. Roots extend deeply into the stable lower body of the talus slope by strong, often fibrous roots. This banking or blocking of rocks can form mounds which can stabilize slopes and initiate successional seres on not too extreme talus slopes. Examples of plants include: Sandberg bluegrass, Bluebunch wheatgrass, and Yellowdot saxifrage. The most extremely disturbed sites can have only the most adapted species Arenaria nuttallii and *Stellaria americana*. The reference community describes the site modal concept of unstable scree with little to moderate vegetation development with indicator species including rocky ledge penstemon (*Penstemon ellipticus*), Buttecandle (*Cryptantha celosioides*) and silverleaf phacelia (*Phacelia hastata*). It also has a sparse layer of tall mesophytic forb species including: rocky ragwort (*Senecio megacephalus*) and yellow columbine (*Aquilegia flavescens*). Phase 1.2 represents the community on moderately stable slopes with moderate vegetation cover that are predominantly graminoid species including Geyer's sedge (*Carex geyeri*). It is related to the following community type. Regionally, there is a defined Geyer's sedge grassland community type that occupies moderate to steep slopes on predominantly southern exposures in association with protected gully slopes near stream headwaters where streambeds are deeply incised in colluvial slopes resulting in unstable surfaces (NPS Veg Map Global Summary, Appendix G). Talus slope vegetation have been studied in Canada as well. In the Caribou Range

of British Columbia Canada, the vascular plant vegetation on limestone talus slopes was described and classified. Polster (1980) found that slope stability and aspect and moisture availability were major factors influencing vegetation pattern. They found that succession is initiated on coarse textured south facing slopes by mat forming species and on fine textured northern aspect by willow shrubs.

Community 1.1
Unstable slopes/low veg cover rocky ledge penstemon-buttercandle-silverleaf phacelia-alpine leafybract aster

Figure 11. Active colluvial slopes flanking cliffs and rock outcrops. This is a typical site of community phase 1.1.

Rocky ledge penstemon-buttecandle-silverleaf phacelia-alpine leafybract aster community. This community represents unstable talus and or scree slopes at high elevation with very steep slopes that are unstable. Disturbances to this community define this ecological site and include: slope erosion or movement due to soil creep, soil slide, sliding talus or rock avalanches, and snow avalanches. The very fact of frequent disturbances create the conditions that constrain the vegetation species able to thrive in this environment. Therefore, defining species are few in number but well adapted to the environmental conditions. On slopes with less disturbance, adventitious colonization by species can occur. Rocky ledge penstemon, silverleaf phacelia, buttecandle and alpine leafybract aster define this site. Average canopy cover of this community is 32%, though can be quite low. There is very low basal cover. Foliar cover, by the line point intercept method, is moderate at 26%. The ground cover is predominantly rock cover including moderate cover of stones (5%), boulders (average 1%), high cover of cobbles (average 31%) and very high cover of gravels (55%). There is lower cover of litter with soil underneath (3%) and this is mostly underneath plants. There is trace amounts of moss and bare soil. The vegetation structure of this community phase is one of two layers of moderate statured shrub, forb and grass species. The tallest layer averages 10-20 inches in height and can include yellow columbine (*Aquilegia flavescens*), fireweed (Chamerian angustifolia), gooseberry currant (*Ribes montigenum*) and field sagewort (*Artemisia campestris*). The lower layer is shorter than 10 inches and is very diverse in grass and forb species and can include Rainier pleated gentian (*Gentiana calycosa*), rocky ledge penstemon (*Penstemon ellipticus*), slender mountain sandwort (*Arenaria capillaris*), and silverleaf phacelia (*Phacelia hastata*). There is high species overlap with community 1.3 which indicates strong fidelity in the communities. Community 1.3 represents more stabilized slopes with some cover,

although low, of shrub species notably shrubby cinquefoil (*Dasiphora fruticosa*) and rock willow (*Salix vestita*).

Community 1.2
Moderately stable slopes/moderate veg cover Geyer's sedge/Sitka valerian

Figure 12. A lusher version (1.2) of this ecological site with vegetation dominated by grasses and sedges in the foreground of the photo. Notice the less stable colluvial slope directly behind with vegetation more typical of community phase 1.1.

Carex geyeri/Sitka valerian (CAGE2/VASI) community. This community represents more moderate slope stability in which sedge species dominate but other tall forb mesophilic species occur. There is moderate vegetation cover with total canopy cover averaging 80% for all lifeforms and layers. The most frequently occurring and highest cover specie is Geyer’s sedge (CAGE2). Species with moderate frequency and canopy cover are Sitka valerian (VASI) and beargrass (XETE). Species that occur infrequently but in high canopy cover include alpine golden buckwheat (ERFL4), yellow avalanche lily (ERGR9), western showy aster (EUCO36), showy locoweed (OXSP) and rocky ledge penstemon (PEEL5). Species that also occur in community phase 1.1 include Sitka valerian (VASI), alpine golden buckwheat (ERFL4), yellow avalanche lily (ERGR9), and rocky ledge penstemon (PEEL5).

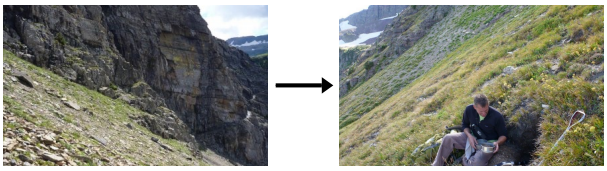
Community 1.3
Most stable slopes/moderate cover shrubby cinquefoil-rockwillow (<10%)

Figure 13. View of community phase 1.3, with more shrub cover representing a more stabilized slope.

Figure 14. View looking down a more stabilized colluvial slope with higher cover shrubs, particularly shrubby cinquefoil (community phase 1.3).

Shrubby cinquefoil (*Dasiphora fruticosa*)-rock willow (*Salix vestita*)/rocky ledge penstemon (*Penstemon ellipticus*)-alpine leafybract aster (*Symphyotrichum foliaceum*). This community represents a more stabilized slope with some shrub establishment, albeit at lower cover. The other species within this community overlap quite a bit with species in community 1.1. The average canopy cover of this community is 65%. 2 sites of NRCS data collected. Snow willow (SANI8) and shrubby cinquefoil (DAFR6) occur as the defining shrub species for this community phase. Other species that occur in both sites include yarrow (ACMI2), Pacific anemone (ANMU), yellow columbine (AQFL), splitleaf Indian paintbrush (CARH4), northern bedstraw (GABO2), alpine timothy (PHAL2), spike trisetum (TRSP2) and mountain deathcamas (ZIEL2). All the species listed here for community phase 1.3 also occur in community phase 1.1, although in different proportions. Species with high constancy occur often, those with low constancy are rare. The average canopy cover is the average of the values for which it occurred. Therefore, species that are rare (only occurred once) show the canopy cover value for the one time it was found. Minimum and maximum canopy cover show the range of cover that the species was found.

Pathway 1.1A
Community 1.1 to 1.2



Unstable slopes/low veg cover rocky ledge penstemon-buttercandle-silverleaf phacelia-alpine leafybract aster

Moderately stable slopes/moderate veg cover Geyer's sedge/Sitka valerian

This pathway represents time without disturbances and potentially additional water to the site leading to the community 1.2 which is moderately stable slopes with moderate vegetation cover and moister site conditions. There are two communities within community 1.2, both of which are dominated by sedges with a mix of tall mesic forbs. One is dominated by shortstalk sedge (*Carex podocarpa*), and the other by Geyer's sedge (*Carex geyeri*).

Pathway 1.1B
Community 1.1 to 1.3

Unstable slopes/low veg cover rocky ledge penstemon-buttercandle-silverleaf phacelia-alpine leafybract aster

Most stable slopes/moderate cover shrubby cinquefoil-rockwillow (<10%)

This pathway represents time without disturbances and the establishment of shrub species, albeit at low covers, that define the community of 1.3.

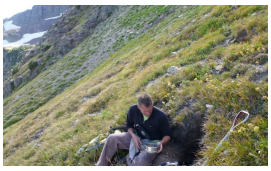
Pathway 1.2A
Community 1.2 to 1.1

Moderately stable slopes/moderate veg cover Geyer's sedge/Sitka valerian

Unstable slopes/low veg cover rocky ledge penstemon-buttercandle-silverleaf phacelia-alpine leafybract aster

This pathway represents disturbance to community 1.2 that leads to increased instability, therefore the lowering of cover of species that stabilize the slope and a return to the community that thrives in unstable slopes of community 1.1.

Pathway 1.2B
Community 1.2 to 1.3



Moderately stable slopes/moderate veg cover Geyer's sedge/Sitka valerian

Most stable slopes/moderate cover shrubby cinquefoil-rockwillow (<10%)

This pathway represents a longer time without disturbance and a transition to a more stable slope community of 1.2 which includes establishment of shrub species, albeit at low cover.

Pathway 1.3A
Community 1.3 to 1.1

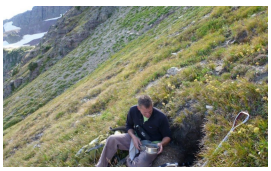
Most stable slopes/moderate cover shrubby cinquefoil-rockwillow (<10%)

Unstable slopes/low veg cover rocky ledge penstemon-buttercandle-silverleaf phacelia-alpine leafybract aster

High disturbance

Pathway 1.3B
Community 1.3 to 1.2

Most stable slopes/moderate cover shrubby cinquefoil-rockwillow (<10%)



Moderately stable slopes/moderate veg cover Geyer's sedge/Sitka valerian

Moderate disturbance

Additional community tables

Table 5. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
spiked woodrush	LUSP4	*Luzula spicata*	–	–	5
bluegrass	POA	*Poa*	–	–	5
alpine bluegrass	POAL2	*Poa alpina*	–	–	1–5
alpine fescue	FEBR	*Festuca brachyphylla*	–	–	3
blue wildrye	ELGL	*Elymus glaucus*	–	–	1–2
alpine timothy	PHAL2	*Phleum alpinum*	–	–	0.5–2
cloud sedge	CAHA6	*Carex haydeniana*	–	–	2
shortstalk sedge	CAPO	*Carex podocarpa*	–	–	1
slender wheatgrass	ELTR7	*Elymus trachycaulus*	–	–	0.5
northern singlespike sedge	CASC10	*Carex scirpoidea*	–	–	0.5
Forb/Herb					
arrowleaf ragwort	SETR	*Senecio triangularis*	–	–	25
rocky ledge penstemon	PEEL5	*Penstemon ellipticus*	–	–	0.5–25
buttecandle	CRCE	*Cryptantha celosioides*	–	–	15
heartleaf arnica	ARCO9	*Arnica cordifolia*	–	–	2–10
Rainier pleated gentian	GECA	*Gentiana calycosa*	–	–	0.5–7
gentian	GENTI	*Gentiana*	–	–	7
silverleaf phacelia	PHHA	*Phacelia hastata*	–	–	1–7
silky phacelia	PHSE	*Phacelia sericea*	–	–	0.5–5
Rocky Mountain groundsel	PAST10	*Packera streptanthifolia*	–	–	5
Scouler's St. Johnswort	HYSCS2	*Hypericum scouleri ssp. scouleri*	–	–	2–5
creeping sibbaldia	SIPR	*Sibbaldia procumbens*	–	–	5
Eschscholtz's buttercup	RAES	*Ranunculus eschscholtzii*	–	–	0.5–5
common yarrow	ACMI2	*Achillea millefolium*	–	–	2–5
Pacific anemone	ANMU	*Anemone multifida*	–	–	0.5–5
alpine leafybract aster	SYFO2	*Symphyotrichum foliaceum*	–	–	0.5–5
spike trisetum	TRSP2	*Trisetum spicatum*	–	–	1–5
rayless arnica	ARDI7	*Arnica ×diversifolia*	–	–	5
Drummond's rockcress	ARDR	*Arabis drummondii*	–	–	5
Canada goldenrod	SOCA6	*Solidago canadensis*	–	–	4
white sweetvetch	HESU	*Hedysarum sulphurescens*	–	–	1–3
alpine smelowskia	SMCA	*Smelowskia calycina*	–	–	3
Parry's silene	SIPA4	*Silene parryi*	–	–	3
cinquefoil	POTEN	*Potentilla*	–	–	0.5–3
cutleaf anemone	PUPAM	*Pulsatilla patens ssp. multifida*	–	–	3
splitleaf Indian paintbrush	CARH4	*Castilleja rhexiifolia*	–	–	3
pussytoes	ANTEN	*Antennaria*	–	–	1–3
fireweed	CHAN9	*Chamerion angustifolium*	–	–	1–3
Virginia strawberry	FRVI	*Fragaria virginiana*	–	–	3

twinflower sandwort	MIOB2	*Minuartia obtusiloba*	–	–	3
bracted lousewort	PEBR	*Pedicularis bracteosa*	–	–	3
roundleaf alumroot	HECY2	*Heuchera cylindrica*	–	–	3
sulphur-flower buckwheat	ERUM	*Eriogonum umbellatum*	–	–	3
lanceleaf springbeauty	CLLA2	*Claytonia lanceolata*	–	–	3
alpine golden buckwheat	ERFL4	*Eriogonum flavum*	–	–	3
Lyall's rockcress	ARLY	*Arabis lyallii*	–	–	1–3
arnica	ARNIC	*Arnica*	–	–	3
rockcress	ARABI2	*Arabis*	–	–	3
American thorow wax	BUAM2	*Bupleurum americanum*	–	–	3
slender mountain sandwort	ARCA7	*Arenaria capillaris*	–	–	2
Rydberg's arnica	ARRY	*Arnica rydbergii*	–	–	2
subalpine fleabane	ERPE3	*Erigeron peregrinus*	–	–	2
phacelia	PHACE	*Phacelia*	–	–	1–2
northern bedstraw	GABO2	*Galium boreale*	–	–	2
yellow columbine	AQFL	*Aquilegia flavescens*	–	–	0.5–2
Sitka valerian	VASI	*Valeriana sitchensis*	–	–	1–2
mountain deathcamas	ZIEL2	*Zigadenus elegans*	–	–	2
varileaf cinquefoil	PODI2	*Potentilla diversifolia*	–	–	0.5–2
sticky cinquefoil	POGL9	*Potentilla glandulosa*	–	–	2
bluebell bellflower	CARO2	*Campanula rotundifolia*	–	–	1
pale agoseris	AGGL	*Agoseris glauca*	–	–	1
dwarf fireweed	CHLA13	*Chamerion latifolium*	–	–	0.5–1
dwarf arctic ragwort	PACY8	*Packera cymbalaria*	–	–	1
fringed grass of Parnassus	PAFI3	*Parnassia fimbriata*	–	–	1
strawberry	FRAGA	*Fragaria*	–	–	1
white thistle	CIHO	*Cirsium hookerianum*	–	–	0.5–1
sagebrush	ARTEM	*Artemisia*	–	–	1
aster	ASTER	*Aster*	–	–	1
Michaux's wormwood	ARMI4	*Artemisia michauxiana*	–	–	1
yellow avalanche-lily	ERGR9	*Erythronium grandiflorum*	–	–	0.5
sweetvetch	HEDYS	*Hedysarum*	–	–	0.5
helianthella	HELIA	*Helianthella*	–	–	0.5
wild chives	ALSC	*Allium schoenoprasum*	–	–	0.5
alpine pussytoes	ANAL4	*Antennaria alpina*	–	–	0.5
hollyfern	POLYS	*Polystichum*	–	–	0.5
saxifrage	SAXIF	*Saxifraga*	–	–	0.5
spearleaf stonecrop	SELA	*Sedum lanceolatum*	–	–	0.5
Fern/fern ally					
Aleutian maidenhair	ADAL	*Adiantum aleuticum*	–	–	0.5
Shrub/Subshrub					
shrubby cinquefoil	DAFR6	*Dasiphora fruticosa*	–	–	0.5–3
creeping juniper	JUHO2	*Juniperus horizontalis*	–	–	2
Canadian gooseberry	RIOX	*Ribes oxyacanthoides*	–	–	1

Canadian gooseberry	RIOX	*Ribes oxyacanthoides*	–	–	1

Table 6. Community 1.2 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
Geyer's sedge	CAGE2	*Carex geyeri*	–	–	3–37.5
sedge	CAREX	*Carex*	–	–	15
rough fescue	FECA4	*Festuca campestris*	–	–	3
Idaho fescue	FEID	*Festuca idahoensis*	–	–	3
prairie Junegrass	KOMA	*Koeleria macrantha*	–	–	3
Hitchcock's smooth woodrush	LUGLH	*Luzula glabrata var. hitchcockii*	–	–	3
bluegrass	POA	*Poa*	–	–	3
Drummond's rush	JUDR	*Juncus drummondii*	–	–	0.5
Forb/Herb					
Sitka valerian	VASI	*Valeriana sitchensis*	–	–	0.5–15
common beargrass	XETE	*Xerophyllum tenax*	–	–	0.5–15
showy locoweed	OXSP	*Oxytropis splendens*	–	–	15
rocky ledge penstemon	PEEL5	*Penstemon ellipticus*	–	–	15
alpine golden buckwheat	ERFL4	*Eriogonum flavum*	–	–	15
yellow avalanche-lily	ERGR9	*Erythronium grandiflorum*	–	–	15
western showy aster	EUCO36	*Eurybia conspicua*	–	–	15
subalpine fleabane	ERPE3	*Erigeron peregrinus*	–	–	3
woodland strawberry	FRVE	*Fragaria vesca*	–	–	3
Virginia strawberry	FRVI	*Fragaria virginiana*	–	–	3
northern bedstraw	GABO2	*Galium boreale*	–	–	3
narrowleaf hawkweed	HIUM	*Hieracium umbellatum*	–	–	3
Scouler's St. Johnswort	HYSCS2	*Hypericum scouleri ssp. scouleri*	–	–	0.5–3
Indian paintbrush	CASTI2	*Castilleja*	–	–	3
fireweed	CHAN9	*Chamerion angustifolium*	–	–	0.5–3
common yarrow	ACMI2	*Achillea millefolium*	–	–	3
slender mountain sandwort	ARCA7	*Arenaria capillaris*	–	–	3
arnica	ARNIC	*Arnica*	–	–	3
cinquefoil	POTEN	*Potentilla*	–	–	3
alpine leafybract aster	SYFO2	*Symphyotrichum foliaceum*	–	–	0.5
alpine phacelia	PHLY2	*Phacelia lyallii*	–	–	0.5
pale agoseris	AGGL	*Agoseris glauca*	–	–	0.5
white thistle	CIHO	*Cirsium hookerianum*	–	–	0.5
Shrub/Subshrub					
shrubby cinquefoil	DAFR6	*Dasiphora fruticosa*	–	–	0.5
thinleaf huckleberry	VAME	*Vaccinium membranaceum*	–	–	0.5
Tree					
subalpine fir	ABLA	*Abies lasiocarpa*	–	–	0.5–3
Engelmann spruce	PIEN	*Picea engelmannii*	–	–	0.5
Nonvascular					
Moss	2MOSS	*Moss*	–	–	0.5

Table 7. Community 1.3 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
sedge	CAREX	*Carex*	–	–	3
alpine fescue	FEBR	*Festuca brachyphylla*	–	–	3
Sandberg bluegrass	POSE	*Poa secunda*	–	–	3
alpine timothy	PHAL2	*Phleum alpinum*	–	–	1–2
blue wildrye	ELGL	*Elymus glaucus*	–	–	2
Forb/Herb					
common yarrow	ACMI2	*Achillea millefolium*	–	–	1–5
mountain deathcamas	ZIEL2	*Zigadenus elegans*	–	–	0.5–5
Canada goldenrod	SOCA6	*Solidago canadensis*	–	–	3
alpine leafybract aster	SYFO2	*Symphyotrichum foliaceum*	–	–	3
rocky ledge penstemon	PEEL5	*Penstemon ellipticus*	–	–	3
Pacific anemone	ANMU	*Anemone multifida*	–	–	1–3
Bourgov's milkvetch	ASBO3	*Astragalus bourgovii*	–	–	3
northern bedstraw	GABO2	*Galium boreale*	–	–	1–3
common cowparsnip	HEMA80	*Heracleum maximum*	–	–	3
Rydberg's arnica	ARRY	*Arnica rydbergii*	–	–	2
cushion buckwheat	EROV	*Eriogonum ovalifolium*	–	–	2
pussytoes	ANTEN	*Antennaria*	–	–	2
yellow columbine	AQFL	*Aquilegia flavescens*	–	–	1–2
twinflower sandwort	MIOB2	*Minuartia obtusiloba*	–	–	2
roundleaf alumroot	HECY2	*Heuchera cylindrica*	–	–	2
bracted lousewort	PEBR	*Pedicularis bracteosa*	–	–	2
spike trisetum	TRSP2	*Trisetum spicatum*	–	–	1–2
arrowleaf ragwort	SETR	*Senecio triangularis*	–	–	2
Parry's silene	SIPA4	*Silene parryi*	–	–	2
rocky ragwort	SEME	*Senecio megacephalus*	–	–	1
valerian	VALER	*Valeriana*	–	–	1
Rocky Mountain goldenrod	SOMU	*Solidago multiradiata*	–	–	1
Asian forget-me-not	MYAS2	*Myosotis asiatica*	–	–	1
common twinpod	PHDI6	*Physaria didymocarpa*	–	–	1
varileaf cinquefoil	PODI2	*Potentilla diversifolia*	–	–	1
nodding onion	ALCE2	*Allium cernuum*	–	–	1
splitleaf Indian paintbrush	CARH4	*Castilleja rhexiifolia*	–	–	1
Lyall's angelica	ANAR3	*Angelica arguta*	–	–	1
slender mountain sandwort	ARCA7	*Arenaria capillaris*	–	–	1
alpine golden buckwheat	ERFL4	*Eriogonum flavum*	–	–	1
buckwheat	ERIOG	*Eriogonum*	–	–	1
fireweed	CHAN9	*Chamerion angustifolium*	–	–	1
dwarf fireweed	CHLA13	*Chamerion latifolium*	–	–	1
western blue virginsbower	CLOC2	*Clematis occidentalis*	–	–	1
white sweetvetch	HESU	*Hedysarum sulphurescens*			1

white sweetvetch	HESU	*Hedysarum sulphurescens*	–	–	1
prairie flax	LILEL2	*Linum lewisii var. lewisii*	–	–	1
seep monkeyflower	MIGU	*Mimulus guttatus*	–	–	1
purple monkeyflower	MILE2	*Mimulus lewisii*	–	–	1
Rainier pleated gentian	GECA	*Gentiana calycosa*	–	–	1
gentian	GENTI	*Gentiana*	–	–	1
bluebell bellflower	CARO2	*Campanula rotundifolia*	–	–	0.5
milkvetch	ASTRA	*Astragalus*	–	–	0.5
onion	ALLIU	*Allium*	–	–	0.5
rockcress	ARABI2	*Arabis*	–	–	0.5
ledge stonecrop	RHINI	*Rhodiola integrifolia ssp. integrifolia*	–	–	0.5
spearleaf stonecrop	SELA	*Sedum lanceolatum*	–	–	0.5
Fern/fern ally					
Aleutian maidenhair	ADAL	*Adiantum aleuticum*	–	–	0.5
Shrub/Subshrub					
rock willow	SAVE	*Salix vestita*	–	–	10
shrubby cinquefoil	DAFR6	*Dasiphora fruticosa*	–	–	7
willow	SALIX	*Salix*	–	–	5
Canadian gooseberry	RIOX	*Ribes oxyacanthoides*	–	–	3
Woods' rose	ROWO	*Rosa woodsii*	–	–	3
prickly currant	RILA	*Ribes lacustre*	–	–	1
creeping juniper	JUHO2	*Juniperus horizontalis*	–	–	1
Michaux's wormwood	ARMI4	*Artemisia michauxiana*	–	–	1
Tree					
subalpine fir	ABLA	*Abies lasiocarpa*	–	–	1
whitebark pine	PIAL	*Pinus albicaulis*	–	–	1
Engelmann spruce	PIEN	*Picea engelmannii*	–	–	1

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Approval

Kirt Walstad, 9/08/2023

Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	12/18/2020
Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

2. **Presence of water flow patterns:**

3. **Number and height of erosional pedestals or terracettes:**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

5. **Number of gullies and erosion associated with gullies:**

6. **Extent of wind scoured, blowouts and/or depositional areas:**

7. **Amount of litter movement (describe size and distance expected to travel):**

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial**

distribution on infiltration and runoff:

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

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12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant:

    Sub-dominant:

    Other:

    Additional:

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**

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14. **Average percent litter cover (%) and depth (in):**

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**

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16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**

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17. **Perennial plant reproductive capability:**
